CCICED Annual Policy Report 2007

(English Edition)

Innovation for an Environmentally Friendly Society

China Council for International Cooperation
on Environment and Development

Editorial Board

Preface

The China Council for International Cooperation on Environment and Development (CCICED) was established with the approval of the Chinese government in 1992. CCICED is a high-level advisory body consisting of senior Chinese and international officials and authoritative experts. Its mandate is to conduct research on major issues in the field of environment and development in China, to put forth policy recommendations to the Government of China on promoting sustainable development and scientific decision-making processes in China, and to contribute to decision making on China's environment and development. CCICED reports to the State Council and is chaired by China's Vice-Premier. Each year the Council meets with a Senior Leader to discuss its recommendations.

Over the past 16 years, CCICED has witnessed significant changes and striking progress in China in the policy field of environment and development. This time span covers the period from the Rio UN Conference on Environment and Development to the Johannesburg World Summit on Sustainable Development, and now to an era where complex environmental challenges such as climate change are mainstream economic and political concerns throughout the world. CCICED continues to be a unique body, highly relevant to China's domestic needs and for building a better international understanding of China's contributions to global environment and development.

With the continuous support of the Chinese government, the governments of other countries and international agencies, CCICED has completed three phases. Phase I (1992-1996) mainly carried out policy studies and research on key issues in the field of environment and development, and disseminated and exchanged international experiences and successful policies. Phase II (1997-2001) shifted the focus from policy research to policy and project demonstrations. Phase III (2002-2006) was established with broader priorities. Based on the successful experience of Phases I, II, and III, Phase IV (2007-2011) was approved by the Government of China, with support by more donors. Now, China has entered into a new era, and CCICED will play a big role in promoting China's Strategic Transformation on Environment and Development.

2007 was a historic year for China's environmental protection. While seeing high-speed economic growth, China took great strides in its progress on environmental protection. The 17th Congress of the Chinese Communist Party paid much more attention to the environment and discussed taking greater efforts towards a better and healthier environment by building a Conservation Culture on the part of the Chinese people. In practice during this past year, China has adopted a series of market-based instruments such as green loans from

banks, and ecological compensation schemes for those who protect the ecological integrity of watersheds and other ecosystem benefits. As a result of the serious control efforts under the 11th Five Year Plan, emissions of the most concerning water and air pollutants, COD (chemical oxygen demand) and SO_2, have started to decrease. China also set out its first National Climate Change Program. Undoubtedly, 2007 ushered in a new epoch of environment and development for China with new opportunities and challenges.

2007 was also a milestone for CCICED. For a decade and a half, CCICED has assembled teams of Chinese and international scientists, economists, engineers, lawyers, policy analysts, and scholars to study and prepare recommendations to the Chinese government on reconciling environment and development. With many achievements behind and great challenges ahead, CCICED launched its fourth phase with more responsibilities. In order to build an organization with greater influence, many reforms are proposed for future years. One is to strengthen public dissemination of policy study outputs. In 2006, CCICED publicized its first Chinese language Annual Policy Report based on study outputs and recommendations from its task forces. High praise for this Chinese version encouraged us to create this current pilot English version, *Annual Policy Report 2007*. It is based on studies and recommendations reported at the Council's November 2007 Annual General Meeting.

The theme of this meeting was "Innovation for an Environmentally Friendly Society." The book includes the research outputs of CCICED from the past year, and covered all major topics and recommendations discussed at the meeting. While the study team reports are the main basis for discussions, they represent views of the individual teams, and necessarily those of the Council. The Recommendations chapter contained in this Policy Report reflects the consensus views of the CCICED members, and is the document forwarded to the State Council and other governmental bodies from the meeting.

The overall set of materials in this book offers many options for China to consider as it continues to strengthen its governance of environment and development. We wish to share this knowledge within and outside of China so that people may better understand China's environment and development situation and its contributions to solving problems of a serious nature domestically and internationally.

We extend our acknowledgements to those who support CCICED's work and China's environmental undertakings. We appreciate the financial support from generous countries and the concerned people doing the research, the International Support Office at Simon Fraser University in Vancouver, the Chinese and International Chief Advisors and their Group, who help to guide the work, and the members of Council who volunteer their time and expertise in support of this undertaking.

The Secretariat of CCICED
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Chapter Ⅰ

CCICED Policy Recommendations to Decision Makers*

1.1 Overview

In light of the innovative strategic ideas and policies on environment and development put forward at the recent 17th National Congress of the Communist Party of China (CPC); the "Three Transformations" set out in 2006; and efforts during the first two years of the 11th Five Year Plan, CCICED believes China is now entering a period of strategic transformation for environment and development.

This transformation towards a resource conserving and environmentally friendly society will be a long-term undertaking with a clear need to meet important milestones such as the environmental targets in the 11th Five Year Plan. The Council believes it will be extremely difficult to achieve these targets with the current framework for environmental management, levels of investment, and pollution-intensive mode of economic growth. The higher-than-expected rate of economic growth, fuelled by a range of incentives at the local level, intensifies these pressures. Reconciling China's environment and development policies is likely to be even more difficult during the 12th and 13th Five Year Plans, since the problems will become even more complex and will include a growing ecological deficit.

Also, while China is focusing its main efforts on primary environmental problems caused by industrial and municipal pollution, a range of secondary, often non-point source pollution problems, mostly from the use of various chemicals, is threatening its environmental security and public health. The Chinese government has begun to pay great attention to the problem. The members of CCICED also have expressed deep concerns about how to address these problems. They involve a wide range of pollutants, including those produced by the burgeoning chemical industry sector.

It is against the backdrop of globalization that China's industrial and urban revolution is taking place; this includes the building of a knowledge-based society and a socialist market economy. China's environment and development process has become integrated with that of the world. While China is faced with new environmental challenges brought about by globalization, it is also creating an impact on global and regional environments. China's ecological footprint, a measure of human demand on

* This chapter is based on CCICED Policy Recommendation to the Chinese government adopted by the Annual General Meeting of CCICED held in Beijing from Nov. 28-30, 2007.

the planet's biologically productive land and water, is still low by comparison to many other nations, if measured on a *per capita* basis. However, it is growing and should become a matter of concern in policy decisions that affect international trade, climate change and other international cooperation. The future of China's environmental quality hinges on tackling these issues and others through changes that involve fundamental reforms and mechanisms for involvement of the whole society in their outcome. This is the key message arising from successful transformative approaches to environment and development in other countries such as Germany and South Korea. Incremental change is not enough.

China's commitment to becoming an innovative society is an essential step in the right direction. Innovation is the opportunity side for environment and sustainable development. The key to its success lies in taking a comprehensive innovation approach to institutional change, policies and technologies.

Supported by various task forces and other research efforts,[1] the 2007 CCICED AGM has focused on policy innovations, particularly on the following two aspects: 1) innovation of strategic thinking, including the transformation of environment and development strategies, as well as the challenges brought by globalization; and 2) innovation of specific policies and mechanisms, particularly on emissions reduction for the 11th Five Year Plan and beyond, and for chemicals management.

This examination of "Innovation for an Environmentally Friendly Society" is intended to set the stage for future work of CCICED, including task forces on Innovation for Sustainable Development, Environment and Health, and Energy and Environment. It marks a shift in CCICED's attention towards collaborative work to identify early warning of key problems, and towards creative solutions that will rely much more on technology and policy innovation worked out in China. The business sector, long recognized as both the origin and centre of innovation, will play a key role in developing and implementing solutions for an environmentally friendly society. Business engagement is key since business makes the operational decisions that most affect environmental outcomes. However, enterprises cannot do so if they are unclear about their obligations, and these need to be clearly defined and legally enforceable.

1.2 Recommendations

The following major recommendations to the Government of China are based on the deliberations and agreement at the CCICED AGM. In addition, more detailed recommendations from the individual CCICED task forces and special study reports will be forwarded for consideration.

1 The studies reported at the 2007 AGM included: *CCICED Task Force on Policy Mechanisms Towards Successful Achievement of the 11th Five Year Plan Environmental Targets, CCICED Special Policy Study on Strategic Transformation of Environment and Development in China, CCICED Special Policy Study on Environmentally Sound and Strategic Management of Chemicals in China, and interim reports from the CCICED Task Force on Innovation for China's Environmental-friendly Society, and from a CCICED-WWF preliminary analysis of China's Ecological Footprint*

1.2.1 Strengthen and add new policies and mechanisms to achieve emission reduction targets

Achieving the 11th Five Year Plan emissions reduction targets is a major challenge for the Chinese government. Despite the significant efforts to date, the challenge is made more difficult by the pace and composition of economic growth. The emission reduction objective was calculated on the basis of the emission volume at the end of the 10th Five Year Plan period. But the Chinese economy is growing much faster than the original estimate of 7.5%. This fast growth rate, and the even faster growth of high energy-consuming, high pollution-emitting industries, will result in a need for a much higher level of emissions reduction than predicted. Structural changes in the economy are essential, as well as policies that provide incentives for process change rather than end of pipe solutions, but this may not occur quickly enough for 2010 targets to be reached. Very demanding targets for pollution reduction will be needed for the foreseeable future, at least to 2020.

The program for achieving the target of reducing SO_2 emissions by 10% compared to the 2005 baseline is heavily dependent on installing FDG (Flue Gas Desulphurisation) equipment in coal-burning electricity stations. This strategy is impeded by the poor performance of FDG equipment and operation, and higher than expected levels of sulphur in coal. Cost effective approaches such as coal washing have not been given sufficient attention. These concerns need to be addressed urgently. Achieving the target of reducing energy intensity (energy consumption per unit of GDP) is a necessary but not sufficient condition for achieving the SOx target. Further efforts will be needed to reduce SOx emissions from the non-power sector.

COD (chemical oxygen demand in water) is an even more difficult problem. It is doubtful that the very ambitious program for constructing urban sewage treatment pipes can be completed as planned. More attention should be paid to sludge treatment and to discharges from the industrial sector and non-point sources. The pricing and financing policies applied in this sector need to be re-examined.

There are serious problems in terms of quality control and performance. Monitoring is inadequate, and is impeded by three sets of data EPBs (Environmental Protection Bureaus) work with that are not compatible. Local EPBs often lack the authority and means to fulfill their responsibilities, and some local governments undermine their efforts. In short, management and institutional weaknesses are holding back progress. Inadequate financial investment is also a major constraint in reducing pollutant emissions. Using international definitions such as those of OECD and Eurostat, environmental expenditures amount to about 0.6% of GDP, about half of the official estimates, and low for countries at this stage of development.

End-of-pipe pollution control approach is necessary but not sufficient to deal with the growing volume of pollution in China. What is needed is an effective total emissions control (TEC) approach that controls both the volume and concentration of pollu-

tion. More emphasis should be put on cost-effective approaches such as washing coal, structural adjustment in the energy and industrial sectors, and removing incentives such as favourable financial conditions that foster excessive investment in polluting industries like coke and steel. Greater use of market instruments is needed to provide continuous incentives to find cost-effective approaches to pollution prevention and control, including innovation. This can include cap and trade market-based systems. Energy conservation and new processes that eliminate pollution production can help. Other economic instruments and strict enforcement of regulations are needed so that it is no longer cheaper to pollute than to clean up.

It is vital that environmental management systems within government be made much more functional, with clearly understood responsibilities and accountability at each level. The performance assessment of local political leaders should place greater emphasis on their environmental performance. Failure to do so results in economic considerations overriding environmental policy objectives.

Therefore, we recommend:

1) Adopting a new "Five Shifts" approach and examining how it could be implemented not only in the 11th, but also the 12th and 13th Five Year Plans: (1) Move to a focus on reducing total emissions and specific improvements in environmental quality; (2) Move from an over-reliance on reducing pollution from selected industries to reducing pollution from all industries; (3) Move from total control of single pollutants to the coordinated control of many pollutants; (4) Move from increasing the number of pollution reduction projects to increasing their quality; and (5) Move from reliance on administrative mechanisms to greater use of market-based instruments.

2) Under the leadership of the State Council, establishing a technological analysis platform for economy-energy-pollutant emission reduction and a joint policy making system between the relevant government departments to carry out dynamic tracking, early warning and response in regard to pollutant emission reduction; and with a strategic focus on understanding the benefits and costs of changing the economic development mode.

3) Constructing a total emission reduction system composed of reduction of resource-energy inputs, much greater efficiency improvement in production processes, and end-treatment of pollutant emissions.

4) Reforming the performance assessment system for local government officials to take account of their responsibility for achieving environmental targets and related policy objectives; creating a simple evaluation system for government officials based on a locally appropriate energy and emission reduction index, as well as the degree of compliance by enterprises with current environmental laws and regulations in their jurisdiction.

5) Improving the technical support capacity of both the central and local governments, including the development of a more integrated environmental information sys-

tem, a scientific indicator system of pollutant emission reduction, an accurate emission reduction surveillance system, and a rigid emission reduction examination and evaluation system.

6) Improving the operability of COD reduction programs focusing on the key polluting industries and non-point source pollution, especially from agricultural sources; increase funding and implement faster construction of urban sewage pipes networks and sewage treatment infrastructure. Optimize SO_2 reduction programs through integrated programs that broaden the focus from scrubbers and other stack controls including quality of coal, and the proportion being washed, more effective supervision of the quality of FDG equipment, and developing a program to reduce pollution from coal-fired boilers in the non-power sector.

7) Beginning now to study trends in pollutant emissions, and how they could be reduced most cost-effectively in the 12th Five Year Plan period, paying attention to all the points mentioned above, but emphasizing greater use of public-private sector approaches to necessary investments; establishing long-term emission reduction mechanisms using market-based instruments including environmental taxes; resource pricing; emissions trading; the establishment of appropriate environmental finance mechanisms; and continuing efforts to build a high-performing administration and management system, particularly at the local level, with necessary upgrading of laws and regulations.

1.2.2 Integrate chemical management strategy into China's overall national environmental and health management systems

Currently, China is producing and marketing approximately 47,000 kinds of chemical products, with about 100 new chemicals in line for registration annually. In the course of production, storage, selling, transportation, utilization and waste disposal, chemicals can have vital impacts on human health and environmental security owing to misuses, abuses, emergencies, and maltreatment of wastes. Many hazardous chemicals that are widely controlled internationally are still produced and used without restriction in China. In addition, accidents involving hazardous chemicals happen frequently. The international community is vigorously promoting SAICM – Strategic Approach to International Chemicals Management, with a proposed target of 2020 for production and use of chemicals in ways that minimize environmental and human health harm.

The rapid development of China's chemical industry sector makes formulation of a robust chemical management system an urgent matter. China's existing chemical administration is mainly limited to the professional safety administration of the flammable, explosive, and acute toxicity chemicals. The methods of chemical environmental administration are limited to end treatment of toxic chemical pollutants and the registration of toxic chemicals upon importation and exportation. The currently used classification system for hazardous chemicals in China does not fully reflect various

potential environmental and health hazards and risks of chemicals. China is yet to exert systematic and institutional environmental administration on the chemicals that have potential and long-term harms on human health and environment.

Therefore, we recommend:

1) Establishing China's Environmentally Sound and Strategic Management of Chemicals System, with environment protection departments as the major responsible institution, coordinated with other relevant departments; and strengthening capacity building to carry out effective testing, evaluation, monitoring and management of chemicals from an environmental perspective.

2) Formulating China's chemical environmental administration strategy, with "prevention as the key measure, combining prevention and rectification of problems, strengthening surveillance, and regulation" as the guidelines. A long-term action plan for risk assessment should be developed. Chemicals with high risks to health and environment should be given earliest attention for possible replacement, and their manufacture and management should follow clean production and green chemistry concepts. The strategy should be WTO compliant.

3) Formulating a special law or administrative regulations on chemical environment administration. This should establish a basic institutional system on chemical environmental administration, including classification and labeling, notification of new chemical substances (currently established only by a ministerial rule), risk assessment and management of new and existing substances, national criteria for prioritization of chemicals of very high concern, appropriate environmental monitoring systems, a right-to-know system for release of toxic chemicals, and environmental accident prevention and emergency response systems coordinated with existing mechanisms.

4) Establishing a system of release recording on toxic pollutants and a publication system for toxic chemical pollutants so that the Chinese public is informed and can participate in the government decision making on chemicals management.

5) Promoting and supporting voluntary measures on the part of chemical enterprises, including Responsible Care and product stewardship initiatives that have been successful in other countries or internationally, and clarify the legal status of voluntary agreements between government and industry and actions taken under China's "Cleaner Production Promotion Law."

1.2.3 Seize the opportunity provided by China's strategic transformation of its environment and development mode

CCICED notes there has been substantial progress since 2003 towards creating a coherent approach to environment and development policies. It is encouraging for the future, despite the magnitude of challenges today. China is setting in place necessary conditions to optimize the potential of future innovations for sustainable development. The current transformation of environment

and development strategy in China is a necessary step for China's social advancement. According to international experience, China should strive for strategic transformation of its environment and development path for the coming 15-20 years, leading to significant improvement of its ecological environment as well as its economic development. The 17th National Congress of the CPC marked a turning point for China's new strategic system to guide sustainable social-economic development—using Scientific Development Theory as an overarching framework for building a harmonious socialist society.

Signals for a strategic transformation of Chinese government policy relevant to environment include: a new industrialization pathway with five criteria, as well as a peaceful development path internationally; and elevating environment protection to the level of a "Conservation Culture," where the objective is building a resource conserving and environmentally friendly society. The guiding idea has shifted from "rapid and sound development" to "sound and rapid development." China is demonstrating its immediate commitment through the difficult pollutant emission reduction objectives in the 11th Five Year Plan.

Other countries such as Germany and Japan have found four key factors in their period of transformative change for environmental improvement. One is public participation and involvement of the whole society in decisions on environment and development. Second is that in most cases it is problems of environment and health that have galvanized action, whether it be Minamata Disease caused by mercury pollution in Japan, or by the effects of smog in Los Angeles. Third is the need for a progression of changes, some immediate and others longer term, towards fundamental technological and institutional changes over periods generally of 5 to 10 years. Fourth is the need to take into account international aspects of the transformation as well, including impacts of the transformation on other nations. The results include substantial new economic opportunities and positive influences on environmental standard setting and practices influencing all sectors in society.

CCICED believes China is now in the most significant period for strategic transformation when it will be possible to accelerate the turnaround in the relationship between environment and development. To take full advantage of this key period, the Chinese government must solve three outstanding problems. First, the strategic transformation is taking a top-down approach and lacks the full involvement and support from all stakeholders and levels of government. Second, detailed and effective policies, capacities and action plans are still missing to carry out the strategies and principles set up by the central government. And third, it is essential to continue searching for better value from existing levels of investment, and at the same time, increase the flow and level of funds in support of environmental protection.

Therefore, we recommend:

1) Building public awareness and participation so that the whole society plays a role in the strategic transformation, including household and workplace consumption and environmental health, monitoring of local development, and direct participation in environmental improvements. Encouraging the participation of environmental NGOs as a way to draw upon perspectives from across the range of societal views. Also, providing special training and education to the policy makers, administrators and managers, especially of local governments at various levels, and enterprises. This capacity building is necessary to sharpen their consciousness of the importance and urgency of the coordinated environmental-social-economic development, and to enhance abilities to deal with practical implementation.

2) Accelerating improvement of China's existing environmental protection institutional system to take maximum advantage of environmental legal frameworks, management techniques and technology. This should include upgrading the institutional status of SEPA and local environmental protection departments; rewriting of key laws such as the 1989 Environmental Protection Law; appropriately stringent standards and the means to enforce their observance; allocating more human, capital, and technical and equipment resources to the environmental protection departments so they are well equipped to be the mainstay for promoting the strategic environment-development transformation. Clearly, the greatest need is to build a high-performing system that will drastically reduce the extent of illegal environmental behaviours, reform the penalty system to ensure financially effective penalties are in place,; create enabling situations where enterprises, cities, towns, and projects of all types have the means to address environmentally sustainable development; and improve the environmental judicial system to secure both public and private environmental welfare and exercise environmental justice.

3) Making full use of market-based policies to promote the environment-development strategic transformation, including environment taxation, resource-energy taxation, green credits, environment insurance, ecological compensation, and emission trading, etc. This market-based approach, with carefully constructed incentives, is essential to fully realize the benefits of innovation, including development and commercialization of environmental and sustainable development technologies.

4) Reviewing current levels of environmental investment in the environmental sector to determine the amounts actually being spent in support of high priority activities, and where necessary redirect or increase the funds required for these priorities. In addition, place greater attention on how to encourage private investment for the substantial expenditures required to carry out ecological/conservation innovations in the industrial sector and to establish innovative resource-conserving and environmentally friendly production and consumption models, including those that support a Circular

Economy.

1.2.4 Address the challenges brought on by economic and environmental globalization in a more timely and effective way

China is facing new environmental pressures through its participation in economic globalization. As the "world's factory," China is host for the relocation of many high energy consuming and high pollution emitting industries. While China enjoys a "trade surplus" in economic terms, it is also building a domestic "ecological deficit," generated by the export-oriented economy that consumes a large quantity of energy and resources and produces a large volume of pollutants and greenhouse gases. In addition, China is also facing severe local impacts from illegal trade of hazardous waste.

China also needs to pay greater attention to addressing environmental effects that its market supply chains may have on other nations. At the same time, it should give full recognition to the positive contribution that a global competitive marketplace could have on its domestic environmental advancement. These are rather new effects that will grow in significance over coming years as Chinese multinational businesses become more active, and as China's resource needs and economic activities continue to increase. China may find itself increasingly vulnerable to various forms of environmental protectionism and other retaliatory action, perhaps involving third parties.

CCICED is encouraged by the new "coordinate and cooperate to protect our only earth" international environmental cooperation principle, which was put forward by the Party's 17th Congress. China's effort in protecting global environmental conditions, such as ODS (Ozone Depleting Substances) reduction, carbon sequestration through afforestation, and its 2007 Climate Change Program are notable. China's own strategic environment and development transformation is linked to success of the international community's efforts to control global and regional environmental concerns, such as climate change.

China must be able to address global environmental concerns from its own perspectives and self-interests. But increasingly its influence on the world's economy and ecology places China in a position of great responsibility to the community of nations. Indeed, the world's economic and environmental security is increasingly being perceived to be in China's hands. Over the coming five years, this perception is likely to be reinforced as China's rapid economic growth continues. China needs to determine where it should place its major efforts to address global environment and development issues.

Therefore, we recommend:

1) Gradually changing the current growth mode of trade in order to adjust the relationship between trade, resources and environment. Make full use of China's trade surplus to import products and technology with high embodied energy and resource content, and reduce export of some goods (especially commodities) with high embodied energy and resources. Find and expand substitutes for goods that require high ener-

gy consumption in their production, or sometimes import them. Speed up transformation of the current foreign trade growth mode, moving from the traditional growth mode relying mainly on price competition, quantity expansion and seeking very high growth rates, to a mode relying on quality improvement, increase of value-added, and optimization of structure. Expand the export of services and strengthen their international competitiveness.

2) Optimizing regional structure for manufacturing goods for export, including strict environmental upgrading of all industrial processing in eastern areas, while making full use of the local abundant human resources in the middle and west of China, and introducing environmentally friendly processing for trade to these areas. Levy an environmental pollution tax on products and industrial sectors with high energy consumption and high pollution, and assign costs for environmental damage to the responsible enterprises. Introduce appropriate advanced foreign technology and equipment, and promote energy saving and emission reduction activities to improve domestic environmental quality.

3) Strengthening environmental aspects of trade for recyclable and waste goods; and conduct regional planning within China for environmental management of trade for recyclable and waste materials. Carry out life cycle analysis for imported recyclables and wastes being reprocessed as raw materials, and enforce strict environmental entry standards into China of such materials. Restrict those processing enterprises in China that import recyclables and wastes from exporting the resulting raw materials, in order to ensure raw materials are used for domestic needs or producing higher value export products – not merely for getting foreign exchange, while leaving behind pollution byproducts. Work with other nations to ensure the honoring of international agreements and international monitoring in order to curb illegal trade in toxic wastes.

4) Developing appropriate regulations for carrying out comprehensive environmental impact assessments on key market supply chains for raw products entering China, including agricultural products such as soybeans, edible oils, fish and cotton, wood products, biofuels, and minerals. Take steps to prevent negative influences on the environment in the countries of origin. Take additional steps to eliminate illegal timber trading and other such problems, including activities banned under the Convention on International Trade in Endangered Species of Flora and Fauna (CITES).

5) Strengthening environmental management of Chinese companies that invest or operate overseas, and improve the Corporate Social Responsibility awareness of these enterprises. Encourage Chinese enterprises to obtain international advanced environmental managerial experiences and environmentally friendly technologies through their investment overseas or establishment of joint ventures in other countries. Such investment in environmental-friendly efforts will strengthen the long term competitiveness of Chinese companies.

6) Enhancing China's participation in bilateral or multilateral environmental cooperation. Promote the implementation of

international environmental conventions within China by setting up complete domestic implementation mechanisms, management systems and framework of policies and regulations. And, participate more actively in the construction of the global environmental regime, while adhering to the principle of common but differentiated responsibilities; maintaining the right for development of all developing countries including China; building an international image of China as an environmentally responsible nation through its actions. Shoulder international obligations within China's capabilities, explore technological cooperation opportunities through South-North cooperation, and strengthen environmental cooperation activities between China and other developing countries in Asia, Latin America and Africa.

6) Combining the endeavors of energy conservation and pollutant emission reduction in China with CO_2 emission reduction in order to develop an energy and industrial system with a relatively low CO_2 emission. In other words, begin moving towards a pathway in China consistent with global efforts to achieve a low-carbon economy in the future.

1.2.5 Construct a "Conservation Culture" through innovation

It is time for China to build greater domestic capabilities for "Made in China" advanced solutions to environmental and sustainable development technologies, along with the associated institutional strengthening and systems to ensure good ideas turn into commercially viable, widely used products. China's Medium-term S&T Plan calls for a major emphasis on environment in future R&D. Yet there are many challenges and barriers that have to be addressed in the National Innovation System (NIS) before it can achieve full potential. Furthermore, sustainable development in China and many other countries has tended to be implemented without much connection to the NIS.

There are significant problems with relying on imported environmental technologies to allow China to leapfrog in reduction on emissions in the same way as it has in other sectors, such as telecommunications. The problems include limited willingness to share advanced technologies (auto emissions), technologies not suited to Chinese conditions, and the high costs of accessing some advanced technologies and intellectual property rights (IPR), such as advanced electrical power generation systems. As well, some transformative technologies like hydrogen-powered fuel cells require additional development effort and time.

On the other hand, China has clear advantages that are not being sufficiently tapped for environmental innovation. Lower labour costs coupled with a potentially large domestic market could make Chinese environment and sustainable development products and services very attractive to the global marketplace. An example is solar photovoltaic panels.

The right enabling conditions for eco-innovation are not yet fully in place within China. These conditions include unleashing creativity within China's vast research system, including academies, univer-

sities and the private sector, but with the recognition that short-term failure of some efforts should be tolerated. The financial investment systems for environmental innovation are still weakly developed and it is important that more venture capital be attracted at various developmental points so that environmental technology markets are strengthened. Regulatory frameworks favoring innovation are needed, especially market-based approaches that provide the necessary incentives for industry to move towards environmentally friendly processing without pollutants and "green chemistry."

Many of the new products arising from biotechnology, nanotechnology and energy technology or other innovations will require assessment of their true potential for achieving environmental improvement and sustainable development progress. And of course, potential negative impacts on the environment also need to be considered. Biofuels are an example. These types of assessment are different from project-oriented evaluations, and proper regulations and guidelines are needed.

The decision to "make or buy" advanced environmental technologies is never simple, and must be decided on the basis of specific situations. For some advanced technologies, the best approach may be to take full advantage of foreign direct investment to draw upon the international experience of multinational companies, but be directed by stringent regulations or guidelines as a condition of investment. International joint scientific and development initiatives are already in place, especially for energy efficiency and some pollution reduction efforts. These will need to be expanded and more will be needed, especially in light of the urgency for solutions to sustainable use of coal, greenhouse gas reduction and other important environmental problems.

Therefore, we recommend:

1) Mobilizing both national and local level interest and willingness to implement environmental and sustainable development innovation strategies. The approach needed goes beyond environmental compliance, which is perceived to be cost driven and inconsistent with economic growth. This need is even more urgent than investment in R&D for new technologies, since many technologies are already available but not effectively used by enterprises, or promoted as solutions by local government. A combination of enforcement, incentives, improved planning, awareness raising, and capacity development is required to address this type of system failure. Development of regional "innovation clusters" appropriate for the environmental and economic conditions is needed to build local-level understanding and access to suitable innovation products and approaches; for example, to address development in fragile ecosystems such as the Qinghai-Tibet Plateau, and the upper watersheds of major river basins, and major coal-producing regions.

2) Strengthening and popularizing the field of environmental technology R&D and removing obstacles to commercialization. Numerous technological breakthroughs already exist in China and others are likely to happen in the future. However, they must

move more quickly from trial stages to commercialization, and be seen as attractive opportunities for investment at all stages. Current incentives do not promote long-term innovation for environmental technologies. This problem can be addressed through a combination of government commitment and involvement in the earlier stages of scientific research and development, and the private sector and investors in the later stages. The problem should be tackled as a central issue via the NIS.

3) Taking action to overcome market failure that hinders environmental technology introduction. Private enterprises should become the main players for the development and implementation of technologies for an environmental-friendly society. However this is not happening to the extent that it should. The limited markets for such technologies, reliance on command and control regulation, inadequate resource and other pricing policies, and the limited sanctions for non-compliance all need to be addressed as components of market failure. Better green procurement policies operating at both national and local levels of government are needed. Preferential loans for initiatives making use of environmental technologies and/or denial of loans for initiatives that shun their use need to be implemented on a much broader basis than existing trial efforts.

4) Raising the public quality of environmental science and technology. China's economic and environmental future depends on making the world's most populous nation scientifically literate and able to create the social environment for many types of technology innovation. The commitment to an "innovation society" depends on improvements to the educational system, and on demonstration of real environmental value arising from eco-innovation. In turn, these depend upon continued improvement in the production and reliability of environment and sustainable development information at all levels, including local communities.

2) Improving public environmental, scientific, and technical capacities. The future of China's sustainable development depends on the dissemination of basic technical knowledge to the largest population in the world. The construction of a "Conservation Culture" will also rely on an improved education system and the increased value of environmental resources.

Chapter Ⅱ

Overview on Innovation for an Environmentally Friendly Society

2.1 Background

This Issues Paper is the sixth in a series started in 2002 to examine key problems in China's environment and development strategy.[1] The purpose of each paper has been to identify major policy questions and issues associated with the theme of the CCICED's AGM. The Council, comprised of senior Chinese and international environmental leaders, provides advice to the Premier and State Council of China based on the work of its task forces and special studies. The November 2007 CCICED AGM is the first meeting of the fourth five-year phase of the Council, and therefore will serve as an agenda-setting session for work to be carried out over the coming half decade. The AGM will examine what it will mean for China to embrace "Innovation for an Environmentally Friendly Society."

2.2 Strategic Transformation and Innovation

2.2.1 2007 – A Year of Environment and Development in China and Globally

The timing of this meeting is especially significant since it comes soon after the 17th National Congress of the Communist Party of China. This Congress firmly embraced scientific development, innovation and the need to address pressing environment and development concerns in China. President Hu Jintao noted the need for "promoting a conservation culture by basically forming an energy- and resource-efficient and environmental-friendly structure of industries, pattern of growth and mode of consumption." During 2007, China introduced its first comprehensive action program to address climate change; established a Leading Group on energy, environment and climate change, which is chaired by Premier Wen Jiabao; and took numerous actions to improve performance in meeting the 11th Five Year Plan's 20% energy efficiency increase and 10% pollution reduction goals. The OECD released its first ever report on China's environmental performance, an important benchmarking and institutional analysis.

This year, environment has risen to the top level of priorities in many countries, including their businesses and communities, with concern for climate change being most prominent. But many other issues are in the spotlight as well, including the need for a

1 This is the Issues Paper prepared by the CCICED Chief Advisors, Professor Shen Guofang and Dr. Arthur J. Hanson with the assistance of others in the Chief Advisors Group.

better understanding of globalization effects, and of the environmental implications related to fast growing countries such as China and India. The International Energy Agency (IEA) in its 2007 energy outlook reference scenario calculates that these two countries would account for 45% of the global increase in energy demand in 2030. It is now 20 years since the famous report *Our Common Future* was produced by the World Commission on Environment and Development. Global progress on sustainable development is still limited, however, and "business as usual" attitudes still persist to an alarming extent.

2.2.2 China's Strategic Transformation of Environment and Development

China is entering a time of strategic transformation towards environment and development. This transformation is focused at present on energy efficiency and pollution control, but with much broader implications on how the world's most populous nation can rapidly align its economy, environmental protection and harmonious social development policies and actions towards sustainable development. China needs to do this on a much-compressed time frame by comparison to many other countries, since its longer target of attaining a "basically well-off society" by 2020 depends not only on continued rapid economic growth, but also on quality of life and a stable social system.

Ultimately this strategic transformation will affect how government governs, how all business enterprises operate within China and in their international operations, how the people of China participate in environmental decisions, and how China participates in global and regional environment and sustainable development cooperation. It will demand new approaches of institutional change, improved planning and management, and technological changes far beyond what China has seen to date in its environmental protection and sustainable development efforts. And it will place unprecedented demands on other nations to adjust and improve their own ways of dealing with issues such as environment and trade, climate change, and many other related matters. One of CCICED Policy Studies is on Strategic Transformation of Environment and Development in China (see chapter IV), which was presented at the AGM.

2.2.3 Innovation for an Environmentally Friendly Society

President Hu Jintao has noted that innovation "is the core of our national development strategy and a crucial link in enhancing the overall national strength." Internationally there is great interest in determining how best to link innovation and sustainable development. It is difficult to believe that societies anywhere can expect to achieve substantive progress on today's environment and development problems without commitment to science and technology breakthroughs. Yet innovation must go much deeper into the way decisions are made and the strength of institutions to implement these decisions; and into the role and functioning of markets that can either encourage

or discourage desirable changes depending on pricing and other signals. It is encouraging that at the 17th CPC Congress such topics were considered. President Hu noted that "China needs to improve institutions for democracy, diversify its forms and expand its channels, and carry out democratic election, decision-making and administration and oversight in accordance with the law to guarantee the people's rights to be informed, to participate, to be heard and to oversee." These are among the most important conditions found in nations like Germany, The Republic of Korea, and Japan that foster innovation during their strategic environmental transformation in earlier times.

China is in a remarkable position as it moves to strengthen its science and technology capabilities. The available funding will place it among the very top nations investing in S&T. A considerable amount of this funding will be earmarked for addressing priority energy, environment and development concerns during China's new 15-Year Science and Technology Plan. In the process, the existing NIS will have to become much more focused on sustainable development priorities and on building independent, indigenous technology that will fuel future economic growth and well being in China. There are many barriers to be overcome, and the gap between goals and performance progress is still large. CCICED has initiated a new Task Force on Innovation for China's Environmentally Friendly Society, which will present its final report at the 2008 AGM. Their Interim Report presented during the current AGM provides a critical examination of this topic in China (see chapter III).

The difficulties of implementing current environmental goals were reported during the meeting, and were based primarily on the work of the CCICED Task Force on Policy Mechanisms towards Successful Achievement of the 11th Five Year Plan Environmental Targets (see chapter III). It is likely impossible to meet the targets without substantial commitment to innovative approaches, and these are not yet in place. Furthermore the challenge will become greater over time, especially during later Five Year Plans since more types of pollutants will have to be addressed and absolute levels of some contaminants are continuing to increase.

Since the dawn of the new century, China has been in an industrialization phase of heavy industry and chemical production. The rash of serious incidents involving chemical spills and contaminations suggests that a stronger approach to chemical management is needed. Such an approach has ramifications for large and small domestic producers, multinational chemical firms operating in China, and for China's participation in overseas chemical markets. Fortunately, this is a subject where it is possible to draw upon innovation experience from a number of other countries such as Germany. A CCICED Special Policy Study on Environmentally Sound and Strategic Management of Chemicals in China would provide some useful recommendations (see chapter VI).

2.2.4 Looking Ahead – Global Problems and China's Needs

China is entering into an era when its impact on the world will be considerable, and therefore its actions will be monitored closely and judgments will be made on its contribution to global environmental security and global citizenry. The extensive past work of CCICED on Trade and Environment, and recent efforts to understand how the effects of globalization affect China's environment and China's impact on other countries suggest that international cooperation will become increasingly significant. It is a topic well suited to CCICED, of course, but may now need to be examined in ways that recognize both China's very legitimate development needs and interests and how other nations should cooperate to provide the environmental space for this to happen.

Therefore, several exploratory initiatives were undertaken in preparation for this meeting. One is a new partnership of CCICED with WWF China to examine China's Ecological Footprint (the final report will be publicized on June 5, 2008, the International Environment Day) with an Interim Report presented during AGM 2007, revealing how China's very low per capita demands on the world's ecological systems are increasing. This is a relatively new way of examining the effect a country may have on the resources and environments of other nations and regions through market supply chains and other ways. This information casts a very different perspective than standard economic analysis of trade and identifies the nature of ecological deficits and surpluses around the world.

CCICED's long-standing interest in Energy and Environment has always been tied to innovation, and specifically to alternative sources and approaches to energy use. Some of these ideas, like wind power, are now in use and it is clear that energy innovation will be one of the most significant areas determining China and the world's success with sustainable development. Climate change adds to the urgency of finding new ways to improve energy efficiency, sustainable use of coal, and of alternatives that will reduce greenhouse gas emission and other harmful pollutants. These topics are being proposed as important elements within the overall context of Energy and Environment for CCICED work over the next two years. In April 2007 CCICED held an exploratory meeting on "A Low Carbon Economy for China." (For the key points arising from this meeting please visit the website: www. cciced.org.)

Clearly, the coming years will not be a time of "business as usual" for China's environment and development situation. Nor is it a time when any one nation can expect to achieve its own environmental objectives in isolation from global environment issues, or without consideration of the environment and development actions of other nations. As China's President and Premier have both pointed out, the environmental burden on China is heavy and the situation is grave. It will require sustained effort, participation of all sectors and regions of the country, and new approaches that build on science, management and institutional approaches. What is called for is a broad base of investment in

eco-innovation. This long-term commitment will become of increasing significance starting with the 11th Five Year Plan, and certainly extending into the 12th and 13th Five Year Plans.

The Government of China has made it quite clear that innovation rather than minor tinkering will drive the new relationship of environment and development. Perhaps the clearest vision is from statements by Premier Wen Jiabao concerning this relationship, in which three principles – Three Transitions – have been laid out: (1) environment and economic growth should be given equal status; (2) environmental problems should be considered concurrently, not after economic growth is achieved; and (3) instead of the current focus on administrative initiatives, environmental action should be broadened to include legal, economic, institutional and other approaches.

2.3 China's 11th Five Year Plan Environmental Performance

The inability of China to meet fully the environmental objectives of the 10th Five Year Plan, and the more stringent pollution reduction and energy efficiency goals during the first year of the 11th Five Year Plan, reflect systemic problems that are described in the CCICED Task Force Report to the AGM. The key point is that only by addressing such matters as institutional strengthening and substantial upgrading of the environmental management administrative structure, can real progress be expected. There is no single approach that can be implemented in isolation. This point has significant implications for success of environmental technology innovation.

While there is considerable investment in introduced technologies, and also evidence of success in their application, there are also observations that much of the investment has not been well spent in terms of improved environmental performance. The reasons vary but include lack of training, poor environmental monitoring and enforcement, and inappropriate choices.

The 11th Five Year Plan will be a time of learning and transition in relation to discovering the best combinations of technological, institutional and management innovations for environmental improvement. It should set the stage for major longer-term investments that will see their full benefits expressed in the decade after, and, in the case of some initiatives, much further in the future; for example, the ITER Project on fusion in which China is a partner. The time available between now and 2010 can be used to put in place a more functional governance system to support environmental innovation, including stronger participation by industry, and awareness raising of communities and people. Fortunately, the necessary investment capital may be much easier to find in China than in some other countries.

2.4 Some Global Issues Limiting Progress

Of the many issues limiting progress on building a better relationship between environment and development in other countries, a handful are particularly significant at this

time of innovation and transition for China.

- An export-driven high growth strategy, with its emphasis on continuous price reduction and mass production of consumer goods, has significant benefits both for the manufacturing country, in this case China, and the consuming countries, whether rich or poor. The reality, however, is that environmental conditions are being compromised in the manufacturing country, and in some of the countries supplying raw materials. This also happens in the richer, consuming countries where cheaper imported goods contribute to ever-increasing demand and over-consumption. It is hard to see how this model can ever truly be sustainable.
- Stimulating domestic consumption in China or other large developing countries from their current low per capita levels could lead to an impossible future global environmental situation. This could happen if consumption levels rise anywhere close to those of the richer countries today because ecological capacity will be exceeded, even with stringent eco-efficiency measures. Ecological footprints continue to rise with economic wealth; already the global resource and environmental situation may be beyond earth's longer-term carrying capacity. New pathways are needed that lead to high quality of life in China and elsewhere, but with relatively limited per capita consumption increases. As well, richer countries must become much more serious about their own transformative needs for environment and development and on sustainable consumption.
- Declining resource and environmental intensity (e.g., use of energy or material per capita or per unit of GDP) is a misleading measure of environmental progress in situations where economic or resource exploitation growth rates are very high. Absolute pollution amounts, or of resource decline, may continue to rise even though utilization efficiency increases. This is particularly important in the debate about greenhouse gas reductions, but also for many other of the pollutants that China and other countries are producing, and for ecological and resource decline globally and regionally.
- Social considerations of poverty reduction, equity in access to education and health care, sustainable cities and towns, sustainable rural development, and creation of new employment opportunities will continue to be drivers of sustainable development innovation in all countries. Yet this type of innovation is still often separated from environmental considerations. China, more than many other countries, is making a serious effort to make the linkages and take an integrated approach. China's success and experience will therefore be of value to many other nations.
- Corporate social responsibility is taken seriously by many large multinational corporations in particular, yet it has not taken hold to the extent that it should anywhere in the world, and certainly

not in most parts of Asia, including China.

- The framework for addressing global environmental protection, and for regulation of market-driven globalization matters, including technology sharing, intellectual property rights, and international trade and investment, is still weak and incomplete. As well, new issues are appearing each year, including many health and environment problems, and new mechanisms such as carbon trading. China's own strategic transformation on environment and development will depend a considerable extent on improvements for international action.
- Innovation in the form of new or improved scientific and technology applications, investment, management and institutional change is needed both nationally and internationally, but often the changes occur much more slowly than desired and with a limited distribution of benefits.

China has now become an indispensable economic partner, stabilizing the world economy, fueling international economic booms, and raising the level of incomes for many developing countries. This success needs to be tempered with the difficult issues of declining environmental conditions. Global attention in recent months has been focused on a range of quality issues, including the efforts to improve the air quality in Beijing and the Olympic Games, to solve the problems of market supply chains and product quality, and how China will respond to climate change.[2] China needs to understand how it can balance its environment and economy relationship in the context of globalization effects.

2.5 Innovation for Environment and Sustainable Development

There are a number of specific characteristics about environment and sustainable development innovation worth bearing in mind, since these are as likely to be as applicable in China as elsewhere.[3]

- The need for innovation increases as the commitment by governments and the private sector shifts from an emphasis on cost-driven regulatory compliance to an emphasis on broader economic/financial, social and environmental benefits.
- Many environmental innovations will arise from industrial innovation not primarily oriented to environmental improvement; for example, energy efficiency and product improvement. The potential for co-benefits is large.
- Environmental innovation is often directed to maintaining public goods, which means that incentive for private investment and return on investment can be limited, especially in relation to alternatives. Market value is needed for

2 See Elizabeth Economy. 2007. *The Great Leap Backward?* Foreign Affairs. September/October; Joseph Kahn and Jim Yardley. 26 August, 2007. *As China Roars, Pollution Reaches Deadly Extremes. The New York Times.*

3 These points are based in part on OECD, 2007. *Environmental Innovation and Global Markets.* ENV/EPOC/GSP (2007)2/REV1. Environment Directorate, OECD, Paris. 101 pp.

technologies to thrive.

- Bringing environmental innovations to full commercialization can be difficult, due to market imperfections and failure, or perverse incentives such as inadequate pricing.
- Technology "lock-in" is a formidable problem for environment and sustainable development innovation, affecting institutional and financing responses even when R&D suggests better technologies are available or could be developed.
- Co-evolution of technologies is often needed; for example, in the relationship of battery technology and hybrid automobile engine development.
- Flexible instruments such as economic incentives and performance standards foster environmental technology innovation more than prescriptive measures (e.g., 'best available technology' regulation), especially if the desired outcome is integrated changes in production or other processes rather than end-of-pipe pollution control.
- Globalization, with its fragmented supply chains, may generate considerable international demand for accelerated development of environment and sustainable development technologies and their rapid deployment, including pressure for suppliers along the value chain to conform to consumer-driven environmental demands.
- Some key environment and sustainable development technologies (e.g., for clean coal use, nuclear fusion, and sustainable transportation) are beyond the capacity of any one country, no matter how technologically advanced, and therefore international partnerships and joint venture activities are desirable.
- Governmental intervention in choosing technology "winners" can be highly controversial. One view is that governments should concentrate on defining clear environmental goals and a framework to address them, while being technology-neutral on how they are addressed.

2.6 China's Innovation Strategy and Key Links to Environment and Development

Scientifically based development, wealth shared fairly among all citizens, harmonious and sustainable development that provides for environmental protection, continued rapid economic growth, improved social services, and greater social equity are cornerstones of current Chinese policy. These elements are reflected in many of the approaches for innovation generally, and science and technology (S&T) strategies in particular.

The context for innovation has been set broadly, as explained by Vice-Premier Zeng Peiyan in a speech to the China Business Summit:[4]

> "…Innovation is the soul of a nation's advancement, as well as the everlasting driving force for national

4 China Daily. 11 Sept 2006. *Innovation is the Soul of Nation's Advancement: Vice-Premier.* www.china.org.cn/ english/BAT/ 180675.htm

prosperity […] Problems often occur when people tend to pay attention to quantitative expansion and speed while ignoring quality […] We have to upgrade our development strategies, transforming our growth pattern and optimizing the industrial structure […] The objectives of reform are to bring economic and social development on the track of comprehensive, balanced and sustainable development."

He pointed out that this effort offers the potential for technology and innovation that could enhance productivity and increase competitiveness for China. The focus on institutional innovation should include reforming the administrative system, accelerating corporate reform, and establishing modern market systems.

Innovation must be linked with improved governance. As noted in a review of China's S&T Strategy: [5]

"the path to creating the overall well-off society will necessarily be characterized by technology innovations supporting greater efficiency and productivity, and institutional innovations supporting improvements in governance—greater market discipline and integrity, less government corruption, and greater administrative accountability."

OECD countries are passing through a transition where stand-alone S&T strategies are now being viewed within a broader context of a National Innovation System (NIS) that can take into account many factors beyond specific S&T plans or strategy. In particular, a NIS must consider the role of the business and financial community not only for participation in research, but also in linking to the demand side and in providing clear pathways to commercialization. An NIS also must take into account the development of innovation clusters with appropriate capacity building and scientific and physical infrastructure development, enabling frameworks and regulatory systems, and help with fundamental matters such as the selection of priority areas of innovation in which to initiate substantial programs.

The NIS approach, however, has evolved relatively independent of sustainable development. Thus, while some environmental concerns may be addressed in specific cases, this is by no means a central element. Rather, NIS tends to focus on building competitive advantage of a country through new technologies. Sustainable development is its own form of innovation, with some specific characteristics. It is mainly in the last 5 years that NIS and sustainable development have become more closely aligned in OECD nations, stimulated particularly through concerns such as alternative energy and climate change, industrial eco-efficiency, sustainable infrastructure development and some aspects of natural

5 Cong Cao, R.P. Suttmeier and D.F. Simons. December 2006. *China's 15-year Science and Technology Plan. Physics Today*.

resource and environmental management.

2.6.1 China's National Innovation System (NIS)

China is following somewhat the same pathway as other nations in creating its approach to an NIS with a very impressive level of S&T investment, and considerable experience with what may best be described as an adaptive approach to its NIS. This system has a number of key characteristics that evolved over the past 25 years.[6] What sets China apart from others are the magnitude of commitment and the rapidity of transition. And China has placed development concerns front and centre in its innovation goals, with a strong commitment for environmental protection.

The public governance of S&T and innovation is relatively complex, as noted in the diagram on the following page (from OECD 2007. Synthesis Report). There are many challenges to be faced, as noted below (from OECD 2007. Synthesis Report).

A strong recognition exists of the need to make the NIS enterprise based. There are numerous mechanisms to involve the private sector and transform state-owned enterprises. Yet the reality is most Chinese businesses invest little in R&D, and it is a challenge to get adequate R&D investment as part of FDI initiatives.

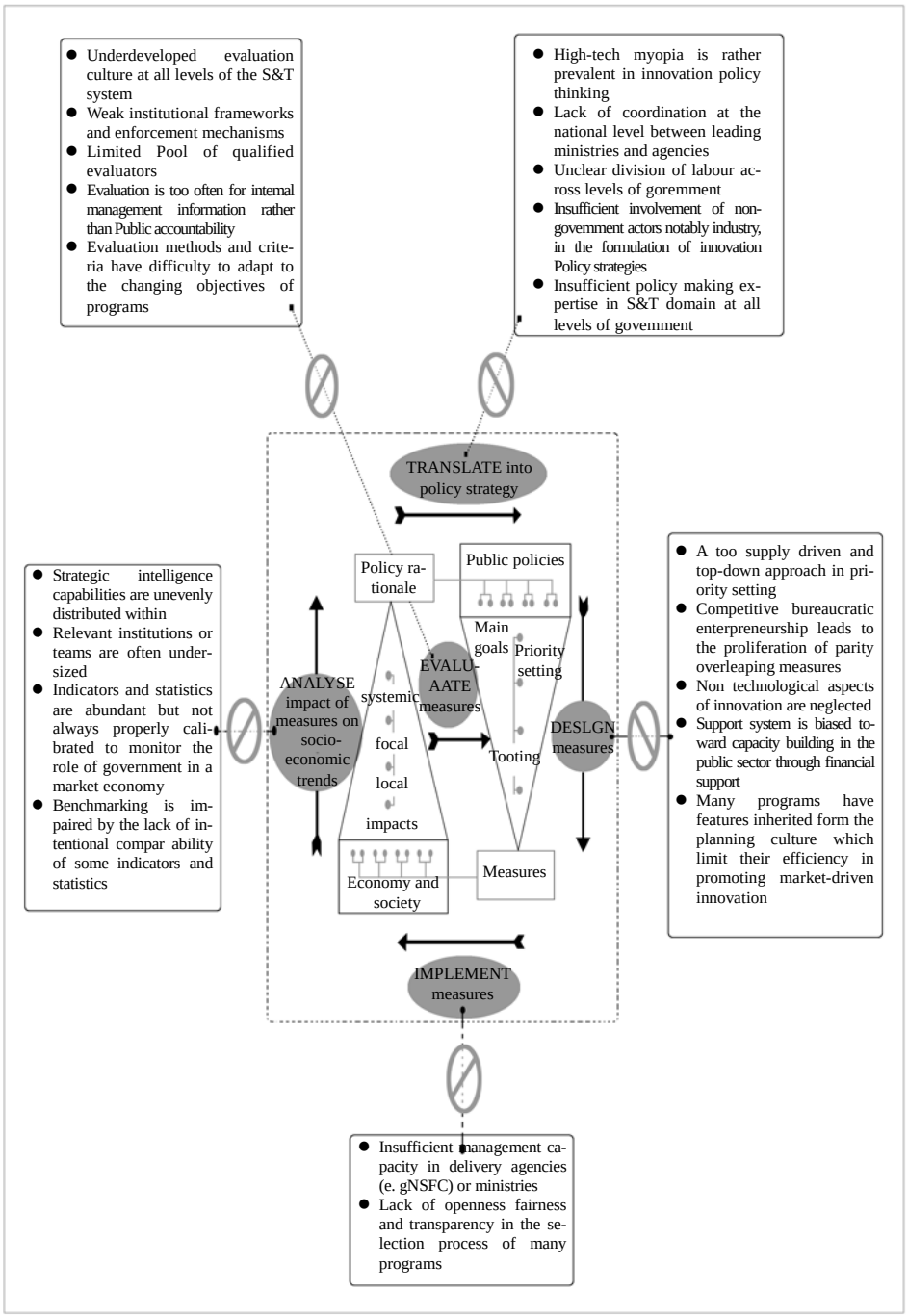
From another perspective, China may be able to tailor its growing innovation capacity to competitive advantage as part of a "global innovation system." As noted by OECD[7]:

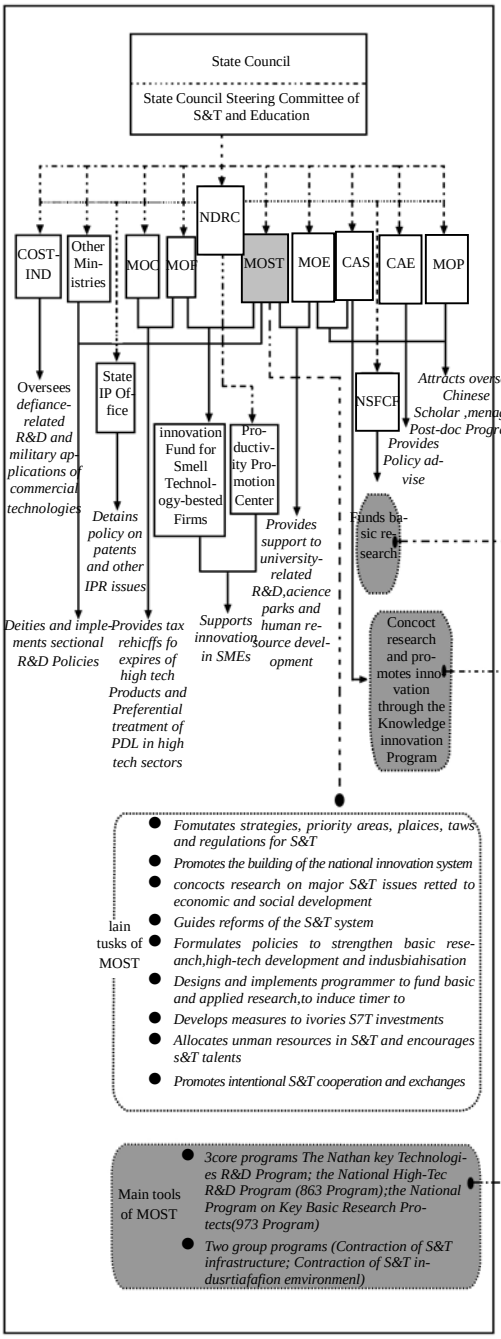
> "China can make a significant contribution to the world's knowledge pool and help to solve global problems. Among these are those relating to the strong demand for energy and natural resources and the environmental pressures associated with the rapid economic growth both of China and other emerging economies. China and OECD member countries have a shared interest in solving these problems."

There could be multiple advantages of China participating extensively in such a system. It is a means of sharing the burden and drawing upon a wider range of experience on complex technologies such as those involved in new energy technologies. China can draw upon its advantages as a low cost producer to commercialize innovation technologies and sell these abroad. And China will gain credibility internationally for its science and technology contributions.

6 See, for example, Shulin Gu and Bengt-Åke Lundvall. 2006. *China's Innovation System and the Move Toward Harmonious Growth and Endogenous Innovation* in Shulin Gu and Mark Dodgson. 2006. *Innovation in China: Harmonious Transformation.* Special Issue of Innovation: Management, Policy and Practice. *eContent Management*, Queensland Australia. 218 pp; OECD. 2007. *China. Synthesis Report. OECD Reviews of Innovation Policy*. OECD, Paris. 68 pp.

7 OECD. 2007 China Synthesis Report.


Underdeveloped evaluation culture at all levels of the S&T system
Weak institutional frameworks and enforcement mechanisms
Limited Pool of qualified evaluators
Evaluation is too often for internal management information rather than Public accountability
Evaluation methods and criteria have difficulty to adapt to the changing objectives of programs
High-tech myopia is rather prevalent in innovation policy thinking
Lack of coordination at the national level between leading ministries and agencies
Unclear division of labour across levels of goremment
Insufficient involvement of non-government actors notably industry, in the formulation of innovation Policy strategies
Insufficient policy making expertise in S&T domain at all levels of govemment
TRANSLATE into policy strategy
Policy rationale
Public policies
Main goals
Priority setting
EVALUAATE measures
ANALYSE impact of measures on socio-economic trends
systemic
focal
local
impacts
Tooting
DESLGN measures
Economy and society
Measures
IMPLEMENT measures
Strategic intelligence capabilities are unevenly distributed within
Relevant institutions or teams are often undersized
Indicators and statistics are abundant but not always properly calibrated to monitor the role of government in a market economy
Benchmarking is impaired by the lack of intentional compar ability of some indicators and statistics
A too supply driven and top-down approach in priority setting
Competitive bureaucratic enterpreneurship leads to the proliferation of parity overleaping measures
Non technological aspects of innovation are neglected
Support system is biased toward capacity building in the public sector through financial support
Many programs have features inherited form the planning culture which limit their efficiency in promoting market-driven innovation
Insufficient management capacity in delivery agencies (e. gNSFC) or ministries
Lack of openness fairness and transparency in the selection process of many programs



Program	Year of start	implemented by	1981-85	1988-90	1991-95	1998-00	2001-2005
Key Tech-nologies	1983		15	35	452	50	50
973	1997	MOST	•	•	•	12	21
883	1988		•	← 59 →			150
NNSFC	1986	NNSFC		5.7	15.8	44.7	100
Knowledge innovation	1998	CAS	•	•	•	54	200
TOTAL			15	•	•	•	521
Total as a share of total public S&T expenditures							17%

Table 3.2 Main MOST Programs

Core Programs		
Key Technologies	863	973
Promote the development of key technologies needed for industrial and social development	Promote R&D capabtiriles in high tech	Support basic research in selected areas

TWO Group Programs	
Construction of S&T infra-structures	Construction of S&T lndustrion Environment
Support the development of infrasl-nuchunes and capable-ness	Support environmental Projects ,regional economic develop-ment, tech-based SMEs and S&T imte-mediarines

Key Technologies million RMB(2004)	883 Program	973 Program
Total funds raised	14985	9293	1031
Govemment funds	3003	4231	903
Gov as % of total	20%	48%	88%

Funds allocated by central govemment to Selected TWO Group programs (million RMB)

	1988	2004
State Key Laboratory Construction Program	125	130
National Engineering Research Center	40	85.5
Spark Prognem	39	105
Torch Progrmm	51	50
Science and Technology Achievements Spreading Program	20	23
National New Products Program	135	140
Innovation Fund for Small Technology bested films	•	500
Agmicuture Siamese and Technology Trans-fer Fund	•	250
Allison Plan for Pro-moting Trade by Science and Technology	•	20
Special Technology Development Project For Research Instions	•	182

Origins of funds for the torch and Spark Programs(2004)

	Total	Torch	Spank
Funds raised (million RMB)	91888	71313	20573
%govemment	3%	2%	5%
%enterise	70%	72%	60%
%bank loans	23%	21%	30%
%oversees	0.3%	0.3%	0.8%
%others	4%	4%	4%

NDRC: National Development and Reform Commission
MOC: Ministry of Commerce
MOST: Ministry of Science and Technology
MOF: Ministry of Finance
CAS: Chinese Academy of Sciences
COSTIND: Commission of Science, Technology and industry for National Defiance
MOE: Ministry of Education
CAE: Chinese Academy of Engineering
MOF: Ministry of Personnel
NSFC: National Natural Science Foundation of China

Source: OECD based on data from MOST and other sciences

A number of strategic tasks have been identified by OECD as possible means for enhancing the efficiency and effectiveness of China's NIS. These include: (1) Adjusting the role of government to enhance provision of public goods through science and innovation; (2) Improving the framework conditions for innovation, such as enforcement of intellectual property rights (IPR), fostering competition, improving corporate governance, fostering open and competitive markets, careful use of public procurement, and promoting technology standards appropriately; (3) Increasing research quality and efficiency by sustaining the growth of human resource for S&T; (4) Improving governance of science and innovation policy, including a focus on central and sub-national division of labour and responsibility, and improving inter-agency coordination; (5) Adjusting the set of policy instruments in order to develop the most appropriate types of R&D initiatives and programs; (6) Maintain adequate support or public R&D, especially for public good priorities such as environmental protection; and (7) Strengthening the linkages between industry and science.

2.6.2 China's 15-year Science and Technology Strategy

China is poised to become one of the world's leaders in S&T investment. The 2006 15-year S&T Plan[8] emphasizes "indigenous innovation" and technology leapfrogging so that some 60% of contributions for economic growth will come from technology advances, with dependence on imported technology no greater than 30%. China aims to be among the top five countries in terms of invention patents and overall S&T expenditure—a "global scientific centre." OECD believes that China is already the world's second highest investor in R&D, spending slightly more than Japan's USD 130 billion in 2006, but far lower than the US investment of USD 330 billion. This represents an increase from 0.6% of GDP in 1995 to more than 1.2%.[9]

The meaning of "indigenous innovation" is somewhat complex, and encompasses three approaches: original innovation, integrated innovation relying upon linking existing technologies for new uses (e.g. application of medical biotechnology for diagnostic testing of the environment), and "re-innovation" involving improvement of imported technology. All three approaches are of value in relation to environment and development innovation. It also should be noted that emphasis on institutional and management innovation is a crucial component for all three approaches—in order to improve implementation success of off-the-shelf technologies as well as innovative technologies.

A likely transition for China is towards greater ownership of intellectual property rights and possibly to industrial standard setting as part of its effort to become an innovation-based society. This has important implications for environment and SD technology development for both domestic use

8 For a useful review of the S&T Plan, see Cao, Suttmeier and Simons, Physics Today. Dec 2006.
9 OECD. 2006. www.oecd.org/sti/outlook

and international applications. The potential dilemma is the length of time to develop new intellectual property, and therefore the uncertainty and lengthy process to bring new technologies into the marketplace.

Another view is that gaining access to sophisticated, available environment and sustainable development technology from abroad is essential for the near term, especially during the 11th and 12th Five Year Plan periods. While such an approach is appealing and in fact occurring, there are cost issues and issues relating to reluctance of some companies to share their most advanced features with Chinese operations. The role of China's government in setting appropriate regulations (e.g., auto emission standards) and IPR safeguards are important.

Chinese-international partnership for development and implementation of new technologies is a hybrid approach to innovation that is likely to be of increasing significance in coming years. It appears particularly important for alternative energy sources, and perhaps for water pollution control technology, hazardous waste management and prevention, etc. Many of these activities can be managed through foreign direct investment strategies, but some might also be done through government-to-government arrangements. Models for the latter exist (EU, USA, etc.)

Almost all of the 20 strategic research topics noted in the S&T Plan are relevant in some way to environment and development, but several are critical including: agricultural S&T, culture for innovation and S&T popularization, ecology, environment protection and circular economy S&T, energy, resources and ocean S&T, human resources for S&T, modern manufacturing development S&T, population and health S&T, regional innovation system, strategic high technology and industrialization of high and new technology, transportation S&T, and urban development and urbanization S&T.

Environment and development innovation may be less in need of S&T megaprojects than some other aspects of the strategy, but it requires greater attention to accelerating the pace of development of promising initiatives, and to the need for funding related to those initiatives where the marketplace has not yet caught up with the societal need (e.g., low cost sanitation and water treatment, brownfield redevelopment, and advanced forms of biorefineries).

Regional and local S&T innovation and concurrent needs for implementation capacity development are significant, and involve the private sector and communities as well as governments at various levels. This aspect of innovation is critical for ecological initiatives and rural development, as well as industrialization in locations where innovative solutions may be needed to address pollution and other environmental impacts.

2.7 A National "Eco-innovation System" for China

The time may be right to propose the creation of a national eco-innovation system for China that could address in a comprehensive way the various opportunities and challenges to innovation for an environmentally friendly society. This approach has

not been widely tested, although it is being actively explored in Europe. Eco-innovation is defined as any form of innovation focusing on sustainable development through reducing impacts on the environment and achieving more efficient use of energy and natural resources. A key question would be how taking an eco-innovation system approach might influence outcomes of the 11th Five Year Plan environmental efforts. By taking a systemic approach, could performance be improved, and to what extent would the results be related to environmental technology and to what extent from institutional improvement such as local government strengthening?

The following 10 innovation issues are indicative of the need for policies and action in a systemic approach to achieving an environmentally friendly society.

1. Create more widespread and effective use of existing environmental technologies that would lead to greater efficiency at a lower cost than developing new technologies, especially for industry and energy pollution control and new building technology.

There are many environmental technologies available at the present time, both within China and elsewhere. Such technologies could be introduced and adapted to specific Chinese development conditions, likely at lower cost and in a more timely way than developing new technologies. A good part of the challenge is not the technology *per se* being a barrier, but rather it is the lack of knowledge about its application, inappropriate incentives and regulation, and the need for an improved implementation management system.

It is sensible and necessary in the short run to focus on immediate opportunities even while seeking longer-term, more transformative options. Using existing technologies is a means for the industrial and construction sectors to demonstrate a commitment to corporate social responsibility in an immediate, goal-oriented and measurable way rather than via promises mainly of future, longer-term performance. It is a mechanism to maximize technology transfer by drawing upon multinational experience, especially as part of FDI packages and through cooperation programs, particularly with OECD countries. An additional benefit of maximizing use of existing environmental technologies is that it will further stimulate the rapid development of a robust environmental service sector within China.

The potential downside of embracing existing environmental technologies is that many will be from an earlier generation designed for pollution clean-up rather than prevention, and some will not be as cost-effective or efficient as newer approaches being designed today. In particular, the move towards elimination of serious pollutants through industrial ecology design and environmental planning presents more attractive longer-term options, including synergies for a circular economy, ability to control emissions such as greenhouse gases, which were not of such a concern in the design of existing pollution control technology, and perhaps discovering better approaches for China's situation.

2. Set environment and sustainable development objectives, standards, and incentives at levels that will promote innovative responses, while putting into place regulatory frameworks that will enable innovation solutions to be implemented effectively.

While China has already taken many initiatives for addressing this set of issues, the results are still far from optimal, suggesting the need for further national and local government interventions. The problems seem to be associated with the following matters:

- ❖ Inadequate drivers for action towards desired innovations (not only for new technology, but also for institutions, investment and management systems). The weak drivers are reasonably well understood. They include weak enforcement and punitive measures that simply become part of the cost of doing business; the continuing ambivalence of many local governments towards environmental management efforts where GDP growth may be threatened; and national laws and regulations that are too general or even work at cross-purposes, etc.
- ❖ Limited returns from existing S&T investment in terms of bringing new technology to commercialization and in terms of the relative low number of patents and other indicators of productivity of the S&T system.
- ❖ Failure of much of China's private sector to develop robust environmental management strategies and to undertake the original R&D that would support innovative solutions to pollution control, energy efficiency and other problems that should engage their interest.
- ❖ Failure to engage the financial sector fully into environmental innovation strategies. For example, it is only recently that bank lending has started to consider environmental matters.

This list of problems is very significant in terms of China's future success with innovation for environment and sustainable development. But it is a list that may well grow over time as new technology innovations emerge.

Experience elsewhere suggests that public perception and markets are unlikely to embrace all forms of technology solutions. This may well be true in the future for China as well—in its domestic markets, but also via market supply chains for China's export-driven economy. Choice of biotechnologies for environmental matters, for example, may influence access of final products to foreign markets.

3. Develop environmental, safety, health and life cycle assessments of impacts arising from new technologies (e.g., biotechnology, nanotechnology) at all stages of their development from R&D to full commercialization.

Many assertions will exist concerning the benefits and risks of new technologies, starting with the earliest stage of scientific research. China has engaged domestically and in joint ventures with funding of initiatives and building of expertise covering a wide range of promising technologies. The new S&T strategy offers even more possibilities. How can there be reasonable assur-

ance that the new investments actually will contribute to China's sustainable development needs in a more effective way? And what safeguards need to be put into place to ensure that the innovations do not create unacceptable health, environmental and safety problems on their own right? The design of existing environmental assessment procedures is not very robust for answering these questions, since the assessment system is geared much more to construction and other types of projects. Even policy environmental assessments are likely to be insufficient.

The OECD and some individual nations have started to consider appropriate assessment tools and procedures, for example, to cover innovations such as biotechnology applications for the bio-economy and nanotechnology and the environment. China will need to place more emphasis on these matters as its S&T strategy unfolds. The time to set in place an innovation environmental assessment system is now, before the new technologies overwhelm regulatory bodies, and before a serious incident occurs that is detrimental domestically and/or internationally.

The issue of whether assertions about the value of the potential S&T application are correct will always be difficult to assess, since the full potential often takes two or more decades in order to be fully realized. The slow unfolding of the hydrogen economy is a highly relevant example. However, the area of technology assessment for environment and development has made considerable progress over the past five years, with development of useful tools and scientific dialogue processes that are valuable. China is already engaged in some of these processes, but likely should be doing more to ensure that initial choices are reasonable.

4. Enhance the contribution to environment and sustainable development innovation by multinational corporations, international joint ventures and partnerships for key technology applications.

The environmental role of the international business community investing in China has been extremely variable, ranging from negative to highly positive. It would be desirable for international businesses to be in compliance with all relevant Chinese environmental laws, but compliance is not enough to address innovation. Instead, multinational corporations should be prepared to consider the following: environment and sustainable development capacity building of staff in their own business, and sometimes with other businesses in the same sector; willingness to share cutting edge technology; support for environmental R&D within company operations and via grants or partnerships with Chinese universities and research bodies; and participation in certification and other innovative voluntary environmental programs. Some international companies operating in China are already engaged in many of these activities, but certainly many others are not. Furthermore, there are many supply chain issues, including subcontracting and outsourcing within China where there seems to be limited consideration of how goods are produced. These problems are exacerbated by the intense competition among provinces for investment

and increased manufacturing opportunities.

The problems go deeper when investments in supporting infrastructure, such as commercial and factory buildings, transportation and utilities are considered. Some excellent trial efforts for LEED certified buildings have taken place, and many individual companies operating in industrial parks have established facilities that compare well with similar operations in their home countries. However, these initiatives appear to represent a small fraction of total investment. Some new industrial operations such as those for steel production tend to be designed at or above international norms. However, there is justifiable concern about the creation of many more facilities that will become brownfield sites or an on-going energy and pollution burden due to the limited initial investment in environmental controls.

What is required is a much greater environmental interest on the part of both Chinese and international investors in China, including those from other parts of Asia. The reality is that only two factors are likely to have a high degree of influence. One factor is strong governmental action of both a regulatory and enabling nature. The second is the market power in rejecting unsustainably produced items or demanding certification or other proof of sustainability. Over the coming 5 to 10 years it is quite likely that both domestic and international markets for Chinese goods will feel pressure from environmental concerns. There is an increasingly coherent approach being followed in environmental regulation, especially at the national governmental level.

5. Attract much more Chinese and international venture capital and private equity in support of environmental services and new environment and sustainable development initiatives, especially those at the start-up and scaling-up stages.

At the leading edge of investment is the role that could be played by venture capitalists in support of environmental and sustainable development innovation. Venture capitalists are typically needed in order to move innovations arising from small entrepreneurial companies from a preliminary stage of development to become a commercially viable operation. Use of venture capital in China is still at a stage where there are numerous problems, including an insufficient regulatory framework, and satisfactory relationships between entrepreneurs and the venture capital sources. There are many types of opportunities available, and until recent times environment has not been the focus of as much attention as other fields such as information technologies and biotechnology. However, the highlighting of energy efficiency and pollution control as key objectives in the 11th Five Year Plan has elevated their significance to such investors.

Environmental services companies will likely prove to be attractive to private equity sources in future years. The conditions to support more private equity investment for environmental protection include: a need for consistent drivers so that there is reasonable assurance of a growing market demand and profits that are at least as good as alternative investments; fair regulatory frameworks that

ensure a level playing field for enforcement and therefore interest—on the part of municipalities, the construction sector and various industrial sectors—in purchasing both environmental equipment and services; and knowledge of the opportunities that are likely in the coming years. Government may also provide some direct stimulus through public procurement policies that favour environmentally friendly products and services. Fortunately, there is a growing understanding of energy efficiency and environmental protection investment opportunities in both the venture capitalist and private equity communities within China.

6. Ensure adequate flow of innovation benefits concerning environment and sustainable development to less wealthy and rural areas of China, especially via the strengthening and support of small- and medium-sized enterprises (SMEs) throughout the country

While most funds for environmental innovation R&D and follow-up commercialization are likely to flow into urban areas where universities, research centres, industry and commercial activities are concentrated, there are many applications that must be developed to meet needs associated with the countryside. Throughout China, the future strength of entrepreneurship will continue to be expressed largely through the remarkable number and variety of SMEs, including many located in smaller centres.

Megaprojects, including giant water and energy initiatives; some transportation projects such as the Qinghai-Tibet Railroad; regional development in China's Northeast and in the Pearl Delta; and development of new cities encroaching into rural lands all have the potential to introduce not only a wide array of environment and sustainable development innovation technologies, but also vastly improved planning and management.

While China has undertaken many unique engineering initiatives in terms of scale and complexity, they alone cannot ensure sustainable development nationally or in the various regions of China. It is particularly important that there also is sufficient scientific effort devoted to solving the many problems related to intensive use of landscapes, ecological construction and restoration, development of eco-communities and green buildings at all scales, including those in smaller cities and towns, and improvement of environmental quality in coal mining and heavy industry. This need is recognized in the new S&T strategy. The Asian Development Bank has noted[10] that SMEs are "more flexible in meeting the market demand for new technology and are therefore able to achieve rapid growth in the market." However, more needs to be done to provide an integrative approach that fosters and takes full advantage of small- and medium-sized enterprises potential to be local and sometimes national entrepreneurs.

The integrative effort should include not only capacity development within the national innovation system to build local environment and sustainable development S&T competence, but also fostering the necessary private sector and venture capital funding opportunities directed to meet needs of SMEs. In addition, within local and pro-

10 Asian Development Bank. 2002. *The 2020 Project. Policy Support in the People's Republic of China*. Chapter 8. *Technology Policy*. ADB, Manila.

vincial level governance, more emphasis must be placed on building appropriate enabling arrangements for entrepreneurs to work successfully but without creating funding sinkholes.

It is at local and regional levels where considerable effort must be applied in order to create *adaptive strategies* for environmental problem-solving. This is a key concern for climate change, for addressing problems associated with natural disasters, and for issues such as desertification and maintaining ecological services. Adaptive strategies recognize that it is human behaviour that must be modified to successfully address environmental change. Such strategies depend upon a blend of technological application, good environmental planning, innovative economic incentives and a high level of public understanding and input.

7. Seek better solutions to high licensing fees, more timely and reasonable access to advanced technology and in general, build more proactive approaches to intellectual property rights matters for environment and sustainable development.

The balance between indigenous technology development and the utilization of environmental technology developed elsewhere will be determined by many factors, but certainly issues surrounding intellectual property rights and cost of access rank high. The problem is more complex than monetary factors only, however. Those possessing advanced technology are wary of losing control over rights, or unauthorized copying, acts of industrial espionage, etc. And there is also sometimes a concern about the absorptive capacity, which leads to staged access rather than leapfrogging.

In the coming years, as Chinese industrial and manufacturing development matures even further, and as the domestic environmental industry sector grows, there should be a much greater capacity and opportunity to assimilate advanced technologies. The value attached to these technologies quite likely will be even greater than today. And there will be new options, especially in alternative energy technology, green chemistry, biorefineries and other applications involving biotechnology and information technology. Energy efficiency, new coal technology and transportation are other areas where major advances are already occurring.

What will be needed are more effective international partnerships and joint ventures aimed at building the levels of trust and understanding, and experimentation with new approaches towards sharing technological experience and advances. In general it should be in the best interests of the rest of the world to accelerate the pace of China's transformation towards clean and efficient technology. Despite broad agreement about this statement, action has been relatively limited by comparison to the need. This is true for both government-to-government (e.g., EU S&T initiatives) or at the level of enterprises (e.g., the limited innovation efforts by overseas automobile manufacturers operating in China).

It is encouraging that new models are emerging; for example, the recently announced JUCCCE (Joint US-China Cooper-

ation on Clean Energy), a not-for-profit initiative designed "to accelerate 30 years of clean energy development into 10 years." It will bring together the US and Chinese government, business, research, and investment interests to address China's current energy efficiency and pollution control priorities. Existing, but still evolving international mechanisms such as the CDM (Clean Development Mechanism), and TRIPs (trade-related intellectual property rights) present future opportunities for China to make further gains towards more equitable arrangements on terms for technology access.

China also will benefit if it becomes a nation capable of exporting environment and sustainable development technology and expertise. This is already the case with solar panels, where China is a leader. New export markets for environmental products, taking advantage of China's comparative advantages such as lower production costs, could help to offset some of the fees paid to license advanced technologies. It also is a means of building economies of scale so that Chinese domestic markets can take advantage of more reasonably priced environmental goods.

8. Develop shared regional policies and practices with key countries and country groups within Asia and the Asia-Pacific region in order to create greater demand for environment and sustainable development innovation, and to create new markets for Chinese environmental goods and services.

With the rising level of need and interest in environment and sustainable development throughout the Asia-Pacific region, especially in South, Southeast and East Asia, there are good opportunities for China to build cooperative environment and sustainable development innovation ventures within the region. The advantages are obvious since often problems are shared or of a similar nature, costs of gaining access to appropriate levels of technologies may be less, and a clean environment will benefit all within the region. Also, there are bodies available that promote cooperation, such as ASEAN and APEC.

With huge populations and booming economies, markets for environmental goods and services in South and East Asia will become larger and larger. Yet there is insufficient cooperation to build a truly cutting edge approach that would take best advantage of the opportunities. It is striking that most of the international technology cooperation, venture capital access and capacity building necessary to supply these growing markets adequately are still via North America and Europe (along with considerable Japanese and growing Korean involvement). China and India could change this equation very significantly through cooperation to become regional environmental innovation leaders.

9. Recognize the role of producing and disseminating reliable information on environment and sustainable development as a central component of national innovation strategy.

People and communities need to understand benefits, costs, and risks associated

with innovation for environment and development and have direct access to benefits; otherwise there may be backlash. Fostering a culture of innovation within a country as large and diverse as China depends on education, public awareness, and a sense of opportunity. Environmental decline is now recognized as a matter of high concern by many of China's citizens, yet relatively few would be able to link problems and solutions to specific modern technologies or other innovations. Certainly the same was true in many western countries until a generation ago. Much of today's enhanced environmental perception has come about through a better understanding of pollution science, ecosystem analysis, etc., accompanied by an active media involvement to popularize scientific findings and to interpret environmental changes. The debates accompanying the search process to define the nature of problems and possible solutions have become an important part of democratic processes.

China's future choices on how and where to engage in scientific innovation for environment and sustainable development one way or another will be influenced by the voice of its people—whether operating through consumer choice, consultative processes, or other ways. It is essential that choices be informed by the best available Chinese and international knowledge, and that will require deliberative dialogue on technology, institutional performance, assessment of impacts and other concerns of the people.

10. Use China's comparative advantages to engage in the substantial markets for green products and services for both domestic and export markets.

China's low labour costs and skilled labour supply, ability to rapidly set up modern, efficient manufacturing plants, and technological design skills can be used to build international leadership in green markets of the future. Part of China's advantage, of course, is the enormous potential size of domestic markets. Chinese businesses have been able to do this already with solar panels. Another opportunity clearly will be in the manufacture the next generation of lights to replace incandescent bulbs.

China has developed unique capabilities related to implementation of Circular Economy. Utilization of the world's waste paper is a one of the most significant examples of how China can meet its needs while contributing to the solution of a global problem. The idea of a Circular Economy is an important expression of an environmental-friendly society. It is one of the most concrete ways to address environmental innovation.

2.8 Conclusion

China's strategic transformation on environment and development may well be unlike that of any other country. Coming some 30 years later than transitions in the OECD countries, China's transformation can be informed by many good and bad experiences of others. The challenge is for China's effort to be more successful than any other nation. Although there are many barriers domestically and internationally,

there is also good reason to believe this success could be achieved so that China becomes a model for others.

Would it be in China's best interest to do so? And how substantial would be the economic, social, environmental and political benefits to the country？These are questions that will need to be debated. But it is clear enough that the entire world will benefit if China is successful.

Therefore, China's commitment to innovation for an environmental-friendly society is likely to become one of the great experiments of our time. It needs to be supported through accelerated efforts to more rapidly find ways to address such difficult and pressing problems as clean coal combustion and utilization, and mechanisms to properly assess new technologies so both domestic and international confidence is maintained. The experiment will start to demonstrate its benefits immediately, both to China and outside its borders. But the greatest payoffs will come in the longer term, hopefully to China's society of 2020, and to the world of 2030 when significant transitions in energy use, industrial ecology, Circular Economy and other innovations should be universal.

Chapter Ⅲ

Building an Environmentally Friendly Society Through Innovation: Challenges and Choices*

3.1 Introduction

Since the industrial revolution in the UK in 1800s, the world has entered a fast stage of economic growth and civilization. This is seen in the increase of the wealth per capita, first in developed countries, and now in the developing countries in the last two centuries. A variety of man-made goods were invented and used each year. But the global resource and environmental situation is already beyond the earth's longer-term carrying capacity. The modern existential crisis, which the Western capitalistic structure has placed itself in, is getting out of control, and manifesting itself in a self-destructive process. Though many government, international organizations and non-government organizations have already spent great effort to reverse the process, it seems that incremental environmental improvements are not good enough to deal with the ecological, health, and development challenges of rapidly rising consumption and population growths. Today, it seems there is no globally recognized strategy for economic growth leading to sustainable development.

China, as a country that is quickly catching up, has entered a period of rapid economic growth. From the 1980s onward, it has witnessed fast economic development and outstanding achievements; however, this comes at the price of its resources and environment. The conflict between economic growth and resources and environment in the nation is becoming increasingly acute.

The uniqueness in China's growth and crises has its roots in several factors. First, China is a world-manufacturing base and produces a lot of goods for the world. Secondly, China is entering its heavy-chemical stage of industrialization. In this stage, pollution per GDP is higher than at other stages. Thirdly, for a long time there has been mismatched strategy: government emphasized economic growth and neglected the equally important sustainable development.

As China faces a challenge that other countries do not have, the Chinese government has decided to build an environmentally friendly society. China could lead the

* The chapter is based on the outputs of Task Force on Innovation and Environmentally Friendly Society. Task Force Co-chairs: Feng Zhijun, David Strangway; Task Force Members: Wang Chunfa，Liu Xielin，Wang Kaijun，Meng Wei, Xue Lan, Granger Morgan, Kelly Gallagher, Tom Preststulen. The Background Report drafting was coordinated by Liu Xielin. Chinese experts Song Xiujie, Zhu Chaowei, Jiang Jiang, and Dai Hongyi are drafting team members.

world in environmentally friendly technologies, provided it catches the opportunity for radical innovations.

Introduced into China in 2005 as a development concept, an environmentally friendly society is one where harmony between man and nature and man and man is promoted on the basis of the carrying capacity of the environment and resources, under the guidance of natural law and by means of sustainable economic, technological and cultural policies. The aim of such a society is to create an efficient productive system, a moderate consumption and living system, sustainable and recycling resource environmental systems, a stable and efficient economic system, an innovative technological system, open and orderly trade and financial systems, a fair distribution system and an enlightened and progressive socialist democratic system. For the 11th Five Year Plan period, China has set the goals of reducing energy consumption per unit of GDP by about 20% and cutting down the total discharge of major pollutants by about 10%. To achieve these goals, it is necessary to uphold the scientific development outlook, develop recycling economy through advanced technologies, and accelerate the building of a resource-efficient and environmentally friendly society though innovation. These efforts are also fundamental to breaking restrictions of resources and the environment and creating better and faster socioeconomic development. Currently, a conspicuous problem China faces is that it has accumulated some advanced environmental protection and energy-saving technologies, but without strict technical controls. Related technologies from the developed world have yet to be introduced to businesses and families. In this sense, it is imperative for the nation's environmental sector to accelerate the entrance of environmental technologies into economic activities and put them to good use. In response, this study aims to find a workable solution from the perspective of the National Innovation System (NIS), to help China transform into an environmentally friendly society.

Innovation comes from the bottom up, not from the top down. China needs to develop incentives to stimulate innovative ideas. This could form a major investment to ensure competitive proposals are received and evaluated strictly on a merit basis. In the long run, it is clear that many ideas need to be supported, since very few innovations will be commercially relevant in the short term. Basic research in fields such as Information and Communication Technology, Nano/Material Technologies, and Bio-technologies need to be fostered at globally competitive levels. Some of these can lead to short-term implementation, but others will provide the basis for capturing long-range ideas.

One of the key elements of a successful innovation system is a cultural setting that allows entrepreneurs to try a new idea, fail without being disgraced, and be given the resources and opportunity to try again. Creativity and innovation, while having a somewhat different meaning, are to a large degree one and the same. China, along with many other countries, has focused much of its education on developing highly specialized skills. These are important in today's

global world. But it is also important in today's world to release the creative potential of individuals and groups. The culture of breaking down disciplines is essential for innovation in science, technology, institutions, and societies that this report documents are needed for the environmentally friendly society.

3.2 Achievements and Challenges of Technology Innovation in the Building of an Environmentally Friendly Society

3.2.1 Achievements of Innovation in the Building of an Environmentally Friendly Society

Environmental protection technology application and innovation are carried out in China either through domestic development or the introduction of technologies from developed countries. This is done by means of joint investment, technical cooperation or technical transfer. China's environmental technologies generally develop rapidly and promise a large potential, with some approaching or even having reached the developed world's levels.

With its rapid economic development, China has increased resources to address environmental issues with greater inputs into advanced technologies. Firstly, China rapidly reduced its electricity consumption per GDP since 1980s. It means that China continuously introduced new technology to improve production efficiency (Figure 1).

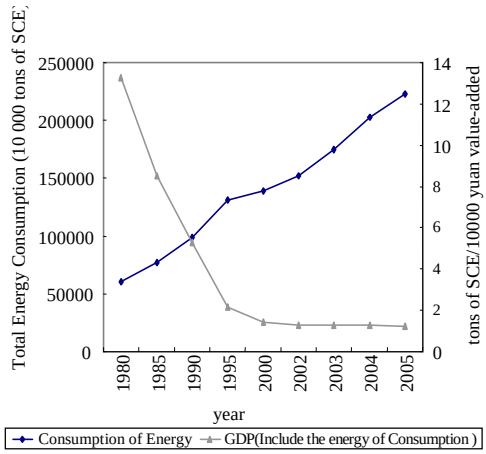


Figure 1: Consumption of Energy in China

Source: China Statistical Yearbook (2006). Beijing: Chinese Press of Statistics, 2007.

Secondly, over the past years China has implemented the national key "water pollution control technology and treatment project," which has led to a workable technological plan and a supporting technological system for water pollution control. Plus, the application of environmental monitoring technologies and facilities, the research and development of such pilot programs as purification of vehicle exhaust gases, desulphurization of flue gas discharged by coal-fueled boilers, disposal of solid waste, cleaner production of key sectors, and other key technologies have effectively improved pollution control and environmental quality in some areas (e.g., river basins). Wastewater discharge per unit of GDP has been decreasing in the last five years (Figure 2).

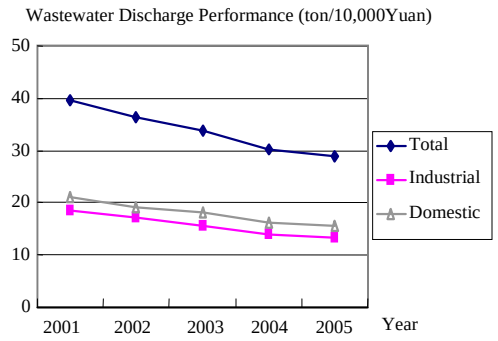


Figure 2: Wastewater Discharge Performance per Unit of GDP in the 10th Five Year Plan Period.

Thirdly, new processes and techniques have been developed to cope with the needs for urban sewage treatment in China by means of advanced approaches for nondegradable wastewater such as bioaugmentation, catalytic oxidation and membrane-biotreatment, as well as high-efficiency inorganic polymeric flocculants. Application of these technologies has helped effectively control water pollution in the key river basins nationwide. Of the 2,130 water pollution prevention and control programs in key drainage areas in the 10th Five Year Plan, 1,378, or 65% of the total, had been completed by the end of 2005. In the drainage areas of the three rivers (Huaihe, Liaohe and Haihe) and three lakes (Taihu, Dianchi and Chaohu), 416 wastewater treatment plants have been completed or are under construction, with a daily treatment capacity of 20.93 million tons. More than 80% of the over 5,000 heavy polluters in these basins have reached the standard for discharge level. As a result, water pollutants in these areas have been greatly reduced, the trend of water environment deterioration has been basically controlled, and quality of water in some parts of the rivers and lakes has notably improved. Statistics show that adoption of new environmental technologies and strengthening of pollution control during the 10th Five Year Plan period has led to remarkable reduction in China's COD emission performance, with more noticeable results seen in 2001-2004 and less reduction in 2005. The emission of COD per unit of GDP in 2005 was 39.45% lower than in 2001.

3.2.2 Challenges to China's Sustainable Environmental Development

It is important not only to consider improvements in environmental management on a per GDP basis (this is referred to as intensity targets), but to also ensure that total pollution is being reduced (this is referred to as absolute reduction – see Table 1). Continued commitment to GDP growth means that the pollution emission per GDP, while important, does little to solve the overall problem. The pollution emission levels must be reduced.

China now faces a very serious situation in sustainable development. Take the year 2006 for example, when the total discharge of wastewater was 53.68 billion tons, up 2.3% from a year prior. To be specific, industrial wastewater declined by 1.1% from the previous year to stand at 24.02 billion tons, accounting for 44.7% of the total; and municipal domestic wastewater rose by 5.8% from the previous year to reach 29.66 billion tons, representing 55.3% of the total.

Table 1 Some Indicator of Air Pollution in China

Atmosphere Environment	2001	2002	2003	2004	2005
Industrial Waste Air Emission(100 million cu.m)	160863	175257	198906	237696	268988
Fuels Burning	93526	103776	116447	139726	155238
Production Process	67337	71481	82459	97971	113749
Sulphur Dioxide Emission (10 000 tons)	1947	1927	2159	2255	2549
Industry	1566	1562	1792	1891	2168
Non-Industrial	381	365	367	364	381
Soot Emission (10 000 tons)	1070	1013	1049	1095	1183
Industry	852	804	846	887	949
Non-Industrial	218	209	202	209	234
Industrial Dust Emission (10 000 tons)	991	941	1021	905	911
Industrial Sulphur Dioxide Removed (10 000 tons)	565	698	749	890	1090
Industrial Soot Removed (10 000 tons)	12317	13998	15649	18075	20587
Industrial Dust Removed (10 000 tons)	5322	5570	5995	8529	6454
Number of Soot Control Zones Established (unit)	3203	3369	3599	3693	3452

Source: China Statistical Yearbook (2007). Beijing: Chinese Press of Statistics, 2007.

The volume of sulphur dioxide rose by 1.5% from the previous year to reach 25.888 million tons; and soot emission fell by 7.9% from a year ago to 10.888 million tons. Investment in pollution control across the country grew by 7.5% from a year ago to hit a record of RMB 256.78 billion Yuan, or 1.23% of the then GDP. Serious accidents of environmental pollution and damage occur nationwide. The quality of 26% of the nation's major rivers was lower than grade V standard. 75% of the lakes became eutrophic to varying degrees. 360 million of the rural population had no access to up-to-standard drinking water[1]. It is estimated that China's current discharge of major pollutants, like sulphur dioxide, carbon dioxide and chemical oxygen demand (COD), far exceeds the environmental capacity, indicating the nation has already entered a period of high incidence of environmental pollution accidents. The grave reality tells a fact: unless China breaks the resource and environment bottleneck, it will see its resources, energy and eco-environment no longer able to sustain and guarantee its national security. Vice Premier Zeng Peiyan recently said with reference to the current status of the environment and prospects going forward, that "The sustainability of China's economic and social development is at stake."

To sustain its economic development and become an environmentally friendly society, China needs to make four major transformations. First, in terms of economic growth pattern, the impetus to growth should be transformed from investment and export driven to domestic consumption and

1 China Environment Statistics Bulletin 2006.

international demand driven. Second, from the perspective of industrial structure, the manufacturing industry should give way to a combination of industry, service sector and agriculture as the driving force behind economic expansion. A steady migration to the knowledge economy is going ahead. Third, on the level of production factor inputs, the basis for development should be shifted from capital and natural resources to human resources and technical progress. Fourth, with respect to resource utilization, the unidirectional linear process of resource waste and product waste should give way to the feedback cyclic process of resource waste and product waste resource recycling[2]. These transformations aim to base economic growth on optimized economic structure, increased technical content, improved quality of population and enhanced quality and efficiency and to give rise to an economic growth pattern characterized by low inputs, high yields, low consumption, low discharge, recycling and sustainability. The core idea here is to promote the development and application of energy-saving and environmentally friendly technologies, with technology innovation as the source, institutional innovation as the guarantee, and social innovation as the basis.

3.2.3 Problems in Environmental Technology Innovation

Despite the successes in the development and application of environmental technologies, we should understand that China still faces a grave overall environmental situation and lags far behind developed countries in environmental engineering equipment. Its common problems remain pronounced, and it has not yet met the requirements of environmental management. Thus the harmonious development of the environment and economy is inhibited. The problems are shown in the following aspects.

(1) Lack of overall strategic planning results in repetitive technology introduction.

China currently has 11,555 environmental protection bodies and 266 environmental research institutes. Nevertheless, one basic feature of its environmental technology development is "taking everything," which means it has used technologies of different countries and different standards, either in R&D or engineering practice.

In 1987-2001, China received a total of USD $5.55 billion in loans, 49.7% of which was from the World Bank, 23.9% from Asia Development Bank, and 26.4% from the Japanese government, to support 45 environmental protection programs.

During the 8th Five Year Plan period, China borrowed 1.21 billion US$ from international financial organizations, and the figure more than tripled to hit 3.98 billion US$ in the subsequent five years' time[3]. The amount borrowed from international financial organizations accounted for over one half of the total foreign capital that went to

2 Ma Kai, Development of Recycling Economy, Building a Resource-efficient and Environmentally friendly Society, *Qiushi*, 16th edition (2005).

3 He Kaili, Song Jianjun, China Environmental Protection Industry, 7th edition, 2002

the nation's environmental protection programs.

In terms of project implementation and completion, capital from these organizations made up for serious fund shortages, helped improve the production and living environments, and pushed forward the development of China's environmental protection sector. However, the lack of overall strategic planning on technology selection, coupled with the rather exacting requirements on procurement that generally come with international loans, made it impossible to guarantee that the procured technologies were the best.

For instance, the German government requires that limited competitive bidding should be carried out for a project financed under its loan and over 50% of the project's goods and services should be supplied by Germany. The Netherlands requires that procurement of technologies, equipment or services worth more than 50% of the values of a contract financed under its loan should be made in the country, and supplies other than from the Netherlands should be contracted by the Dutch suppliers and be insured with Credit Insurance Ltd. NCM. In the case of South Korea, the government requires that the successful supplier of a project funded under its loan should be selected through limited competitive bidding from eligible South Korean suppliers. In addition, 75% of the equipment and services should in principle be procured in South Korea with the remaining 25% in China or a third country.

Due to the above restrictions, the primary instrument and elements for process control of pollution treatment facilities and for environmental monitoring cannot be localized, and thus have to be imported again and again. In any case, China has not put in place specific policies, guidelines and equipment (product) standards to provide overall strategic guidance for technology introduction. This has also contributed to the blind and repetitive introduction, impeded introduction channels and introduced technologies that are unsuitable for China. An example of repetitively introduced technologies is the desulphurization technology for thermal plants.

China has now substantially improved its overall funding capabilities and should therefore address the issue of overall strategic planning in a new light. Major funding would be needed in order for China to take the global lead. This would not only help China to deal with its own dramatic environmental problems, but by developing this as an indigenous specialty by creative funding incentives for the private sector, governments, universities, and research institutions, new growth industries would emerge for the global markets.

(2) Absence of technical assessment standards and means prejudices the effectiveness of technology introduction.

Absence of assessment, pilot programs and tracking for technology introduction, combined with the headlong pursuit for "popularity" to the neglect of maturity, have turned China into an experimental field for all kinds of technologies. Huge amounts of money have been spent only to find the results are unsatisfactory. Unavailability of corresponding specifications and standards

(for interface, for example) has led to the introduction of different types of monitoring devices that cannot operate on a uniform platform. Besides, scientific and effective assessment means are available to assess these devices for accuracy and reliability. As a result, many online monitoring devices cannot be connected to the networks of the environmental departments, or even if they can, they are unable to provide reliable data to support the management of the environmental departments. These problems have not only prejudiced the effectiveness of technology introduction, but also resulted in a huge waste of state capital.

A remedy to this situation would be to establish a number of competence centres for research-focused innovation with a high international scientific quality. Emphasis should be given to cooperation between research-intensive companies and renowned research institutions. In this context, transfer of technologies, internationalization, and education of scientific researchers should be strengthened and adequate incentives provided. By using such centres to establish rigorous standards, and then applying these standards rigorously, innovation in itself would result.

(3) Most domestic developed new technologies are not mature enough to be put into industrial application.

A longstanding problem in China's development efforts is the lack of connection between development and production engineering. This is primarily attributable to the fact that the results are not mature enough to be put, or effectively put, to practical commercial and industrial use. A solution to this problem requires the creation of a development system integrating production, education and research, a system that is oriented toward economic development and environmental protection, and based on the support of businesses. In addition, capabilities should be enhanced for market demand forecast, technology selection and assessment, and technology application forecast, so as to identify environmental protection technology development plans that meet market demands. It is also necessary to strengthen capabilities to make the research results more practical and to introduce them to the market and expand their market share. A technology extension system and a venture capital investment system for technological development and application should be created.

(4) An incomplete technological assessment system impairs transformation of technological results.

China has made great headway in both the transformation and extension of environmental protection technologies and its ever-improving technological system. Nevertheless, it still lags far behind the developed countries in the transfer rate and contribution rate of technological results, with some virtually becoming stagnant and unable to be connected effectively with production. For instance, 84% of the technological achievements in the 7th and 8th Five Year Plan periods reached the intended advanced levels, but few were applied. This result is attributable to (a) lack of an objective and equitable environmental technology assess-

ment system; (b) failure to connect technical assessment with the overall strategy on environmental protection and strategy on environmental technology development; (c) failure to gear the technological project assessment toward the state's major demands on environmental management and pollution control; (d) absence of widely applicable and representative assessment technologies; (e) the extension efforts, which are not systemic and not connected to the targets of environmental management, are unable to provide support for environmental management; and (f) disorderly competition, which makes the effective transfer and extension of good technologies impossible, leading to poor investment results, huge waste, and slow pace in minimizing pollution.

(5) No systematic management and scientific guidance is available for pilot programs.

Pilot programs cover new technologies and introduced technologies. As for new technologies, constant improvement and follow-up development will still be needed during the pilot process. All pilot programs have limited applicable conditions, so in order to make a program serve as a model and provide guidance to other similar techniques, a systematic management system and the corresponding supporting research and monitoring means should be provided. This will indicate the program's conditions, results, and applicable scope in a comprehensive, systematic, and complete manner. However, instead of whole process management, current management is limited to technical assessment after program completion.

(6) The creation of a national environmental technology innovation system with businesses as the main players has not been decided.

Environmental technology development in China largely relies on specialized colleges, universities, and institutes. Over the past years, domestic environmental engineering firms have grown rapidly with improved strength in capital and technology. However, they are too preoccupied with undertaking projects to devote any resources, technological or economic, to development. That explains, in part, why China still has to import some core technologies and key equipment. As well, these firms have not established a technology innovation system, and most users, averse to the possible localization risks, require procurement of a certain proportion of foreign equipment. All these lead to the low localization rate of environmental engineering equipment. The low rate directly affects China's environmental protection technology development, which in turn makes localization more difficult.

3.3 Environmental Technology Innovation: International Experience

3.3.1 Measures and Experience of the European Union (EU) in Pushing Forward Environmental Technology Innovation

The European consumers are increasingly concerned about environment and health. The EU has become a leading manufacturer and exporter by encouraging consumers to buy green products, which leads to more stringent environmental standards. They also promote environmental technologies, which have boosted the competitive advantages of some sectors (e.g., power generation, photoelectricity, wind energy, and water management techniques and treatment).

The Environmental Technologies Action Plan (ETAP) adopted by the European Commission on January 28, 2004, aims to harness all potential to reduce pressure on natural resources, improve the quality of life of European citizens, and stimulate economic growth. ETAP complements the EU's sustainable development strategy and supports the Lisbon strategy, and is therefore ready to be adopted by developing countries. The EU encourages adoption of advanced environmental technologies in each investment and makes corresponding target decisions. These measures will further expand market and lower cost, and are supposed to be jointly implemented by the commission, member states, research bodies, organizations, industries and communities.

The objective of ETAP is to eliminate obstacles, develop environmental technologies in an all-dimensional manner, protect environment, and promote competitiveness and economic growth. It aims to ensure that in the forthcoming period the EU becomes a leading force in the development and introduction of environmental technologies in the developing world. Finally, it intends to mobilize all the involved parties to actively participate in this plan. To better implement the plan, the EU has studied the three key points of environmental technologies: from development to market, improvement of conditions for market operation and global actions.

Given the worldwide economic growth and pressure on natural resources, existing technologies are not adequate to safeguard sustainable development, in the longer term. The Action Plan puts forward actions to attract more private and public investment for the development and demonstration of environmental technologies. The actions aim to improve the innovation process and to take inventions out of laboratories and onto the market.

The EU has two initiatives for creating technology platforms and testing networks with an intention of understanding how to establish public-private partnerships and how to bring research closer to the market. A technology platform brings together all the interested stakeholders to build a long-term vision of developing and promoting a specific technology or solve particular issues. The EU decided to build two environmental technology platforms for hydro-

gen, fuel cells and photovoltaics in the first half of 2004 and technology platforms for water supply and sanitation in early 2005. These platforms are built on projects with environment, economic and social benefits.

Testing environmental technologies verifies the performance of innovative technologies and helps protect human health and environmental safety. The establishment of networks of testing centres makes the information consistent and comparable and assessment parameters reliable.

3.3.2 Measures and Experience of the US in Pushing Forward Environmental Technology Innovation

The Environmental Protection Integration (EPI) initiated by the US aims to integrate the environmental concerns into the existing departments, related policies, organizational arrangement and power structures. Development of EPI experienced four stages, from reliance on the state governments to federal regulation, further to support for sustainable development. EPI as a policy tool has been widely adopted across the US.

Apart from having spent substantial funds over decades in developing environmental technologies, the US government has put great emphasis on partnership with businesses and research bodies. A case in point is the Advanced Technology Plan (ATP) carried out by the Department of Commerce in 1990-1999, which covered the technological field of energy and environment. Implementation of ATP involved the US government, research bodies, and private businesses, which contributed over half of the total investment and were entitled to use the technological results derived from the plan. This method not only leveraged funds from more diverse sources but also promoted technology application. What's more, the US government has set great store by research cooperation between various departments. The (Environmental Protection Agency) EPA-led cooperation plan in 1994, which was designed to enhance technology sharing among departments, facilitated the application of environmental technologies in various sectors. The national environmental technology strategy unveiled in 1995 aimed to guide, coordinate and push forward the development, application and commercialization of environmental technologies.

The Environmental Technology Verification Program (ETV) initiated by EPA verifies the performance of environmental innovative technologies. The ETV greatly accelerates the entrance of environmental technologies into the domestic and international marketplaces. Created in October 1995, ETV carries out assessment of environmental technologies (air, water, soil, ecosystem, waste, pollution prevention and monitoring) performance as a public-private partnership. The technology purchasers and vendors, license holders, consulting engineers, financiers and exporters, in particular those in technology sectors, guide ETV efforts. Vendors of all kinds of technologies may apply for verification. All the test/quality assurance plans require the joint participation of technological experts and applicants, and update is subject to peer review or test. Immediately after a technology has been verified, all the related test proce-

dures, performance reports and verification statements will be published on the ETV website. Execution of ETV quality management plan (compatible with the quality standards recognized by the US and internationally) assures the highest data quality.

Starting in April 2004, ETV conducted four surveys: consumer satisfaction with ETV website, ETV's impact on the sales volume of environmental technologies, degree of technology innovation, and the purchasing power for the verified technologies and adoption of such technologies in decision-making process. The first survey was conducted in February 2004, while the latter three were carried out from 2005 to 2006. So far, 272 technologies have been verified.

3.4 Environmentally Friendly National Innovation System (NIS): A New Model

Building a resource efficient and environmentally friendly society requires having a sustainable development road with high technical content, good performance, little resource consumption, and little pollution. But how should the lack of initiatives to innovate during the process, as well as the underlying causes, be dealt with? How should the failures of governments, markets and systems that are commonly seen throughout the process be dealt with? Only by combining NIS with sustainable development can we establish a new technology-economy model featuring resource efficiency and environment friendliness.

The education systems of China and many other parts of the world focus on training people with highly specialized skills. It is often the case that these specialists are trained to a level of expertise that does not permit them to be creative. The concept of creativity as a key to innovation needs to be introduced into the universities and colleges of China. This may take some radical restructuring.

Another aspect would be to establish a national network of centres, with the task of assessing all current situations affecting the environment on a continuous basis, and monitor the developments towards the target conditions for improvements with the overall objective of reaching a status of excellence – a prerequisite for taking the global lead.

3.4.1 Building an Environmentally Friendly Society Requires the NIS to be Aligned with Sustainable Development

An NIS is an institutional arrangement whereby technologies are integrated into the economic growth process. The core of the system is to create a favorable mechanism under which technology and information flows and is applied throughout the society, on the basis of interactions among the technology developers, disseminators and users and government bodies. The system in reality is manifested as a network of businesses, universities and government bodies in a nation focusing on technological development. It creates an interactive network mechanism, under which, all players carry out a variety of technological, commercial, legal, social and financial activities to develop, protect, support and regulate new technologies.

It is generally held that an NIS primarily consists of businesses, research institutes, research-oriented universities and colleges, general education institutions, public labs, intermediaries and others innovation-related government bodies. The core elements of these are businesses as the main player of innovation; research bodies and research-oriented universities and colleges as the technology, education, and training suppliers; and intermediary organizations as the major force for technology transfer and diffusion. The relations among these elements have a direct bearing on the information flow within the NIS. The governments are the coordinating bodies in the system; and a nation's financial system, history and culture, which constitute the basic ecological environment for NIS operation, have a direct impact on the system's operation performance. The NIS setup refers to the framework of the relationships among the parts involved in technology and information flow. The core of the NIS is the interaction among the developers, users and disseminators of technologies. Other factors actually function as the conditions or background for the NIS. There are two core issues: information flow and system failure.

First, from approach of NIS, it is not enough to just have resource efficient and environmentally friendly technologies. What is of real importance is the flow and wide application of technologies among players. Second, the external factors that influence the efforts to build an environmentally friendly society through environmental technology innovation include not only the institutional guarantee and financial system, as provided by the Chinese government, but also historical and cultural factors that are hardwired in the people's ideology. Therefore, technology innovation aside, it is necessary to initiate social innovation to create social and cultural environments that encourage all players (governments, businesses and citizens) to actively adopt environmentally friendly technologies. Third, environmental technology innovation is plagued by the failures of markets, governments and systems. The key to creating institutional innovation favourable to environmental technology innovation is ideological innovation, and this leads to innovative social transformation.

Under the guidance of the scientific development outlook, the NIS is an institutional system that fully reflects the values of natural resources and ecology. It is also a sound development mode under which the economic reproduction is organically connected with natural reproduction. By allowing sustainable development to be based on technology innovation, this mode greatly promotes the sustainable development of the human society. The NIS, guided by the scientific development outlook, is reflected in the following three aspects:

(1) "Green" technology innovation. Efforts to develop environmental technologies should be strengthened to ensure that the supply meets the requirements of socioeconomic development. Environmental requirements should be proposed for all the research development activities through assessment from the perspective of environment friendliness. Judgment of technological programs should take into full consider-

ation their environmental values, rather than merely economic values.

(2) "Green" institutional arrangements. Related systems should be designed to encourage the diffusion and application of green technologies. These include systems for encouraging businesses to carry out environmental technology innovation and take environmental technologies to the market; to enable them to consume fewer resources; produce less pollution; reduce environmental costs and enhance competitiveness; encourage social organizations and members to actively adopt environmentally friendly technologies and products; and realize the win-win of economy and environment on a broader level.

(3) "Green" economic and social management. The governments' functions should be "green," which means economic functions are combined with environmental protection functions. The scientific development outlook requires us to base ourselves on a system that is conducive to the constant environmental technology innovation. Under the system, environmental technologies flow and are applied among the technology developers, disseminators and users and governments. Under the system, a sound internal mechanism that enables environmental technologies to facilitate sustainable social and economic development gradually emerges.

3.4.2 NIS, guided by the scientific development outlook, needs to overcome failures

A general view of China's environmental technology innovation system's status quo reveals market, system and government failures for technology innovation. As the demand of social development for a "green" NIS becomes increasingly urgent, the adverse impact of these problems appears ever more pronounced.

(1) Market failures. Generally, the majority of environmental technology innovation is not likely to see equitable economic returns directly, nor see compensation from the market for the time being, largely due to the current systems and mechanisms. Considering the long lead-time and large investment of environmental technologies, the businesses that seek short-term profits are unwilling to invest much in such programs. Besides, inputs by the Chinese government are too limited to remedy these failures. As a result, in its transmission process towards a society featuring harmony between man and nature, China lacks the fundamental technological support.

The reasons for market failure are that (a) under the incomplete market system, businesses are not established as the main players of environmental technology innovation. The businesses, therefore, do not have the motivation to echo the government's voice, leading to limited directions of innovation. (b) The markets for technological results transfer and transformation are still underdeveloped, and other related technical and financial markets have just been developed. (c) The nature of environmental technology innovation makes the failures more prominent. The demands of environmental technological research and supply of results are to a large extent decided by the government,

instead of the market. But in drawing up policies, regulations and standards, the government rarely considers the response of the market from the aspects of economy and benefit. (d) Management and decision-making still follow administrative orders, rather than being guided by the concept of market economy. (e) Relaxed law enforcement is rather prevalent, making acting within the law more expensive than acting against the law. The lack of motivation to adopt environmental technologies gives rise to a vicious circle.

It is difficult to establish businesses as the main players of environmental technology innovation efforts in the absence of an appropriate institutional guarantee. Businesses, as the main players in the market, are primarily driven by prospects of profits, without which, they are unmotivated. If businesses are unenthusiastic about environmental innovation, the research personnel will feel unenthusiastic as well. If there is no market demand, results are unable to be translated into productive force and to realize values and bring returns from the market. The research personnel are then unlikely to gear their innovation efforts towards the needs of businesses or to give much attention to results transformation. They never even give any thought to whether there will be a market potential at all in the course of innovation. The important guarantee and prerequisite for environmental technology innovation is to put in place commercial systems, measures and platforms, and to remove the obstacles to commercialization in the course of technological development, diffusion and application.

(2) System failures. If interactions between industrial sectors and universities and research bodies, and between government bodies and businesses are impeded, difficult situations will result. For technology developers, they will see results pile up and a level of profits that is insufficient to sustain the necessary follow-up investment. For technology users, they will not be able to access the leading-edge technologies to replace the backward ones that they have used for a long time. Eventually their demands for environmental technology innovation are diluted. These situations not only result in serious waste of social resources, but also dampen the enthusiasm of technological suppliers and users, putting shackles on the long-term development of environmental technology innovation.

(a) Disconnections exist between industrial or specialized departments and technological authorities, and between different industrial departments that are related to environmental resource management and innovation. The different administrative authorities inevitably give rise to selfish departmentalism. It is a rather common phenomenon that different stages of an environmental issue are managed by different departments, that without clearly defined responsibilities, are often locked in disputes and even conflicts with each other. The technological authorities have different opinions and judgments on environmental technology innovation from the industrial departments because of their different interests. The industrial departments largely proceed from the perspective of solving the actual problems they currently face, and

their understanding of the demand for environmental innovation are relatively practical; whereas the technological authorities usually comprehensively balance the resource distribution throughout the course of innovation, with activities that are related to industrial development being emphasized over environmental protection and other public interest.

(b) Fragmented management systems restrict innovation efforts. The intrinsic nature of environmental issues requires systematic and comprehensive innovation. But in China, technological system and business management system are fragmented, leading to a lack of coordination as to the targets, process and management. This situation affects the efforts to work around the comprehensive and systematic environmental problems. Plus, environmental polices formulated in different stages are inconsistent, causing a large amount of repetitive work and serious waste. In China, less than 20% of environmental technological results have been translated into productive force, and no more than 5% have formed industry scale. However, in the developed countries such as the US, Japan and others, the two figures are over 80% and 30%[4] respectively. Statistics show that China sees an average of 2～3 new environmental protection technologies every day and a total of about 800 every year, but only 10%[5] of them are extended and applied.

(c) Innovation efforts are not systematic. Internal relationships between environmental technologies (e.g., those between the environment and energy, between water resource and water pollution, between industry and agriculture, and between local factors and holistic factors) require that innovation-related activities be considered as a whole. It is important to form the concepts of regions and river basins. China's environmental problems are structural, complex, cumulative and holistic. Its environmental dilemma is closely related to the history of its economic and social development, and is the result of problems of different periods stacking up. It is attributable to both erroneous development concepts and human mistakes. Thus, it is technically impossible to determine which government in which period should be held accountable. And it is also impossible to make the polluter pay by simply separating responsibilities. Solution of the environment problems necessitates the efforts of the central government. Under this context, the current innovation activities are not systematic.

Take, for example, the impact of foreign capital on China's efforts to build an environmentally friendly society. On the one hand, China tries to attract foreign direct investment (FDI) through various forms and levels of policy incentives; on the other hand, a large percentage of FDI that flowed into the nation goes to pollution-intensive businesses in the secondary industries, which deemed as "marginal businesses" in the developed nations, account for 84.19% the total businesses that have received FDI. So, it is certain that FDI contributes considerably to pollution. According to the data of the third national industrial census, most of ozone depleting substances (ODS) were produced and consumed by foreign-invested businesses. Many foreign-invested businesses take advantage of the local government's anxiety to develop economy to ex-

4 Gu Haibo: Exploration of China's Legal Incentives for Diffusion of Environmental Technologies, Science & Technology Progress and Policy, 8th edition, 2005.

5 Xu Wei, Development and Application of Environmental Technologies and Related Property Rights Policies, Decision and Information, 11th edition, 2006.

ploit the loopholes in the environment-related laws and regulations.

(3) Government failures. Currently, how and by what means environmental technologies are managed, still follow orders. Governments work out related regulations and standards and require businesses and other economic entities to follow. Under socialist market economy, the involvement of the market diversifies interests. Even the interests of local and central governments do not always agree, for they inevitably base their decisions on their respective maximum interests. The current environmental legal system and the status of law enforcement don't motivate businesses to consciously meet the requirements of environmental regulations. In an ideal scenario, environmental regulations standards would be stringent and laws would be strictly enforced. Businesses would pay far more for causing pollution in violation of the law than they would for acting according to the regulations and standards, or they would get far more from control than they would spend. Such being the case, the businesses would actively seek every technology possible to lower their pollution control costs. The strong market demand would then push forward the related innovation activities, which in turn would be able to generate returns from the market. But the problem is how to make regulations and standards achieve such results. At present at least, it is something impossible, since decisions will have to be supported by information of businesses; obtaining such information, although theoretically possible, entails huge costs and difficulties. So far, governments have adopted a host of regulations, policies and incentives and carried out promotion and education activities with the aim of promoting technology flow and application and improving the situation where inputs are limited and production, research and education are disconnected – but the results are unsatisfactory.

This shows that only by providing organizational guarantee and pushing forward system reform, can the obstacles to building an NIS guided by the scientific development outlook, be surmounted. The existing organizational systems must be reformed and a system must be created that allows environmental technologies to flow among the developers, disseminators and users. All social organizations and members, including governments, businesses, universities and colleges, research institutes, intermediaries and individuals, should be involved in the process. Businesses should always be a main force in the creation of NIS, and governments should be responsible for remedy market and system failures. Governments should establish a good system framework and implement effective measures to make every social organization and all members consciously spread and use environmental technologies. In an environmentally friendly society, the harmony between man and nature will be stable and long lasting.

3.4.3 The government is a key force behind the sustainable national system of innovation.

Participants in the NIS include businesses, governmental research institutes, universities,

colleges and technological organizations and intermediaries. The linchpin of facilitating the creation of an NIS guided by scientific development outlook, is to enable these participants to interact in a sound manner in order to promote the flow and application of environmental technologies. In this process, the government plays a critical role.

(1) Support businesses to become the major player in technology innovation.

If and how businesses as the major player can boost environmental technology innovation, depends to a large extent on the government's guidance and stimulation. To provide guidance and stimulation, the government should actively invest in development and effectively utilize the existing domestic and foreign achievements. It should provide necessary conditions, improve environment, and deepen reform to encourage businesses to engage in innovation and international cluster innovation. To be specific, it should (a) provide guidance by formulating related economic and technological policies to make businesses the major investor for innovation; (b) change its current manner to support businesses in undertaking national research and development tasks; (c) improve the technological transfer mechanism to support technology integration and application by businesses; (d) help accelerate the creation of a modern corporate system to boost the internal dynamic of businesses for technology innovation; and (e) create an enabling environment for the innovation activities of small- and medium-sized enterprises.

(2) Stimulate environmental technology innovation through financial policies.

Financial supporting policies are the most directly and widely adopted policy tool by the world's governments. They function as the rectifier of market failures to encourage technology innovation. Detailed means include direct subsidy, tax incentives and government procurement. The Chinese government should both refer to international experience and take its own conditions into account when designing a green financial policy package that is sustainable and effective, to encourage domestic technology innovation and international cluster innovation. Under the concept of green operation, it should encourage and guide businesses to take the initiative to invest in development and try to adopt green technologies. It should encourage large businesses with capital or technology strengths to actively carry out environmental technology innovation that promotes the development of green industries. It should support businesses to strengthen education of their employees, making them realize that technology innovation has a direct bearing on the sustainable development of businesses and the society as a whole. In doing this, they will consciously promote and safeguard the green images of businesses in the course of production operations.

(3) Pool strengths to create a financing mechanism for environmental technology innovation.

New environmental technologies are characterized by large inputs, long lead-time and low profits. Considering this, develop-

ment cannot rely solely on the funds provided by the government or depend entirely on the spontaneous workings of the market. Rather, we should pool the strengths of both sides to create a new mechanism. On the one hand, the government should provide funds to create a dedicated financing channel for businesses carrying out technology innovation, and allocate more of its special environmental funds as loan subsidy and loan discount for these businesses. On the other hand, social capitals should be attracted to build a commercial financing support mechanism. For instance, financial bodies dedicated to such businesses can be established by way of borrowing, providing guarantee, issuing corporate bonds and shares, and absorbing private capital to compensate for the absence of institutions when businesses try to get funds for innovation.

(4) Create an intellectual property rights protection system that encourages environmental technology innovation through laws and regulations.

According to the *Paris Convention* and the patent compulsory license system under the TRIPS Agreement, in order to protect the environment and prevent and eliminate environmental pollution, the advanced environmental technologies of developed countries may be used under a compulsory license system. China should broaden the applicable scope of the *Law on Environment Impact Assessment*, which only applies to planning and construction projects to cover the intellectual property rights system, particularly patented and unpatented technologies. It should introduce a self-assessment system; produce more and better environmental protection laws, regulations and standards; step up law enforcement; and popularize environmental education to enhance the public's awareness.

(5) Green assessment for technological activities.

When research institutions, firms or higher learning institutions try to introduce their new technology into use, all should be assessed for technology ethics. Clear conclusions should be drawn regarding the social and environmental impact that may result from related technological activities or results, in order to serve as the basis for project approval.

3.5 Push Forward Environmental Technology Innovation: Foresight and Realization

China is experiencing accelerated industrialization and urbanization, and at the same time witnessing pronounced conflicts between economic growth and environmental protection. The overall environmental situation in the nation remains grim. In some regions, the serious environmental pollution and ecological deterioration goes unchecked; the discharge of major pollutants surpasses the carrying capacity of the environment; water, land and soil are seriously polluted; and pollution by solid waste, vehicle exhaust gases and persistent organic pollutants increases. In the first two decade of the new century, China will see a continuous population growth and the GDP quadruple from the

level in 2000. The greater demands of the economic and social development for resources will put increasing pressure on environmental protection.

(1) Bottlenecks placed by the environment and resources become more severe, and pollution aggravates.

Although on a *per capita* basis the energy and resource utilization rate is low, the *total* energy and resources utilization is extremely high, and discharge of major pollutants has exceeded the environment's carrying capacity. Worse still, pollution and damage has spread from land to offshore, from surface to underground, and from single to combine. Industrial structure pollution shows a spatial pattern of gradient transfer and change. In some key economic regions and river basins, point source pollution, line source pollution and non-point source pollution co-exist, domestic and production pollution stack up, new and old pollutants are mixed, pollution of water, air and soil mutually influences, and safety of nuclear and radio environment is under threat.

(2) Harm caused by new pollutants and persistent organic pollutants is increasingly visible.

Some new pollutants, like antibiotics, endocrine disrupting chemicals, algae toxins, and pesticide oxidation degrade and pose a larger, longer and more unpredictable threat to the ecosystem, food safety and human health. Persistent organic pollutants are causing greater harm. In addition to detrimental national hazards, these problems are starting to have a negative effect on export products.

(3) Ecological and environmental problems become more complex and bring more risks.

Social stability and the environment are increasingly imperiled by such problems as entropic lake and inshore water, regional acid deposition, combined air pollution, soil pollution and non-point source pollution, harmful and toxic pollutants, regional (river basin) ecosystem degradation, biodiversity reduction, alien species invasion, genetic resource loss, and environmental emergencies.

Facing the mounting pressure on resources and the environment, the government puts forward that we should uphold the scientific approach in achieving economic and social development, accelerate building a resource efficient and environmentally friendly society and promote the harmonious development of man and nature. The government has placed resource saving and environmental protection in an important strategic position as it works out the country's development goals. The fundamental tasks of environmental technology innovation are to build an environmentally friendly society, and while ameliorating the overall environment, realize sustainable and rapid economic growth.

(4) Create radical innovation laboratories for intensified research for a more harmonious life.

Appealing physical and virtual places (experimentarium) for modern living should be established, based on a substantial reduction of non-renewable resources. They

should be places that would attract Chinese and international scientists, researchers, PhD students, designers, architects, artists, philosophers, politicians and business people to meet. Here, they could study how to approach sustainable development from different perspectives, based on a profound understanding of the earth's ecological system.

Target what the world could look like as it alienates the cycles of nature. Understand how materials flow. Use materials over and over again. Create a place that shows the world it is possible to live with a high standard of living, and yet have no waste, since everything is utilized effectively. Establish cross-disciplinary and cross-cultural collaborative projects in almost every human activity. Focus on what is really needed and why, away from superfluous lifestyles. Identify large projects that need the contributions of several countries. China provides ecological conditions with enormous diversity; hence it would be beneficial to roll out such projects in China as global pilot demonstrations.

China's future environmental technology demands:

Facing the mounting pressure on resources and the environment, the government has put forward strategy of upholding scientific development outlook in achieving economic and social development, accelerating the building of a resource-efficient and environmentally friendly society and promoting the harmonious development of humans and nature. If China wants to solve the environmental problems that it may encounter in future development, it must build a resource-efficient and environmentally friendly society. To achieve this important goal, we should fully exploit the existing technologies to boost environmental technology innovation. We should focus on and strengthen the development of technologies in the key areas of an environmentally friendly society, areas such as human health, food safety, pollution control, comprehensive resource utilization, advanced intelligent traffic design for cities, design of energy-saving architecture, new energy development and utilization, biodiversity protection, rural eco-environment protection, marine ecology protection, recovery and restoration of degraded ecosystem, protection and enhancement of fragile ecosystem. It is also important to put in place an NIS that promotes environmental protection.

China, as a responsible power, not only works to solve the environmental problems it encounters, but also seeks to contribute to a better global environment. China has participated in the international cooperation in almost all fields. It has set targets for energy conservation and greenhouse gas emissions reduction for the 11th Five Year Plan period. The nation will, as required by the scientific development outlook, include the combat of climate change, implement the sustainable development strategy, accelerate building a resource-efficient and environmentally friendly society as part of the overall and regional plans for national economic and social development. It will enhance its abilities to combat climate change and perform the international conventions by driving forward the research and development in the

key areas of climate change; stepping up the creation of a climate monitoring system; and developing global climate change monitoring technologies, greenhouse gas emissions reduction technologies and climate change adaptation technologies (low carbon emission technologies). China's near-term and future demands for environmental technologies are listed below.

Medium- and long-term demands:

A comprehensive analysis of China's social and economic development trend in the light of its medium- and long-term plan for science and technology development shows that the nation's environmental technology development in the next 10-15 years will be chiefly in the following aspects:

- ❖ Guide and support the development of recycling development. Develop integrated, cleaner production technologies for pollution-heavy sectors; enhance waste reduction, reclamation and safe disposal; and step up research on common technologies for the recycling economy.
- ❖ Provide comprehensive treatment of regional environment. Implement technology integration and demonstration for comprehensive treatment of river basin water environment pollution and regional atmospheric environment pollution, and for comprehensive treatment of typical degraded ecological function zones; develop technologies for guaranteeing the safety of drinking water and for environmental monitoring and early warning; and greatly increase support for the development of technologies that have the potential to improve the environmental quality.
- ❖ Promote the development of the environmental protection industry. Focus on the research of environmental protection equipment, instrument and facilities that are suitable for China; expand the market share of domestic environmental protection products; and raise the level of environmental protection equipment and technologies.
- ❖ Actively participate in the international environmental cooperation. Strengthen studies on measures for the implementation of global environmental conventions, and on uncertainties of climate change science and the resultant impact; develop technologies for monitoring global environmental changes and for cutting down greenhouse gas emissions; and enhance capacities for responding to environmental changes and for implementation.

Priorities:

- ❖ Comprehensive pollution control and waste recycling: Focus on the development of regional environment quality monitoring and early warning technologies; develop key technologies, like the technology for controlling city-cluster air pollution; develop unconventional pollutant control technologies; waste reclamation technologies, integrated cleaner production technologies for pollution-heavy sectors, and establish a technological demonstration mode for developing the recycling economy.
- ❖ Rehabilitation and restoration of eco-

system functions of the fragile ecological areas: Focus on the development of dynamic monitoring technologies for ecosystems of such typical fragile ecological areas as karst terrains, Qinghai-Tibet Plateau, the upper and middle reaches of the Yangtze River and Yellow River, Loess Plateau, desert, desertified land, agriculture-animal husbandry zones and mining areas; technologies for controlling grassland degradation and rat damage; ecosystem rehabilitation and restoration technologies; technologies for protection and rehabilitation of ecology along the Three Gorges Project and Qinghai-Tibet Railway Project and in the complex mining areas; build technical support models for rehabilitation and constant improvement of different ecosystem functions; and design systems for comprehensive assessment of ecosystem functions and for technological evaluation.

- Marine ecology and environment protection: Focus on the development of marine ecology and environment monitoring technologies and equipment; strengthen research on technologies for marine ecology and environment protection; develop technologies for protection and restoration of offshore ecology and environment and for dealing with emergencies at sea; and develop high-precision technologies for forecasting dynamic marine environmental data.
- Global environmental change monitoring and measures: Focus on the development of technologies for accurate monitoring of large-scale environmental changes; technologies for control, disposal and utilization of such greenhouse gases as carbon dioxide and methane discharged by major sectors; biotechnology for carbon sequestration and carbon sequestration engineering technologies; and conduct studies on measures for combating climate change, biodiversity protection, ozone layer protection, and persistent organic pollutants control.

3.6 NIS-based Environmentally Friendly Society: Institutional Realization

Effective social management provides the basis for a resource-efficient and environmentally friendly society. If China is to build such a society, it has to complete basic social engineering of basing its environmental technology innovation efforts on reliable institutional guarantee and social management structure. It would do this by promoting social innovation through planned institutional innovation and social management system reform in the next 10-15 years, which constitutes a key period for the nation's dramatic social transformation. Building of an environmentally friendly society requires creating an NIS under the guidance of the scientific development outlook.

3.6.1 Institutional Innovation

To build the system, it is necessary to: (1)

improve the statutory tax system that encourages technology supply and adjust the government's functions; (2) improve the market system that is oriented toward environmental technology innovation, in particular allow businesses to play a bigger role as the major player of innovation; (3) use government procurement policies; (4) innovate the social management system; (5) and encourage ideological innovation. The ultimate goal of environmental technology innovation is to create a society-wide system that promotes environmental technology innovation, technology supply, sharing and application.

3.6.2 Innovation of Social Management System is the Guarantee

The objective of stimulating the population at large to be environmentally aware is very important. The leadership should show why this is important, and show the population that they can take pride in seeing China work to become a global environmental leader. Is it possible that regional levels of government could be encouraged to demonstrate that they can take the lead to compete with each other to be the best environmental jurisdiction? In the long run this will ensure that they can also be the most economically successful. What this means is that in the context of "it's glorious to be rich," it is necessary to be environmentally friendly if the objective of being rich is to be sustained.

Innovation in the social management system means to create an environment and atmosphere suitable for constant innovation of environmental technology through re-allocation of social resources, thus to encourage all organizations and members of the whole society to voluntarily participate in the creation, application and popularity of energy-saving and environmental protection technologies.

3.6.3 Give Full Play to the Basic Roles of the Community

Community is the cell of the society, and also one of the basic units of society. As for construction of resource-efficient and environmentally friendly society, we first are required to build the community into an "environmentally friendly community." Traditionally, China has laid less emphasis upon the concept of the community, and the social management function of grassroots communities. Instead, China has exercised supervision and management over grassroots through registered permanent residence. Along with the transformation of social structure and changes of social management system, the community is becoming a network for social management, public service and social support, which may replace the "units." In implementation of social welfare, social relief, social charity, occupational support, public security, family planning, health services, judicial correction, environmental protection, grassroots mediation of social disputes, and life services, the community is playing increasingly active roles.

3.6.4 Active Action of Social Groups

In order to achieve an environmentally

friendly society, it is not only necessary to set up environmentally friendly social groups, but also to bring full play to linking the roles of social groups, which includes all social forces such as enterprises, relevant governmental departments, institutes, and colleges and universities. China has a large number of social groups with rational layout and constantly optimized structures, and the scope of their businesses covers science and technology, education, culture, public health, labor, civil affairs, sports, environmental protection, legal services, social intermediary services, and rural special economy. Social groups have already become an important force to build environmentally friendly socialism. Up to the end of 2006, there have been 192,000 social groups nationwide – up 12.3% from the previous year.

The participation of all social members is fundamental to successfully build the environmentally friendly society, and for all social members, the important way to participate in community construction is joining non-governmental organizations such as social groups. In this way, all social members may exchange and talk with the government, and then make decisions.[6] This can create a favourable environment and conditions for building environmentally friendly society. Besides, industry associations can unite relevant enterprises together to complement each other, and form an integrated composite force and scaled economy. Enterprises will share the risks and profits together, greatly enhancing the competitiveness of Chinese enterprises in domestic and international markets, and also boosting the industrialization of green technological achievements made by enterprises and institutes. By guiding, providing service, exercising self-discipline, coordinating and supervising roles, the social groups may maintain market order and boost fair competition. At the same time, social groups may take full advantages of prompt information and controlling the overall situation to assist enterprises to resolve difficulties in production.

3.6.5 Orderly Participation of the Public

The development of environmental protection activities in western countries is inseparable from the public's active participation. Many environmental issues have been gradually resolved as the public, especially those who suffer from the environmental hazards as well as environmentalists action. Some groups that suffer from environmental hazards have launched a series of environmental protection campaigns. Such moves have often made the government to legislate environmentally and take management measures. China's environmental protection has been dominated strongly by the government, so it is worth studying how to reflect people's will in the process of technological innovation. Green and environmental protections are not only matters for the government, but also for people's living and production. Therefore, it is necessary to include environmental protection awareness into technological innovation. Only in this way can we achieve sustained economic and social development. In April 2005, the State Environmental Protection Administration (SEPA) held the first public hearing on Yu-

6 Licheng: "Construction of non-governmental organizations and harmonious community." Weishi, Jan. 2007

anmingyuan's anti-seepage project. In February 2006, the *Provisional Measures for Public Participation in Environmental Impact Assessment (EIA)* were issued. Meanwhile, the higher specification and broader coverage of *Measures for Public Participation in Environmental Protection* have also been under legislation. Greater public participation in environmental protection is closely related to the environmental policies, people's daily life, and the rapid development of environmental NGOs. During the process of public participation, NGOs may converge public opinions and then form policy gaming capacity.

Attention should be paid to the Blue Planet Prize most recently awarded for drafting environmental laws that support citizen action for the protection of the environment. As for public participation in a system of technological innovation, the public shall have the right to inquire and supervise projects that damage the environment. They shall have the right and appropriate channels to obtain ecological technology. Public supervisory systems include public announcement, hearing system, mass reporting system, police and people joint supervision system under EIA, as well as public opinion system for civil green organizations and public media. We should, through public education, training and publicity, mobilize the public to carry out direct and grassroots-orientated supervision, so as to promote the development of technological innovation for ecology.

3.7 Overall Strategy and Preliminary Actions

Construction of a resource-efficient and environmentally friendly society is a strategic move to implement the scientific view of development, and also necessary requirements to enhance the independent innovation capability and build an innovative nation. A resource-efficient and environmentally friendly society shall be constructed based upon technological innovation, so first of all, we should adopt the scientific view of development to guide the construction of national innovation system. In doing so, we objectively need to adjust China's environmental developing strategy, so that technological innovation may truly become the main driving force and fundamental basis to build the environmentally friendly society. In addition, the environmentally friendly society of China must be developed within Chinese characteristics. On this basis, we put forward the following policy suggestions for achieving the environmentally friendly society through innovation:

3.7.1 Action for system failure

1. The State will strengthen the guidance, support and supervision on local environmental protection, improve regional environmental supervision agencies, coordinate inter-provincial environmental protection, and focus on the outstanding environmental problems. Local people's governments will be responsible for regional environment quality, supervise the environmental protec-

tion of the lower level's governments and environmental action of key units, and establish corresponding regulatory mechanism for environmental protection. Legal persons and other organizations will be responsible for resolving relevant environmental problems. Local people's governments above the county level should strengthen the construction of environmental protection agencies, clearly define the functions, organization and outlay, further summarize and explore the regulatory mode of urban environmental protection agencies, and perfect local environmental management system.

2. In accordance with the regional ecosystem management approach, we will gradually straighten out the division of responsibilities, and enhance the coordination and wholeness of the environmental supervision; establish and perfect environmental supervision system monitored by the State, supervised by the locals and charged by the units. Environmental protection departments at all levels should be strict in implementing various environmental regulatory system; order polluting units to treat within time limit and suspend production for rectification; convene relevant experts and representatives to put forward the review opinions for EIA of development, construction and planning; improve transfer procedures for environmental crime cases; and coordinate judicial authorities to deal with various environmental cases.

3. Mobilize the central and local enthusiasm for innovation, because excessively stringent environmental protection is always inconsistent with the economic development goal of local government. Under normal circumstances, we can see that the Central Government has good policies, but they are not properly implemented locally. For instance, the energy consumption of unit GDP shall be reduced by 20% in the 11th Five Year Plan, and it is required that all provinces shall make great efforts to reduce the energy consumption to a certain extent. If weighing the reduction goals of energy consumption in the 11th Five Year Plan proposed by all provinces, we can see that the State’s goal of 20% energy saving cannot be achieved in the 11th Five Year Plan. However, given that the 11th Five Year Plan of each province has legal effect inside the province, and is approved by the people's congress at the provincial level, so under these circumstances, it is worth considering how to set up the binding mechanism for national constraint indicators. Therefore, it is more urgent than R&D of new technologies to rationalize these factors and put these technologies into use.

3.7.2 Action for Market Failure

1. We should truly encourage enterprises to become the main body in the construction of environmentally friendly society. Enterprise is the main body of environmental technology input; the main body of innovation and decision-making; the main body of bearing risks; and the main body of environmental ethics. All of these have required that enterprises should consciously undertake social responsibilities, promote environmental technological innovation, and develop resource-efficient and environmentally friendly enterprises.

2. We should strengthen the R&D and popularity of environmental technology. Energy-saving technology, environmental protection technology and low-carbon energy technology are the basis for environmental technology, so we should increase the investment, and vigorously promote technological cooperation and transfer. Through the government technology program and great efforts of research units, we have made a lot of important technological breakthroughs. However, the lack of commercialization and active enterprises has made it ineffective to popularize new technologies. A large number of new technologies have not been applied in a timely way, and the existing system and incentive measures do not promote long-term innovation of environmental technologies.

3. Popularize and use environmental protection technology in the construction of new countryside.

4. Speed up hi-tech industrialization and popularity of the advanced applicable technologies. Optimize integrating and demonstrating of major environmental pollution control technologies, cleaner production technologies and recycling economy technology; effectively promote the development of innovation of China's environmental protection technologies and industrialization; and accelerate the upgrade of technologies of China's environmental backbone enterprises. The State Environmental Protection Administration will select a batch of enterprises with independent IPRs or the advanced environmental protection technological achievements, according to the annual plan to carry out national demonstration projects. They will adopt fund grants and discount loans on the key demonstration projects, provide preferential policies for the successful environmental technologies, and popularize them throughout the country.

5. System for perfecting government procurement. Thus in the government procurement, the top priority will be given to energy-conserving and environmentally friendly technologies and products.

3.7.3 Action for Government Failure

1. Achieve the adjustment of governmental functions. The governmental departments shall bear more responsibilities to promote the construction of an environmentally friendly society, and increase the investment in the development of environmental protection technologies and financial support on transformation of technological achievements.

2. Increase the executive force for various laws and policies in the construction of environmentally friendly society.

3. Boost policy coordination. In the process of specific technological innovation and practice, the policy makers often tend to proceed only from their own departments and units, rather than from the overall situation or from problems and goals. The policies formulated, in general, are not consistent. As a result, lack of coordination and the contradictions between policies have become obvious and frequent.

4. Create a radical innovation structure with major funding/incentives. Government should spend more money on innovation in both basic and applied environmental

science. The new funding can give related institutions more freedom to do radical innovation.

5. Raise the public quality of environmental science. We will launch various green educational programs to raise the public quality of green science, culture, and consciousness. We will implement the Action Plan for All-people Scientific Quality, create a favourable social environment for technological innovation; strengthen innovative education; and cultivate young people's innovative awareness and capabilities.

6. Implement the sustainable development strategy and sustainable consumption policies and action programs for achieving China's sustainable consumption patterns, as specified in *China's Agenda 21*; establish a meaningful consumption view and consumption patterns; open up more publicity channels; make multi-directional and multi-form green publicity; guide green consumption; and advocate green lifestyle.

7. Make full use of local and civil advantages to actively launch green civilization creation activities, such as green districts, green communities, green schools, green parks, green cities, and green units, etc., to gradually form the social style of all-people participation in green action.

8. Establish administrative guidance and administrative contract with legal system. Many ecological technologies have been implemented by scattered farmers, herds or fishermen and residents in grassland, farmland, woodland, and rural communities, etc. The land use right and disposition right are decentralized given that the household contract policy has been implemented. In the implementation of technological innovation and ecological results, the administrative agencies should adopt voluntary, beneficial and contractual principles. The administrative guidance and administrative contract are most suitable for the popularity of technological innovation and ecological results. Great importance shall be attached to administrative guidance and administrative contract for environmental protection in China's eco-environment laws, in particular to the indemnificatory measures, such as investment, benefits distribution, risk sharing, preferential policies for rewards and punishments, etc.

This is a joint preliminary report from the international and Chinese team members. During the coming year, the task force will continue its studies through sub-reports and workshops. We look forward to presenting our final report in the fall of 2008.

Chapter Ⅳ

Strategic Transformation on Environment and Development: Global Experience and China's Solutions*

4.1 Introduction

In recent years, China has embarked on a strategic transformation of its approach to environment and development, representing the start of new efforts by the central government to integrate environmental protection and socio-economic development in a mutually productive way. Two significant characteristics mark this change: first, environmental issues are being placed at the center of the national agenda, with environment protection starting to enter the mainstream of national development. Second, economic and social policies are starting to incorporate environmental considerations in a substantive way. Such changes are motivated by the interactions among environment, economy, society and politics in China and are accelerated by globalization.

Strategic transformation of China's environment and development agenda implies that China will seriously engage in the mitigation of its severe pollution and ecological degradation, and will have to reconcile the environment with socio-economic development. A series of creative strategic thoughts and policies on environment and development were presented at the 17th National Congress of China Communist Party (CPC), which concluded on October 21, 2007. Internationally, a similar strategic transformation occurred in Japan in the late 1960s and the early 1970s, Korea since the mid-1980s, Germany since the mid-1970s and quite radically in the mid-1980s, and Los Angeles and the USA since the late 1960s. However, each of these transformations occurred at an earlier era of technology and policy development, and China now has the opportunity to benefit from the lessons of those countries that have gone before—and to emphasize pollution prevention and control.

The objective of the report is to provide an overall framework for strategic transformation of the environment-development relationship in China. To this end, Section Two elaborates and explains the strategic transformation taking place in China, based on both Chinese domestic evidence and comparison with past international experiences. Section Three analyzes the domestic

* The Chapter is based on the outputs of Special Policy Study on Strategic Transformation of Environment and Development in China: Global Experience and China's Solutions. Task Force Co-chairs: Ye Ruqiu, Christopher Flavin. Members: Ren Yong Pan Jiahua, Jeremy Warford, Tariq J.Banuri, etc.

background and motivation for the strategic transformation now underway, including the relationships among the environment, economy, society and politics in China. Section Four elaborates the motivation for strategic transformation from the perspective of globalization—mutual environmental impacts on, and responsibilities of China and the world in the context of environment and development. Section Five makes policy recommendations to the Chinese government on how to accelerate strategic transformation towards sustainable development.

4.2 Strategic Transformation: The Chinese and International Context

Recognition of the need for strategic transformation of China's approach to the environment and economic development can be seen in several government pronouncements and policy initiatives that occurred in the early years of the new century. Taken together, they appear to signal fundamental changes, reflecting growing understanding of the importance of environmental sustainability by the Chinese people and their leaders.

4.2.1 Signals Ushering in Strategic Transformation

Signal 1: The Scientific Outlook on Development / Building a Harmonious Socialist Society

In 2003, China's government announced its intent to "stick to the principle of people first, adopt the concept of comprehensive, coordinated and sustainable development, promoting integrated development of economy, society and people," also known as the Scientific Outlook on Development. The Scientific Outlook on Development takes development as its essence, putting people first as its core, comprehensive, balanced and sustainable development as its basic requirement, and overall consideration as its fundamental approach, which has been addressed in the President Hu Jintao's report at the 17th CPC Congress and now formally written into the amended Constitution of CPC.

In 2006, the government announced the goal of achieving a "harmonious socialist society." Among the eight objectives and tasks to build a harmonious socialist society, the important one in the context of environment reads that "resource utilization efficiency should be greatly increased, the environmental quality should be sharply improved, and the building of a resource-conserving and environmental-friendly society should be accelerated." This signifies that the government has started on a new pathway for strategic transformation of environment and development.

Signal 2: New Path of Industrialization and the Path of Peaceful Development

To take the new path of industrialization, as presented at the 16th Party Congress, there are five criteria to meet: high scientific and technological content, good economic effects, low resource consumption, less environmental pollution, and full use of human resource advantages.

Environment has become an important factor in China's effort to follow the Path of

Peaceful Development. The President of China announced the country's desire to "assist and cooperate with each other in conservation efforts to take good care of the Earth, the only home of human beings," in 2007.

Signal 3: "Three Transitions" in Managing Environmental Protection and Economic Development

The "Three Transitions" formulated at the 6th National Conference on Environmental Protection in 2006 are the guidelines for environmental protection in the new era. "Equal Attention" requests governments, enterprises, and relevant stakeholders to give equal attention to environmental protection and economic growth. "Synchronization" suggests keeping environmental protection abreast of economic development. "Integration" indicates that to settle environmental problems, legal, economic, technological and administrative measures shall be used in an integrated manner.

Generally, specifying step by step from strategy to tactics and supplementing each other, the "Three Transitions" constitute the guidelines for the undertakings of environmental protection in the new era.

Signal 4: Sound and Rapid Economic Development

In recent decades, the government has advocated "rapid and sound" economic development. This motto was changed to "sound and rapid" at the 5th session of the 10th National People's Congress this year. This change indicates that economic development must be coordinated with social needs within the context of resource and environmental limits and capacity. The most immediate implication is that the target economic growth rate is no longer subordinated to the need to improve efficiency, reduce consumption of resources, and protect the environment.

Signal 5: Mandatory Targets for Population, Resources, and Environment

In 2006, the Chinese government set up for the first time systematic quantitative targets for population, resources, and environment within the 11th Five Year National Economic and Social Development Plan Outline. Some of the targets are mandatory indicators, including reduction of 20% of energy consumption per unit of GDP and 10% of emission volume of SO_2 and COD against 2005. In June 2007, the State Council set up Leading Group for Energy Conservation and Pollution Abatement led by Premier Wen Jiabao, and published the "Scheme of Energy Conservation and Pollution Abatement," which includes 45 concrete measures and actions in 10 groups.

Signal 6: Circular Economy Law and Other New Policies

According to the legislation plan, the National People's Congress will discuss and approve within this year the first law in the world entitled "Circular Economy," which will promote the economic mode to improve eco-efficiency through waste reduction, reuse and recycling. The government is also considering reforms in national economic instruments in order to provide strong incentives to energy-conservation and pollution abatement. The reform of resource taxation also has entered a fast track mode and an approach is expected to be released soon. The state has invested in building capacity

for creating emission-reduction indicators, monitoring, and performance review.

All these signals have been amplified and integrated in the most important documents for the country and the Party. Taking into account the significant signals listed above, the report at the 17th CPC Congress notes seven innovations and progresses. First, when reviewing the work of past five years, "our economic growth is made at an excessively high cost of resources and the environment," is listed as the first outstanding problem on the country's way forward. Second, the Scientific Outlook of Development has become a component of a system of theories of socialism with Chinese characteristics and a general outline to balance environment and economy development. Third, Conservation Culture has been put forward for the first time. Fourth, it's confirmed that the development pattern must be transformed through optimizing the economic structure and improving efficiency while reducing consumption of resources and protecting the environment. Fifth, the principle for international cooperation of environmental protection is clearly defined in the statement of the Path of Peaceful Development. Sixth, the consideration of environmental requirements is incorporated in the improvement of the basic economic system and macroeconomic regulation. And seventh, building a resource-conserving and environmentally friendly society has been place high on the agenda in China's strategy for industrialization and modernization, and it also demands each organization and family act accordingly. Environmental issues have been lifted to a higher level than before, with the greatest importance attached to them since China's founding.

4.2.2 International Experiences

This section of the report explores for instances of strategic environmental transformation over the past half-century: industrial pollution and energy efficiency in post World War II Japan; industrial pollution in Korea following democratization in 1987; acid rain in the 1980s and recycling in the 1990s in Germany; and air pollution in Los Angeles, especially following the 1977 amendment of the Federal Clean Air Act.

(1) Japan

Extremely rapid economic growth in the post-WW II years, carried out with little or no concern for the environment, led Japan to severe public health problems. It was first manifested in the 1950s, and included mercury poisoning (Minamata disease), cadmium poisoning (Itai-Itai disease) and inhalation of sulphur oxides (Yokkaichi asthma). These generated tremendous public concern, and citizens' movements (often in spontaneous reaction to specific pollution-related incidents), stimulated by the mass media, put pressure on elected officials to take action. This created a watershed in Japanese social, economic and industrial policy, in effect placing the environment at center stage, and initiating a series of measures that in a relatively short time led to major improvements in public health and the quality of urban life.

Political equality and freedom of speech were critical to the rapid success Japan

achieved in reacting to the public health catastrophes of the 1950s and 1960s. Educational policy, particularly in technical fields, has played a key role in the development of Japan's environmental movement. Establishment of a partnership between the public and private sectors has also been a uniquely Japanese characteristic and an effective means of reconciling pollution abatement and economic growth objectives. Another Japanese characteristic is the extreme concern on the part of individuals and enterprises to avoid public criticism for anti-social behaviour, particularly within their local community. The structure of government in Japan has also been conducive to sound environmental management at the local level. National-local government relations with regard to environment follow the conventional pattern, with actual implementation of pollution control, including establishment of local standards and regional pollution control plans, being entrusted to local governments.

These factors resulted in major environmental improvements in the 1960s and 1970s, which took place in parallel with a sustained period of rapid economic growth. Japan still faces important environmental issues, but it is clear in retrospect that the country experienced a strategic transformation in environmental policy and practice in the 1960s.

(2) Republic of Korea

The Republic of Korea experienced a dramatic decline in environmental quality as the economy developed rapidly in the 1970s and 1980s. Rising living standards and the emergence of a democratic system in 1987 dramatically created the opportunity for a new look at environment and development relationships. Korean citizens expressed their unhappiness about environmental conditions, as seen by citizen action in response to the incidents of Onsan industrial complex, of nuclear facility construction projects in Anmyon Island and Gulup Island in 1990, and the phenol contamination of the Nakdong River by the Doo-San industrial conglomerate in 1991. While severe environmental problems remain in Korea today, the decade after 1987 was a period in which environmental issues began to take center stage, laying the foundation for continued improvement in environmental performance in the country.

The new priority given to environment by the Korean government in the late 1980s and early 1990s is illustrated by the rapidity with which new environmental legislation and policies were introduced. In 1996, the government established "Green Vision 21," the blueprint for the period from 1995 through 2005, which was designed to raise Korea's environmental standards over the long term to match those of the industrialized countries. While tightening these regulations, the government also skillfully redirected public environmental concern towards the environmental problems caused by consumption. The institutional and legal frameworks to ensure environmental protection were firmly in place.

The local self-government system was introduced in 1995 and this decentralization has changed the dynamics of environmental decision-making in Korea. However, the

transfer of all enforcement duties in the areas of air, water quality and municipal waste management to local authorities since 2002 has in some cases led to a general weakening of the permitting and enforcement systems.

As in Japan, the basic enabling factors for the development of more effective environmental governance in the time period considered here included education, public awareness about the environment, and the ability of people damaged by environmental pollution to influence political decision-makers. But the route was slightly different, using environment as part of a general platform for political and social change, with NGOs rather than spontaneous citizens' movements being the driving force. Public participation in policy making has been improved through an amendment to the Act on Administrative Procedures, which protects the rights and interests of citizens. In addition to such critical internal forces, Korea has been influenced by external pressures, including its entry into the OECD, which placed assessment of its environmental performance closer to that of the industrialized nations.

Despite the dramatic improvement in environmental awareness and policy that took place after democratization, the overall environmental record of Korea is mixed and the longer-term sustainability of the changes remains to be seen.

(3) Germany

Germany has not always been an environmental pioneer. As in other European nations, after World War II both East and West Germany's main goals were promoting economic development, although under different political-economic models. Environmental protection was not yet a major public concern before 1972, when United Nations Conference on the Human Environment (UNCHE) was held in Stockholm.

Initial changes to Germany's environmental laws were made primarily as top-down decisions (as opposed to a response to public opinion). Internationally, environmental problems, such as acid rain, were starting to attract more attention and other countries. Domestically, a change in government proved critical in the timing of West Germany's initiation of a national environmental program. The formation of a coalition government between the Social Democratic and the Free Democratic (Liberal) Parties in 1969, just as environmental policy changes were beginning in other Western countries, provided a window of opportunity for change. In the following years there was a transfer of control over measures to combat pollution from the Ministry of Health to the Ministry of the Interior, which in 1986, was eventually named the Ministry of the Environment, Nature Conservation, and Nuclear Safety. In 1972, an amendment to the Constitution conferred on the federal government the power to enact legislation that in effect overrode the states in areas such as air and noise pollution and waste management. In addition, the federal government was able to issue guidelines on the enactment of state legislation on matters such as water quality and planning as well as the preservation and conservation of nature. Another significant action was the

formation in 1974 of the Federal Environmental Agency.

Despite the important changes that took place during the 1960s and early 1970s, the government's decision to massively expand the system of nuclear power plants in the wake of the 1973 Organization for Petroleum Exporting Countries (OPEC)'s oil embargo, brought a powerful counter response. This came in the form of citizens' initiatives for environmental protection, antinuclear protests, and the formation of a green political organization, Die Grünen (the Green Party). Green lists and parties were increasingly successful in elections at the local and Länder levels during the 1970s. The German Green Party's performance in federal elections improved progressively in the 1980s. This shift in Germany's political culture began West Germany's transition towards international environmental leadership. In the past two decades, major German political parties have all greened considerably.

Germany's public and leaders have come to the conclusion that pollution and energy inefficiency come with unacceptably high costs to the economy, society, and the environment. This was the result of a number of factors, including learning from abroad (the case of the early 1970s), value change, the electoral successes of the Green Party, and acceptance by German political leaders and industry of the need to find new approaches to economic development.

Germany's current Chancellor, Angela Merkel, was head of the German Environment Ministry at the time of the Kyoto Protocol negotiations. Germany's political and economic leaders also appear to believe that if Germany can succeed in the areas of environmental protection, energy conservation, and clean energy development, its industries will have a stronger chance of remaining internationally competitive.

German policies are especially noteworthy because of the international impact they have had. Because Germany's economy is so large, changes in German environmental policies tend to reverberate internationally. To give just a few examples, Germany's 1983 Large Combustion Plant Ordinance became the basis of the European Union's 1988 Large Combustion Plant Directive; its 1991 Ordinance on the Avoidance of Packaging Waste helped shape the EU's 1994 Directive on Packaging and Packaging Waste; and its national greenhouse gas mitigation policies account for close to three quarter's of the entire EU's emission reduction pledge under the Kyoto Protocol. In many environmental areas, Germany is setting international environmental benchmarks and shaping European approaches to environmental protection.

(4) Los Angeles

Strategic transformation of environmental policy in Los Angeles stems mainly from citizen concern about dramatic increases in air pollution, caused by industrial and automotive emissions after World War II, and compounded by temperature inversions in the greater Los Angeles area. It is evidenced by significant adverse impacts on public health. The transformation has evolved gradually over the last fifty years, with a succession of legislative and regulatory

measures enacted at the federal, state, county and city levels of government. However, environmental awareness and policy in California has typically led the rest of the United States towards even higher environmental standards.

Indeed, the state of the natural environment had for a long time been a particular concern of Californian residents, and evidence about the public health impacts of air pollution had been well documented. Highly educated in these matters and led by a number of national NGOs (Sierra Club, Environmental Defense Fund, etc), the issue confronting Californian residents by the mid-1970s was not awareness, but frustration with the inability of public agencies to address their problems. The amendment to the Federal Clean Air Act in 1977 permitted democratic processes to become more effective at the local level, and in the case of the Los Angeles area, public pressures contributed to the creation of the South Coast Air Quality Management District (AQMD) in 1978.

The release by AQMD of its 1989 and the slightly modified 1991 regional air quality plan was the toughest, most intrusive set of air emission regulations ever in Los Angeles, or anywhere else. AQMD proposed 130 measures that could in principle be adopted in the short term, using current technology and existing regulatory authority.

Overall, the combined federal-state-local government regulatory approach has been successful in reducing emission of pollutants in the USA. Furthermore, California standards not only for auto emissions, but emissions from paint, small engines, etc., have influenced products used in many parts of the world. As in the case of Japan and Korea, basic enabling factors included education, public awareness about environment, and the ability of people damaged by environment to influence political decision makers. Such forces have been mobilized in various ways in California, including some spontaneous citizens' protests against specific projects or policies, as well as the on-going role of specifically environment-oriented NGOs in putting pressure on elected representatives. Combined, when the overall national legislative structure permitted it, they became effective in influencing local policies, with the creation of AQMD being a major contribution.

(5) Implications for China

The cases briefly described in this paper show that the process of integrating environment into the mainstream of economic and social decision making has taken many forms. It may take place rapidly, in response to specific environmental problems, or may evolve gradually, based on growing understanding of the issues and changes in governance that permit such awareness to lead to action. In this regard it may be said that China is already on the path to such a transformation, with rising living standards and public awareness, combined with increased technical efficiency and the international requirements associated with its export-led economy and membership of the WTO all contributing to this. Progress is exemplified by legislative measures and specific examples such as the solar powered city of Riz-

hao in Shandong Province, where many of the enabling factors seem to have come together. Nevertheless, China has a long way to go before transformation becomes a reality on a national scale, with implementation and enforcement of legislation and standards being of central concern. Some of the lessons from the case studies about the requirements for successful transformation to take place are summarized below.

Growth vs. Environment

China has already experienced several serious environmental crises, and should not wait for additional public health catastrophes to further galvanize public action. China has made strenuous efforts to improve environmental quality in the country, but the severe pollution problems now facing China's cities and some parts of the countryside require more dramatic action, including the integration of environment into the mainstream of economic decision making rather than as an add-on.

Enabling Factors

As illustrated by each of the cases, a significant effort to reduce environmental pollution – at the city or regional level in the face of the imperatives of growth and development in any society – requires a combination of public awareness and participation, and a responsive political and administrative system. Emergence of a strong system of environmental governance will typically require a major driving force.

Holistic View

A key issue in environmental management concerns the role played by agencies other than those with specific environmental mandates. Sectoral policies are often designed with no environmental objective in mind, and may in fact be of critical importance in influencing environmental behaviour.

Maintaining the Momentum

Achievement of standards in the short term should not encourage a government to rest on its laurels. Continued improvement will be required as living standards continue to increase. The societies that have successfully achieved strategic environmental transformation have realized on-going economic benefits arising from commitment to innovation, tightening of standards, and increased competitiveness.

4.3 Domestic Motivation and Foundation for Strategic Transformation

4.3.1 Dilemma of Environment and Economy

(1) China's Economic Growth, Industrialization, and Environmental Quality

In the years since economic reforms began in 1978, China's aggregated GDP has expanded by 58 times, increasing by an average of 9.78% annually, to become the 4th largest economy in the world. The industrial sector has always been the major driving force during this time of rapid economic growth. Since 1978, the aggregate industrial output has generally sustained the double-digit rate of growth. Since 1991, the contribution rate of the secondary industry to GDP has been basically over 60%, with two peaks of 70.5% and 69.8% appearing respectively in 1994 and 2003. In terms of

the industrialization process, China has experienced four stages after 1978 (Figure 1).

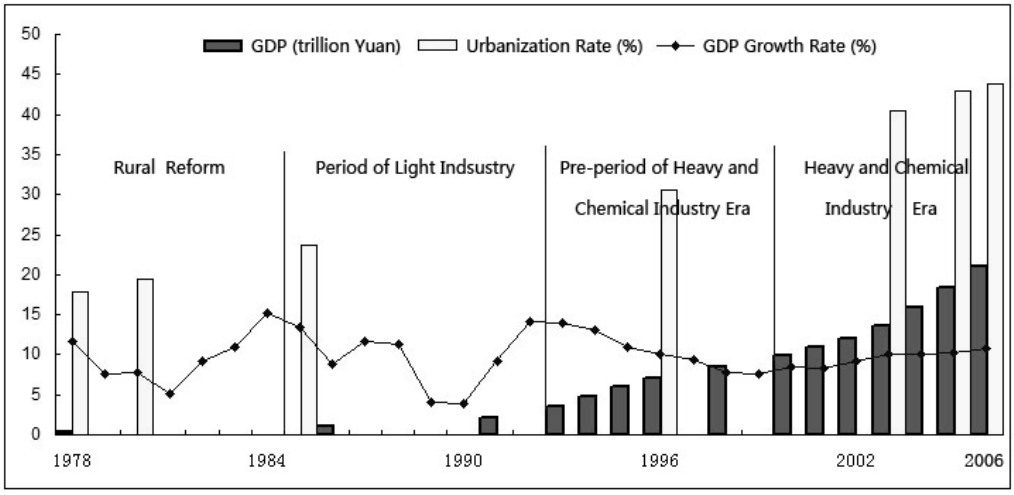


Figure 1: China's Economic Growth and Its Stages (1978-2006)

Source: *China Statistical Yearbook*, 1990-2007.

The first stage is from 1978 to 1984, a period of economic recovery, featuring rural reform and booming agriculture. In that period, the proportion of the agricultural output to GPD had been over that of the tertiary industry, in which the two industrial sectors became equal in output, both accounting for 28.5% of GDP. The second stage is from 1985 to 1992, when non-agricultural industries developed at relatively high speeds, characterized remarkably by the growth of light industries and textile industries and catering mainly to the needs of feeding and clothing of the residents. The third stage is from 1993 to 1999, a pre-period of the heavy industry and chemical industry era, when the output of the heavy and chemical industry began to apparently surpass that of light industry. High growth industries included energy and raw materials (petroleum and natural gas exploitation), infrastructure and basic public facilities (road, harbor, and electricity), and household electric appliance (colour TVs, refrigerators, washing machines, and air conditioners).

The fourth stage is 2000 to the present, when China has entered the heavy industry and chemical industry era. Electrical power generation, steel, machinery equipment, vehicles, ship building, chemical industry, electronics, construction materials have become the major driving forces for economic growth to meet the residents' consumption needs of durable goods, such as private residences and vehicles.

The acceleration of urbanization has become another key driving force for the development of the Chinese economy. China's urbanization rate in 1999 doubled the rate of 17.92% in 1978. By 2005, the rate had reached 43%. This noted economic growth and industrialization process has determined

four features of the environment problems in China.

(A) *The types of environmental problems and the degree of their deterioration are closely connected with economic growth and industrialization process.*

In the late 1970s, pollution from industrial point-sources mostly located in urban areas appeared in China. By the late 1980s, air pollution and river pollution in urban areas were becoming serious. In general, the environment during that time was being polluted and damaged even though environmental protection activities were taking place, because the protection activities lagged much behind the pollution and damage activities. As a result, the environmental situation worsened rapidly in the 1990s. In particular, the large-scale pollution accident of the Huaihe River in 1994, and the floods of the Yangtze River, the Songhua River, and the Nenjiang River in 1998 warned China that its environment and ecological conditions were badly deteriorated. During the mid-1990s, the scenario was "partial deterioration and general development towards worsening," and thereafter the scenario changed to "partial improvement, general deterioration or the deterioration trends still unchanged." The previous "partial deterioration" was an outcome of the initial period of industrialization. The "general deterioration" thereafter represents the cumulative effect of partial deteriorations, a result of the mid term of industrialization of heavy industry orientation, while "partial improvement" was the major achievements of environmental protection endeavors.

(B) *A compressed industrialization process brings about multiple and interactive environmental problems.*

In developed countries, different stages of the century-long industrialization process have experienced different environmental problems. On the contrary all environmental problems that have been recognized up to now have their presence in the past two decades in China. When its per capita GDP reached 1000 US$ at the turn of this century, China at the same time was faced with a complex of environmental problems including industrial pollution, household pollution, acid rain, ecological degradation, global environmental problems, and persistent organic pollution (POPs), and so on. Thanks to the structural, compound and compressed nature of the environment problems, environment protection in China is destined to be a complex, arduous and protracted undertaking.

(C) *Rapid economic expansion leads to enormous pollutant emissions.*

Since entering the era of heavy industry and chemical industry in 1999, China has reached a fast growing stage of pollutant emissions; for example, the volume of industrial waste gas, waste water and solid waste have increased annually by 22%, 8.5% and 17% respectively. The rapid expansion of economic size has created an enormous amount of pollutant emissions. It is estimated that currently China ranks the first in the world in terms of SO_2 and ODS (ozone-depleting substances), and the second in CO_2 emissions. China is also among the world top emitters in terms of COD and NO_x emissions.

(D) *The dual structure of economic de-*

velopment has led to the "dualization" tendency of environmental problems.

China started and strengthened its industrialization in urban areas and in the coastal areas of the East. Therefore, environmental pollution appeared and deteriorated first in these areas, while pollution in the West and the rural areas was less serious before the 1990s. A new dualization tendency is being created in environmental quality and capacity of environmental protection between urban and rural areas, as well as the East and West regions. The dualization of environmental-related matters is also reflected in the imbalanced distribution of environmental benefits and relevant economic benefits between natural resource exploitation regions and other regions: the upper and lower reaches of river basins, and the key ecological function conservation zones, and others.

(2) China's Economic Growth Pattern and Its Eco-efficiency

Generally speaking, China's economy is still in the extensive pattern heavily sacrificing resources and environment, with features such as high capital input, intensive resource consumption, heavy pollutant emissions, and low-efficiency output. If China's development pattern was still maintained as before, it would be unsustainable with its limited capacity of resource and environment.

The Chinese Academy of Sciences projected three scenarios of the impacts of China's socio-economic development on resources and environment in 2020[4], given the situation of 2000 as the base point.

- Scenario 1: if the current resource and energy efficiency and the pollutant emission level were retained, by 2020, the impacts of socio-economic development on resources and environment would be four to five times the level of 2000.
- Scenario 2: if the environmental quality of 2000 is to be maintained, the resource productivity (resources consumed per unit of GDP) or eco-efficiency (GDP per unit of pollutant emissions) must be improved by four to five times.
- Scenario 3: if the environmental quality is to be improved by a very big margin by 2020 and the impacts on resources and environment are to be halved against that of 2000, then the resource efficiency or eco-efficiency must be improved by eight to ten times.

In a word, China's pattern of economy growth with high costs of resources and environment has run its course. The only options are the above-mentioned scenarios 2 and 3. That is to say, the paradigm changes in relationship between environment and economic growth must take place. There are no other ways out for China.

4.3.2 Conflicts and Cooperation Among Relevant Stakeholders

The essential manifestation of the environment-society relationship is the influence of environment on the public life and the degree of concern of the public about environmental quality and their attitude to environmental protection. These criteria can be employed to judge whether the environment-society relationship has changed in

fundamental ways. Many factors influence the environment-society relationship, including the amount of damage caused by pollution and ecological degradation, the standard of living and environmental consciousness of the public, access to information, and the rights of the people.

The environment-society relationship in China has experienced three stages by and large.

(A) Before the 1990s, most of the public had little understanding of environmental risks, and seldom participated in environmental activities. The mainstream appeal of the society at that time was to shake off poverty and get rich. This retrospective judgment will not necessarily be totally accurate. However, at least there currently isn't any literature that can repudiate it.

(B) In the 1990s, especially in the latter half of the decade, environmental pollution raised the level of public concern and attracted growing media attention. Starting with the 9th Five Year Plan, China launched the large scale Comprehensive Program of Regional Pollution Control, implemented the massive "Zero O'Clock Action" for industrial enterprises in the Huaihe River basin to comply with emission standards, and started the total pollution control plan. The Chinese government gradually attached greater importance to environmental protection, and rules on disclosure of environmental information were introduced.

(C) At the beginning of this century, as China's living standards continued to improve, the environment-society relationship reached a new stage. Currently the environment-society relationship in China presents four major features:

- ❖ The environmental consciousness of the people has been generally enhanced.
- ❖ The public demand for environmental improvement is constantly rising.
- ❖ A more open, transparent and interactive exchange mechanism is starting to come into being between the environmental protection authorities and the public.
- ❖ The era of frequent environmental accidents has increased public concern and led to a growing number of protests as citizens seek to protect their environmental rights.

The environment-society relationship in China appears to be reaching a strategic transformation point. Conflicts between the government bodies responsible for environmental problems and the affected public are increasingly common. If handled properly, the "conflicts" can turn into social cooperation as public consciousness and capacity increase.

4.3.3 Pressures on Governance and Political Willingness

The environmental issue is also an economic issue, a social issue, and a cultural issue. Hence, it is necessarily a political issue. The domestic and international experience has shown that the success of the environmental endeavors depends more often than not on the strategic positioning of environmental issues in the political and governmental agenda of a country.

In 1972, the Chinese government sent delegates to attend the United Nations Conference on Human Environment held in

Stockholm. Subsequently, in 1973, the Chinese government held the first National Conference on Environmental Protection, initiating the process of environmental protection in China.

China's first Environmental Protection Law came into force on September 13th, 1979, and was formally promulgated and implemented in 1989. At the second National Conference on Environmental Protection held at the end of 1983, it was stipulated for the first time that protecting the environment was a basic national policy, and the environmental protection guidelines of "Three Synchronizations for the Integration of Three Aspects"[1] was established. In the same period, three basic policies for environmental protection were formulated: "application of comprehensive measures with the first priority of prevention and combination with treatment," and "the polluter is obliged to treat the pollution," and "reinforcing administration." In order to strengthen environmental protection, the Chinese government promulgated two "State Council Decisions" in 1981 and 1984.

In the 1990s, the Chinese government accomplished five major changes in the strategies of environmental protection. First, starting from 1997, the Government has held an annual "Central Government Meeting on the Population, Resources and Environmental Protection" that sets the year's agenda for environmental protection. At the same time, the Chinese government also promulgated two "State Council Decisions" on strengthening environmental protection in 1990 and 1996 respectively. Second, the Chinese government released the first independent Five Year Plan for environmental protection with definite quantitative objectives (such as the total volume control of pollutants) in 1996, namely the National 9th Five Year Plan on Environmental Protection and the Long-Range Objectives for 2010. Third, at the macro-economic level, the Chinese government took measures such as economic structural adjustment to reduce pollution burdens from industrial sectors, and enhanced investment in environmental protection through pro-active fiscal policies; Fourth, against the backdrop of thinning the central government organizations, the former State Environmental Protection Agency was upgraded to the SEPA in 1998 with position promoted from the vice-ministry to ministry level and jurisdiction expanded and strengthened. Fifth, in 2000, the Chinese government included the environmental protection capacity and the sustainable development capacity in the objectives of strategies for building a moderately prosperous society in an all-round way in the coming 20 years.

In the new century, the government went further to raise three significantly strategies: The Scientific Outlook on Development, Harmonious Society, and Peaceful Development. These strategies accommodate environmental protection and social-economic development in one organic and integrated system, where environmental protection is enshrined in a more important strategic position. Gradually, China's government has begun to understand the profound and difficult relationship between environmental and socio-economic development, and has lifted environmental protection to an unprece-

1 This means to synchronize the planning, implementation, and development in economic construction, urban and rural construction, and environmental protection in order to reconcile environment, economy and social development.

dented level of priority. In recent months, the government has signaled that it is prepared to promote the strategic transformation of environment and development. However it is also clear that translating these ideas into effective action will be a difficult task.

4.4 Globalization Forces Affecting the Strategic Transformation

4.4.1 Opportunities and Challenges through Globalization

(1)Impacts of International Trade on China's Environment and Development

Since its reform and opening up at the beginning of the 1980s, China has been experiencing continuous opening up at an increasing scale. China's entry to the WTO in 2001 indicates that its economy is even further interlocked with the world economy. At present, China already ranks third in the world in terms of export and import of goods. It is not only a main supplier of manufactured goods for the world, but also an important market for goods from many countries. According to statistics from WTO, for year 2005, China's export and import of goods accounted for 7.5% and 6.3% respectively of the world total, ranking third in the world. For 2005, the contribution rate of China's export and import of goods to the world total is 14.3% and 8.3% respectively.

Impacts of international trade on China's environment and development are relatively complicated. The impacts can be positive or negative. Potential positive influences refer to the expectation that China can improve its resource allocation efficiency through international trade, because it can seek resources from sources throughout the world. At the same time they drive forward the sustainable development of Chinese economy by way of introducing advanced technology and equipment from outside in order to improve the utilization efficiency of resources and the environmental treatment level.

Negative influences refer to the greater environmental pressure brought about by the growth of production, and other negative influences on the environment arising from the increases of domestic consumption accompanying rising income standards and the growth of transportation.

(2) Positive influences of international trade on China's environment and development

International trade makes it possible for China to solve the problem of supply shortage by way of importing natural resources and taking advantage of the ecological goods and services from other countries. Therefore it makes it possible for China to produce and export by using resources where it does not have enough domestic sources or comparative advantages, and thus still develop its economy. Generally speaking, because of the optimization of its resources, international trade has played an important and obvious role on promoting Chinese economy; it is mainly demonstrated through improving China's industrial structure and employment structure, promoting scale operation and specialized production, and alleviating scarce restrictions on Chinese economic development for the shortage

of resources.

Conflicts between the shortage of resources and unbalanced energy supply and demand are alleviated through the import of raw materials and energy.

Because of its increasing need for resources and energy, China's import of raw materials and energy has been accelerating and China has become a main importer for raw materials and energy in the world.

Import of materials has expanded the supply base and alleviated the conflict between market demand and supply. For instance, China's import of cotton increased by five times between 1999 and 2005. In recent years, the fast growing Chinese economy and the rapid development of the transportation sector led to the accelerated growth of energy import, such as import of petroleum. China turned from petroleum net exporter to net importer in 1993, and became a net importer for crude oil since 1996 with net import of crude oil reaching 148 million tons in 2006. From 2001 to 2006, China's import of petroleum increased by 122.4%, with an annual increase averaging 17.3%. Its dependence on petroleum imports increased from 29.1% in 2001 to 47.3% in 2006.

In addition, because resources are embodied in the imported products, China can realize benefits from the indirect import of natural resources. From 1996 to 2001, China's import of agricultural products equals a saving of 186 billion cubic meters of water resources. Because China's import of crops is in accordance with comparative advantage for utilization of water resources, the trade would therefore alleviate the endangered water shortage situation in China to a degree and improve global utilization efficiency of water resources.

China reduces its direct import of resources through the import of recyclable and waste materials.

China has become the largest importer for waste materials in the world. In recent years, driven by the potential economic benefits, imports of wastes into China increased at quite a fast speed. From an objective point of view, the import of waste materials replaces part of the direct import of raw resources, and can play a positive role for the recycle and reuse of resources in China and throughout the world. Also, disposal costs for wastes are quite high in developed countries, while the relative cost in China is cheaper. Therefore, China enjoys a certain degree of comparative advantage in the trade for waste goods and resources.

Recycling and reuse of those imported wastes, which contain relatively little toxic substances and comparatively higher content of reclaimable resources, present overall advantages. Examples include scrap iron and steel, paper, wood, second-hand mechanical and electronic products. When compared with mining of mineral products and other resources, the import is conducive because the recycling of wasted resources can improve smelting and processing efficiency, lower resource consumption and reduce direct import of resources. In 2006, China imported a total of 38.95 million tons of waste materials worth 13.347 billion US$. For some categories, import of wasted resources has accounted for a quite high proportion.

For instance, in 2006, China imported a total of 4.188 million tons of wasted steel, which equals to 1/5 of total import that year for iron and steel; a total of 19.62 million tons of waste paper, about twice as much as imported that year for paper pulp (7.96 million tons). According to a report issued in July 13, 2007 by *Forest Trend*, an organization headquartered in Washington D.C., the flourishing waste paper recycling industry in China has saved a large area of forest in the world. And for 2006 alone, China avoided cutting a total of 54 million tons of lumber by way of waste paper recycling.

Through international trade, China has introduced foreign advanced technology and equipment, improved its utilization efficiency of domestic natural resources, and upgraded its environmental treatment standard.

Active international trade activities provided China with optimized resource allocation, technological bases and management experiences for solving problems concerning environment and development. Under the current situation that developed countries far exceed China in terms of resources utilization efficiency and environment treatment standard, China can greatly improve its resources utilization efficiency and upgrade its environment treatment standard by carrying out international trade for technology and goods, and introducing advanced technology and equipment directly from developed countries.

By introducing advanced production technology and pollution treatment technology, China would be able to produce more environmentally friendly products, carry out more efficient means of production, obtain foreign advanced management experience more easily, and discharge less pollution. In recent years, trade for services has grown quite fast in China. From 1982 to 2005, import and export of trade for services increased from 4.34 billion US$ to 157.08 billion US$, an increase of 35.5 times within slightly more than 20 years time. At the same time, China has already become an important importer for high-tech products in the world. The import of high-tech products even exceeds the import of resources that are in short in China, such as energy. Taking the figure in 2005 as an example, the import of computer chips amounted to 81 billion US$, 1.6 times the import volume of crude oil for that year.

(3) Negative influences of international trade on China's environment and development

With China's increasing contribution to world trade, including the large quantity of manufactured goods to the world and China's role as an important processing base for the world, the global resources consumption and environment pollution is becoming more concentrated on China, and further aggravates the damage to China's ecological environment. In fact, while China rapidly accumulates a trade surplus, it is rapidly accumulating an environmental trade deficit. However, because current Chinese statistics for trade balance are calculated by volume, the trade surplus figures neglect the hidden resource consumption and environmental pollution costs. It behooves us to calculate embodied energy, as well as environment pollution and carbon dioxide discharge

problems associated with trade.

Negative influences of international trade on China's environment are mainly reflected in three aspects. First, the export of goods, especially those goods whose production requires high consumption of energy and causes severe pollution further aggravates pressure on China's environment and resources, accelerates the over-consumption of non-renewable resources and the degradation of ecological environment in some areas. Secondly, in recent years, the import of waste to China has been accelerating, and in particular the illegal import of electronic waste goods has led to serious environmental problems. Some 80% of the exported electronic wastes in the world are exported to Asian countries, of which 90% was exported to China. Thirdly, China imported a large number of luxury goods. These imports tend to bring several negative influences:

- Luxury goods, such as cars, consume large amount of petroleum and resources and therefore will cause severe pollution.
- Import of luxury goods consumes large amount of capital, and has a high opportunity cost; their import would make less capital available for investment for environment improvement.
- Consumption of luxury goods motivates the social drive for luxurious means of consumption, and from an objective point of view, it will intensify the domestic pressure on environment.

Costs have been paid on resources and environment to fulfill fast growth of foreign trade. Since its reform and opening up, China's total import and export of foreign trade increased by 45 times, and its ranking in the world increased from 26th in 1980 to 3rd place in 2005. In recent years, total foreign trade of China has become huge and continues to be at surplus, with import and export of goods totaling 1760.69 billion US$ in 2006, a surplus of 175.5 billion US$, the balance for current account reaching around 9% of China's GDP. The excessive trade surplus has not only resulted in serious imbalance of BOP (Balance-of-payments), causing trade conflicts, but also forced China pay high prices on resources and environment.

First of all, because the national tax on resources and the compensation charge for resources are quite low in China, environment pollution cost is not listed in the enterprises' books as a cost. This phenomenon leads to the excessive supply of resource-intensive products and stimulates the over-investment in heavy industry. Moreover it has resulted in the export of a great number of resource-intensive products with high consumption of energy and high pollution to the environment. The export of such products uses China's resources and raw materials to subsidize foreign consumers, meanwhile keeping the great amount of pollution in China, causing net loss of welfare to Chinese citizens. For example, through the assessment on environmental influences by export of goods of textile industry from 1999-2004, it was found that pollutants and energy consumption increased as textile exports scaled up.

Secondly, research on trade for waste

materials has shown that many renewable metals were shipped back to some developed countries after their treatment and recovery in China. Therefore the import of wastes did not always play its role to supplement for domestic shortage of resources. Instead sometimes it is merely a means to earn scanty profits in return for pollution to the environment, and further consumption of energy and resources.

Evaluating China's core resource and environment issue from the perspective of net export of embodied energy

Although China continues to upgrade its import and export structure, it is still operates mainly at a relatively lower end in the supply chain of goods. Compared with imports from developed countries, exports from China have low added-value, while consuming more resource and energy per unit of export trade volume. According to some research, the embodied energy implied behind import and export of foreign trade is huge, either in its absolute value or in its speed of growth. In recent years, China has already become a net exporter for embodied energy. It is estimated that, from 2001 to 2006, China's net export of embodied energy increased from 210 million tce to 630 million tce, and it is growing at a relatively stable speed. The net export for embodied energy totals 240 million tce in 2002, around 16% of primary energy consumption for that year. It is mainly exported to countries such as the US and Japan, with net export above 75.24 million tce and 48.94 million tce respectively, and 50% of the export total for embodied energy.

Some traditional export industries are leaders in terms of export of embodied energy because of their large export quantity. The top three are garments and other fiber products, instruments, meters, cultural and office machinery facilities, and electric equipment and machinery. In 2002 for example, the three industries accounted for 13.4%, 12.3% and 12.5% respectively of total embodied energy export. Industries engaged in raw chemical materials and chemical products manufacturing, and smelting and pressing of ferrous metals, account for little in total export trade (3.5% and 1% respectively). However, because these are typical energy intensive products, they account for 7.1% and 2.3% in embodied energy export respectively, far exceeding their proportion in trade volume. After deducting the influence of semi-finished goods, the ratio increases even further, accounting for 8.0% and 2.8% respectively. This phenomenon indicates that the processing of energy intensive goods for export would consume great amount of domestic raw materials and intensify negative influences on domestic energy and environment.

China's consumption of energy would at the same time lead to discharge of pollutants and carbon in large quantities. At the time when China exported net embodied energy, it also net discharged a large amount of carbon dioxide and sulphur dioxide. According to investigations, the embodied energy export in 2002 equals to 238 million tons of carbon, while the embodied energy import equals to 70 million tons of carbon, therefore resulting in a net discharge of 168 million tons of carbon. In 2004, the embodied

energy export is 462 million tons of carbon, while the embodied energy import is 140 million tons of carbon, resulting in a net discharge of 322 million tons of carbon.[2]

Besides, equilibrium assessment for trade and environment reveals that of the discharge of SO_2 during China's 10th Five Year Plan period (2001-2005), foreign trade resulted in a SO_2 deficit of around 1.5 million tons, which accounts for around 6% of the annual total discharge of SO_2. When considering the differences between production structure and trade structure, the SO_2 deficit caused by foreign trade would be much higher, since trade growth far exceeds the growth of production.

It is obvious that the research on embodied energy demonstrates the unique role that China plays as 'the world manufacturer' in international trade, and reveals that China's fast growth of energy consumption, major pollutants and discharge of carbon dioxide results not only from expansion of its domestic investment and demand-stimulated consumption, but also from the accelerated export of goods driven by consumption demand from other foreign markets. Developed countries import goods from China to replace their own production. Thus at the time when China increases its energy consumption and waste discharge, these developed countries actually decrease their own need for energy and discharge and were the main beneficiaries. Especially for the US, this accounts for 31% of China's net export embodied energy, followed next by Japan and then the countries of the European Union.

In summary, it is not a complete consideration of impacts if merely the wealth accumulation effect of trade is taken into account. Although international trade can promote economic growth and provide economic and technological bases for environment treatment, China should at the same time take into consideration the negative influences of the fast growth of international trade on the environment. With the deepened globalization of the world economy and the accelerated growth of Chinese foreign trade, it would be difficult for China to avoid in the near future, negative situations such as high energy consumption, aggravated pollution and increased carbon dioxide emission, which is caused by trade for waste materials, net export of embodied energy, and other factors. In fact, China's current growth mode of trade has brought about great pressure on its resources and environment at the time it stimulates economic growth. Considering its limited resources and environment, the Chinese government should pay high attention to the environmental price that China has been paying for its trade growth, and drive forward with the adjustment on its domestic industry structure and optimization of the trade development mode.

(1) Impacts of FDI on China's environment and development

Since the 1990s, China has been a major destination for global foreign direct investment and is in the leading position among developing countries. Especially since 2001, despite periods when global flow of FDI decreased sharply, FDI entering China continued to increase at high speed. According to statistics from the UN Conference on

2 The Tyndall Centre for Climate Change Research, Tao Wang, Jim Watson 2007, has just published a new briefing. It suggests that 23% of China's carbon emissions are due to the manufacture of goods that are exported to industrialized countries, which has a similar result with our result on the net value of net emission.

Trade and Development, global FDI totaled 916 billion US$ for 2005, an increase of 29% from 2004, in which FDI to developing countries totaled 334 billion US$, which is a record high in history. Although China adjusted its foreign investment policy since 2005, the FDI to China still totaled 72.4 billion US$ in 2005, and China became the third largest FDI recipient in the world, accounted for 22% of total FDI to developing countries. At present, countries and region with investments in China exceed 190. Over 450 of the Fortune 500 companies invest in China.

Influences of FDI on China's environment and development can be positive or negative. In terms of its positive influences, with the expansion of the scale and the improvement of its utilization in China, FDI speeds up China's technological improvement and industrial structure upgrading. FDI can improve the resource utilization efficiency as well as China's capability for treatment of environmental pollution. Some companies making FDI set an example in terms of environmental protection and play an active role with the environment protection industry and environment protection technology development, and contribute in other ways to the improvement of China's environmental situation. FDI actively contributes to China's economic and social development.

On the other hand, FDI brings about great negative influences on China's environment and development. The negative influences mainly reflected in issues such as international trade conflicts, unbalanced economic development, technological lock-in effect, and the outstanding problem of achieving harmonious development between local and foreign invested companies. Meanwhile the transfer in larger scales of industries with high energy consumption and high pollution to China also aggravates the pressure on China's resource and environment.

(2) Contribution of FDI to China's environment and development

The contribution of FDI to China's environment and development is reflected in promoting China's technological improvement and industrial structure upgrade. At the time it improves China's resource utilization efficiency, it also upgrade China's capability for treatment of environmental pollution. FDI speeds up China's economic growth and technological improvement, accelerates domestic industrial structure upgrade, promotes fast growth of foreign trade (import and export from foreign invested companies account for around 60% of China's total import and export volume of foreign trade), and drives forward labor flow and transfer among regions and industries, and improves Chinese labor qualification structure.

In particular, since the 1990s, under the guidance of Chinese policy for utilization of foreign capital, many global companies invested a lot on research and development and technological transfer activities in China at the time of their expansion of investment in China. For relevant industries, the 'spillover-effect' caused by this type of technological transfer has introduced not only advanced technological products and equipment, but also improved the managerial level of local companies. Regionally, eastern

coastal areas are foreign investment intensive, and while the concentrated foreign investment improves the industrial development level nearby, it also sets up an example. The experience is radiating outwards and stimulates labor transfer and technology upgrade into the middle and western parts of China.

Moreover, because many global companies attaches great importance on social responsibilities such as environmental protection, at the time of their investment, they also brought with them advanced pollution prevention and treatment technology, environment management ideas and measures, carried out clean production actively, and set up a good example in terms of environmental protection within China. Many international companies saw the great market opportunities for development of the environmental protection industry and environmental protection technology in China, and therefore promoted actively to introduce their environment industry, technology and equipment into China.

(3) FDI's negative influences on China's environment and development

With the accelerated growth of FDI inflow, its negative influences on China's environment and development have become obvious. First, the great scale of export by foreign invested companies leads to a rising trade deficit for other countries and the aggravation of unbalanced BOP, which causes great pressure on RMB appreciation.

Secondly, China's preferential policies to foreign invested companies lead to the 'squeezing-out-effect' on domestic companies, and curb the development and expansion of local companies. A survey report by the Development and Research Center of the State Council pointed out that of all the industries opened up to foreign investment, the largest five companies in each industry are almost all controlled by foreign investment. Of the 28 main industries in China, foreign investment owns majority control in 21 industries. Meanwhile, Chinese national brands are repeatedly threatened by foreign global brands.

Thirdly, because of drawbacks in China's policy for foreign capital introduction and the unbalanced structure of these investments, FDI aggravates the unbalanced nature of China's industrial structure, regional structure and enterprises structure. In recent years, the actual foreign capital, which was used in manufacturing industries, accounts for around 70% of the total, in which agriculture and service industry takes much less. In regional distribution, 85% of FDI concentrates in the eastern area, and only 15% are in the middle and western area, and this pattern results in the weak position that middle and western regions have in terms of sharing capital and technological advantages of FDI.

It is worthwhile to mention that even though technology that FDI employs is more advanced than the average domestic level, it is far from the internationally recognized advanced technology, and the related resource utilization efficiency and environmental performance are lower than the advanced technology applied in their home country. Because of the lock-in effect of these technologies, it is difficult to implement more advanced technology in China,

and therefore delaying technological upgrade and innovation of Chinese industries. Besides, due to factors such as the technological barrier and privacy of global companies in recent years, more and more companies with foreign investment have begun to turn to solely owned operations and therefore, it is impossible for China to fully utilize their advanced technology, and experience.

With the deepening of economic globalization and the expansion of the introduction of FDI to China, the negative influence of FDI on China's resource and environment has been increasing. Statistics shows that foreign invested companies come to concentrate on industries with high consumption of resources and produce high pollution. In 1995, foreign invested companies engaging in pollution-intensive industry accounted for 30% of the total, and this figure rose to 84.19% in 2005. High polluting and high resource consumption industries became the major investment directions for FDI, with industries such as chemical, petroleum, leather, dying and printing, electroplate, pesticide, paper making, mining and metallurgy, rubber, plastics, construction material and pharmaceuticals.

Foreign investment, which played a more direct role in environment protection, amounted to less than 100 million US$, less than 0.2% of the total. Furthermore, there is also research, which indicates that FDI is the main driving factor for environmental pollution and resource exhaustion in eastern regions. Because of the increasing requirement on environmental standards in eastern regions, foreign companies, driven by China's strategy for developing the middle and western regions, will possibly engage in mining industry and manufacturing industry in the middle and western part of China, and transfer the backward and eliminated industries from eastern region to the western. The final result would be 'pollution transfer' to the middle and western regions of China.

When considering fully the influences of FDI on China's environment and development, FDI brings more obvious economic benefits to enterprises and the local level. However, when considered from a macro level, we should pay high attention to the negative influences of FDI on China's environment and development.

There is a big divergence of the influences seen from a micro and macro level. Reasons for the divergence are quite complicated: there is no clear-cut policy dealing with foreign capital introduction in China and no mature mechanism for the assessment to the local government. Therefore local governments tend to exchange environmental quality for access to foreign capital, and local officials use the amount of capital investment introduction as the means to fulfill their political careers. Meanwhile, the current regulatory situation in China also causes the divergence, including low prices for resources, some low standards for environment, unhealthy environmental rules and regulations, and lax enforcement of environment rules. All these problems related to FDI should be adjusted and solved through policy adjustment, and therefore further explore the positive aspects of FDI on China's environment and development and reduce or avoid its negative influences.

4.4.2 Global Impact of Transformation of China's Development Mode

(1) China's economic growth and global impacts

The fast growth of the Chinese economy has both positive and negative influences on global environment and development. Globalization creates a platform for win-win positions between China and the world. China's active participation in economic globalization strengthens its own comprehensive national power base and also creates active influences for the world economy. On the other hand, the fast growth of the Chinese economy creates large demand for energy and resources. It brings pressure not only on domestic resources and environment, but also has a certain degree of influence on the world environment and development.

(2) China's contribution to the world's economic and trade growth

Thinking globally, China can fully make use of 'two resources, two markets' by developing international trade and global investment, and thus promote the sustainable development of China's economy. Since its reform and opening up, especially after China's entry to the WTO in year 2001, China has made active contribution to the world economy and international trade at the time when it benefits from economic globalization.

The influences are firstly reflected in its role as a new driver for the world economic growth and the engine for the growth of the world economy and international trade. According to statistics provided by IMF, in calculation with purchasing power parity, China's GDP in 2005 accounted for 15.4% of the world GDP total; and according to statistics from the World Bank, since its entry to the WTO, the contribution rate of China's economic growth to the economic growth rate of the world averages 13%, and in 2005, the figure is close to 29%.

Secondly, by leading the change of global industrial structure, China upgraded the position of some countries for export of their primary products, and these developing countries thus benefited from this change. Due to the growing demand from China for petroleum and raw materials and the rising international market price, some developing countries thus improved their BOP situation, and more developing countries realized fast economic growth.

Thirdly, China's economic and trade growth improves the global resource allocation efficiency, provides the international market with large amount of cheap goods, drives forward the structural adjustment of developed countries and holds down inflation. For instance, following the five years after China's entry to the WTO, European Union countries benefited from their investment in China. Their import from China doubled, and cheap Chinese products helped them to offset inflation and interest concerns.

Fourthly, with the fast growth of China's foreign investment and through aid programs, the Chinese government and enterprises helped to build a lot of infrastructure, and to conduct personnel training and technological transfer to other developing countries. These activities have greatly improved

the local economic development and employment in developing countries and regions, such as countries and regions in Africa.

Furthermore, China has also promoted the recycling and reuse of waste materials at a global level through trade and investment, and this activity has not only alleviated shortage of domestic resources, but also drove forward the effective allocation and utilization of global resources.

(3) China's ever-increasing development need brings pressure on the world environment and development

At a time when China's economic development brings about active influences on world development, it also creates a certain degree of pressure on the world's resources and environment. The pressure is reflected in two aspects.

First, the fast growth of the Chinese economy and large production and consumption activities following this growth have brought great pressure on global resources and environment. Besides huge demand for petroleum and other raw materials, the growth ultimately is limited because the energy structure relies mainly on coal. China's ever-increasing energy consumption results in the acceleration of carbon dioxide discharge, and the discharge would create a certain degree of effect on the global climate change. From 1973 to 2004, CO_2 emission in China increased from 5.7% to 17.9% of the world discharge total. In 2004, China's GDP accounted for around 5% of the world total. However, according to calculations by the World Bank, during 1994 to 2004, China's energy consumption accounted for around 30% of the world newly increased consumption, in which coal 59%, petroleum 28%, and iron consumption accounted for more than half of the world newly increased total.

Secondly, Chinese companies, in the process of obtaining outside resources and exploring foreign markets, because of the lack of advanced technology and experiences, also brought about some negative influences on the local environment of other countries and regions. In essence, these problems came into being not only because of the great economic and social development needs in China, they are also driven by international market needs under the economic globalization.

Energy consumption and carbon emission are the main factors which influence world climate change. From the perspective of world climate change, the concern is how to assure future self-development room for developing countries, including China. Because its initial human development needs have not yet been satisfied, carbon emission in China will continue to increase. However, with the fast growth of the Chinese economy, consumption needs and structural needs of China's residents have already taken tremendous change. Taking into consideration the development needs brought about by the large population scale of China and the economic benefits brought by China to other countries in the world, it is a topic facing all countries in the world—how to share the world climate resources equally, and at the same time cause no damage to security of the world environment.

(4) China's overseas development investment (ODI) and its global impact

China's accelerated economic growth has created huge demand on natural resources. It is also bringing about a wave of investment by Chinese enterprises in other countries.

Driven by the needs for resources and market power in recent years, investment by Chinese companies overseas is growing quite fast. From 1990 to 2006, these increased by 23.5 times. From 2002 to 2006, investment overseas increased at an annual average rate of 60%, forming a leading position in the world. To the end of 2006, more than 5000 Chinese enterprises set up around 10,000 overseas enterprises in 172 countries, with net foreign direct investment accumulated at around US$90.63 billion. In 2006, direct investment by overseas Chinese companies accounted for 2.7% of the world total, and China ranks first among developing countries, and ranks 13th in the world.

Accompanying investment by Chinese companies overseas, the export of services by Chinese companies has also grown quite fast. The proportion of export of service by Chinese companies increased from 0.7% of the world total in 1982 to 3.3% in 2005, and the ranking also upgraded from 28th to 8th place. As one important point of China's opening up policy, the development of investment overseas and service trade all promoted the prosperity and stable development of the world economy.

In terms of regional distribution, the main investment destinations for Chinese companies are South America, Asia, Europe and Africa. Because of its abundant labor resources, China has provided through service trade a large number of technology-oriented labor resources to developed and developing countries. For instance, China has provided many construction and designing engineers through ODI mode to countries such as Japan, South Korea, Singapore, Algeria, Sudan, and others. For these countries and regions, growth of China's investment overseas and service trade is a win-win choice. Developed countries can obtain cheap commodities and service, and developing countries such as African countries can get more development opportunities by attracting Chinese companies to explore their local resources, which results in investment growth, more employment opportunities, and improvement of their infrastructure conditions.

The development history of Chinese investment overseas reveals that it has already experienced the process of going from government-oriented to market-oriented investment. At present, policy for Chinese investment overseas has entered a deep transformation stage that is mainly reflected in three aspects:

- A transformation from political objective oriented to business benefit oriented investment
- A transformation from unified adjustment by the central government to self management by local government and enterprises
- A transformation from single objective for resources to multi-objectives combined with seeking resources, technology and market

Driven by interests as well as poor supervision and management, some Chinese enterprises have created pollution and damage to the local environment during their investment overseas and have caused some degree of negative influences in the world. These companies should start from a position of developing the corporate environmental responsibilities of their relevant enterprises, and embrace 'Corporate Social Responsibility,' a voluntary measure internationally. These concepts should be brought into national trade policy, investment policy, financial policy and credit policy, and therefore promote the continuous and healthy development of Chinese companies.

(5) China's choice of different development modes and the impact on the global environment

From the history of industrialization of countries in the world, the energy consumption intensity curve of leading industrialized countries appears as an upside down 'U' corresponding with different stages for industrial structure. At present, China is at a stage of capital-intensive industrialization, which is a stage when energy consumption and pollutants discharge are accelerating. From statistics in 2006, China's energy consumption strength and unit GDP pollutant discharge began to appear at a point of inflection. From the latter half of 2006 to the first half of 2007, the energy consumption intensity has been decreasing continuously for four quarters, and discharge of SO_2 also started to decrease. Growth of total discharge of nitrogen oxide substances became stable, while manufacturing industries with high added value and high processing degree became the leading industry for growth.

However, China's great industrial scale could lead to further increase of energy consumption and CO_2 emission. With the limited capacity of global environment and the obvious impact by climate change, China should prepare for further energy saving and less discharge of pollutants.

A different industrialization mode would result in different impacts on energy and environment. To differentiate from its traditional industrialization mode, the Chinese government is setting up a new path for industrialization. The so-called 'new type of industrialization' is the type of industrialization that bases its foundation on being resource saving and environment friendly, and it not only has some of the features of traditional industrialization, but also follows up and utilizes the newest achievements from the world's scientific and technological reform. It is in accordance with the industrial development of leading industrialized countries, and enables modern service industry to develop at a fast speed also.

Based on the relationship between the mode for economic development and energy consumption and pollutants discharge, three scenarios for China's future development might be considered:

- The new type of industrialization mode with a high objective to achieve; this mode can realize discharge reduction objective of all stages
- To continue the traditional industrialization mode with high energy con-

sumption and environmental pollution

- ❖ The medium mode with a lesser objective for the new type of industrialization; under this mode, discharge reduction objectives for all stages would not be achieved

The above three scenarios differ a lot in terms of their support of energy and environment to China's economic and social development. When considering fully the relationship between China's economic and social development, its energy and environmental carrying capacity, and its influence on the world, China should try its best to realize the new type of industrialization mode and avoid the continuation of the traditional industrialization mode.

From a general point of view, China carried out compressed industrialization, a type of industrialization which could greatly shorten the process for industrialization comparing with that of those pre-industrialized nations. However, as the process is carried out in a short period of time, energy and resources consumption strength grows quite obviously. Because of its large population and great economic scale, China would possibly consume tremendous amount of energy and resources during its industrialization process, and it would bring severe impact on the world. Thus in reference to China's industrialization road, the relationship between industrialization, resources and energy, and its impact on the world energy and environment situation, there are five considerations.

First, restrictions facing industrialization in China is different from that facing other pre-industrialized countries; the restrictions are more reflected on population, resources and environment, although there also exist restrictions by capital and technology. Secondly, destination for China's industrialization is different from other pre-industrialized countries, and the difference is in particular reflected in per capita occupancy of resource consumption and material wealth. Thirdly, China will carry out industrialization under a context of peace and development and under the current international law and organizational framework. Fourthly, there is no clear cut line for China's industrialization; industries with all types of production factors exist at the same time. Fifthly, China's industrialization is being carried out under the background of continuing development of economic globalization and China's deeper involvement in the world globalization. The resource sourcing issue for China therefore should not only be solved at the level of country's in the world but should also take into consideration its negative impact on the world environment. And it is an important issue that must be solved properly in China's process of industrialization.

4.5 Conclusions and Policy Recommendations

China is entering a period in which strategic transformation of its environment and development has become an urgent priority. The experiences of other countries suggest that such a transformation could have great benefits for human health and natural systems, and that the economy will in the end benefit from the transition. A growing number of stakeholders at the national, provin-

cial, and local level recognize the historic opportunity to become an environmentally friendly society, while improving economic qualities and developing a harmonious society.

Evidence from other countries also suggests that significant environment and development transformation can take 15 years or more, and needs an integrative approach of public support, enlightened political leadership nationally and locally, and participation by business and industry. While much can be accomplished immediately through better implementation of proven environmental technology and management, environment and development strategic transformation is most successful when it proceeds beyond end-of-pipe pollution control, to build new approaches based on the social and economic strengths of the nation; to create new products and services that lead to improved international competitiveness; and to implement responsible environmental action internationally.

Taking these observations into account, China will need to frame its environment and development strategic transformation in a way that maximizes opportunity, especially during the coming 15 to 20 years. In this time frame, China needs to establish a practical pathway that fully reflects scientific-based development, the "Three Transitions" principles for reconciling environment with economy, and other guidance that has set in motion the strategic transformation. Such a practical pathway shall lead to systematic actions in all dimensions of political, economic and social, as well as environmental factors and conditions in order to move strategic transformation forward.

In the political dimension, good environmental governance needs to be established for the purpose of mobilizing governments at all levels and inter-agencies, enterprise, the public and other stakeholders. In the economic dimension, sustainable consumption and production is the right way for China to attack the conflicts among sustained growth of the economy, natural resource shortages and environmental pollution. In the social dimension, encouraging public and NGO participation in environmental affairs through establishment of concrete mechanisms is a pressing issue, while also cultivating an environmental-friendly culture including consciousness and life-style.

In the environmental management field, efforts need to be concentrated on resolving key problems such as inadequate legal authorities for environmental policy enforcement, a still weak environmental voice in decision making for national development, poor capacities, and loose enforcement of environmental laws and policies. In doing so, strategic transformation on environment and development in China will be distinctive, carried out more quickly than in any other society, and lead to benefits that will far outweigh costs.

The following seven policy recommendations are proposed for consideration by the Chinese government to accelerate its strategic transformation.

(1) Accelerate improvement of China's existing environmental protection system to take maximum advantage of the latest

environmental technology, management techniques, and legal frameworks.

To accelerate the pace in the strategic transformation period, the Chinese government should attack three pressing and interactive problems in the existing environmental protection system: loose enforcement of environmental laws and policies, poor capacities of environmental agencies for fulfillment of their responsibilities, and a weak environmental voice in the process of decision-making for national development, Three solutions to those three problems are needed:

- ❖ Revise the existing environmental laws to adapt to new requirements of strategic transformation, including the 1989 Environmental Protection Law, the Water Pollution Prevention and Control Law, the Air Pollution Prevention and Control Law, and others as soon as possible. Among a number of new requirements for revising the existing environmental laws, it is critical to set up increasingly stringent environmental standards and rigorous punishment for non-compliant environmental behaviours, with the aim of changing the existing locked-in situation in China where the costs of non-compliant environmental behaviours are much lower than those of compliant ones.
- ❖ Install sufficient human resources and allocate sufficient funding to environmental agencies at all levels to ensure good capacities for fulfillment of their environmental responsibilities. As compared with the situations in other countries successful in environmental protection, poor capacities of environmental agencies at all levels in China (including human resources, know-how, funding, and equipment such as monitoring) have become a bottleneck to improvement of Chinese environmental performance.
- ❖ Upgrade the status of environment agencies at all levels in order to increase the environmental voice in the decision making process of socio-economic development. This is of critical importance for socio-economic decisions and policies to take environment into consideration, which is beneficial both for strengthening environmental protection and for facilitating changes of economic growth pattern. Upgrading the SEPA to become a ministry of environment and improving coordination among different ministries in environmental affairs are good starting points.

(2) In the process of accelerating strategic transformation, China should rely more on the application of market-based policies, including environmental cost internalization via pollution taxes, energy, and fuel taxes.

OECD country experiences have demonstrated for many years that market-based policies, such as natural resources pricing reform, environmental taxes and fees, emissions trading systems, and green financing, are the most cost-effective measures for both environmental and economic purposes. The application of market-based policies has

been discussed for a decade or more in China. For the purposes of both structural adjustment of "sound and fast economic growth" and achievement of energy-saving and pollution abatement targets, China should immediately start an intensive process to introduce more environmental economic instruments for internalizing environmental costs of economic activities. This is actually particularly well addressed in the "Three Transitions Principles" for reconciling environment and economy raised by the Chinese government in 2006. The immediate actions in this regard should be enhanced with joint efforts among economic, financial and environmental agencies of China.

(3) Build public awareness and participation so that the entire society plays a role in the strategic transformation, including household and workplace consumption and environmental health, monitoring of local development, and direct participation in environmental improvements.

Three reasons why China needs to build public awareness of strategic transformation and public participation are: 1) strategic transformation is still at an early phase in China, and relevant stakeholders including local governments, enterprisers and citizens are less aware of the arrival of the strategic transformation and its implications; 2) as compared with the governmental and enterprises' efforts in environmental protection, the role of the public has been weak for a long time in China; international experiences show that the public plays a critical role in not only motivating but also accelerating the strategic transformation; and 3) in terms of awareness and know-how, strategic transformation of environment and development has a broader context than normal environmental education and communication in China. Therefore, China should strengthen and renew the public awareness education and communication activities for strategic transformation and establish formal mechanisms for the public and NGO participation.

(4) Accelerate eco-innovation in all key sectors, based increasingly on Chinese endogenous technologies and approaches, and place particular attention on how accelerated adoption can take place.

China has set up new ambitious and detailed strategies and planning for science and technology innovation. From the perspective of accelerating strategic transformation, science and technology innovation in China needs to draw more attention to four points: 1) innovation should be environmental-friendly, i.e., eco-innovation; 2) emphasis of innovation should be on all key sectors such as environmental industrial sector, energy sector, building and infrastructural sectors, transportation sector and those industrial sectors with intensive energy consumption and heavy pollution; 3) make full use of Chinese endogenous technologies and approaches while introducing advanced technologies from abroad; and 4) provide more financial supports for dissemination of better technologies.

In accordance with the transformation of

China's environment strategy, changing the current growth mode of trade is necessary in order to adjust the relationship between trade, resources and environment.

Fast growth of China's foreign trade is closely related to its position in international distribution. China has become an important importer for energy, raw materials and high-tech products, and a net exporter for textile products, machinery, heavy industry materials and equipment. Research on embodied energy has revealed that the fast growth of energy consumption and pollutant discharge in China is not only a result of meeting its domestic investment and expansion of consumption needs. Fast growth of exports led by external demand is also a very important driving force. Initial research suggests that at the same time as China is accumulating its trade surplus, its 'deficit' for environment and resources is also expanding.

In order to turn around this situation, China should not only adjust import and export structure of foreign trade, but also turn around the current extensive mode of trade, which has been carried out for a long period of time. The following proposals are suggested:

- ❖ Make full use of China's trade surplus to import products and technology with high embodied energy; reduce unbalanced trade of goods and reduce problems concerning imbalances created by net export growth of embodied energy. Owing to the tremendous domestic need, it is not possible for China to avoid importing large amounts of oil and gas resources. But at the time when China imports such energy products as petroleum, natural gas, etc., it should also find and expand substitutes for goods that require high-energy consumption in their production, or sometimes, import them; and finally, restrict the export of such goods.
- ❖ Speed up transformation of the current foreign trade growth mode, moving from the traditional growth mode relying mainly on price competition, quantity expansion and seeking very high growth rates, to a mode relying on improvement of quality, increase of profit, and optimization of structure.
- ❖ Reduce the resource and energy deficit at the same time as reducing China's trade surplus; levy an environmental pollution tax on enterprises with high energy consumption and high pollution; and increase the current low price of some resource products and assign costs for environmental damage to the responsible enterprises.
- ❖ Restructure the current processing trade mode, to further develop trade for service industry and continue to optimize domestic industrial structure. Optimize regional structure for manufacturing goods for export, including promoting the upgrade of processing trade in eastern areas, making full use of the local abundant human resources in the middle and west of China, and introducing environmentally friendly processing trade to these areas. To expand the export of services, strengthen international competitiveness of Chinese commodities and services. At the same time, introduce advanced foreign technology and

equipment, and promote energy saving and emission reduction activities in order to improve domestic environmental quality.

- ❖ Strengthen environmental monitoring of trade for recyclable and wasted goods; conduct regional planning for environmental management of trade for recyclable and waste materials; and maintain the environment for sustainable development. Conduct life cycle analysis for imported recyclable and wastes that could be used as raw materials, and enforce strict environmental entry standards into China of such materials. Have comprehensive assessment on environmental impacts on the origin countries for import of raw materials such as cotton, wood, ore, etc., and take steps to prevent negative influences on the environment in the countries of origin.
- ❖ Strengthen the honoring of international agreements, domestic policy and legal monitoring in order to curb illegal trade in toxic wastes. Restrict processing enterprises that import recyclable and wastes from exporting the resulting raw materials, in order to ensure that it is used for meeting domestic needs or producing high value export products, not merely for obtaining foreign exchange, while leaving behind pollution.

(5) Strengthen management of global enterprises and Chinese companies that invest overseas, and improve the Corporate Social Responsibility awareness of these enterprises on environmental protection

In essence, ODI and FDI both refer to the home country attaining capital, technology and resources from other countries. It is an effective means to expand markets. From the point of process and usual patterns of globalization, gradient transfer of industries has some common features, and investment activities from developed countries to developing countries would provide meaningful experiences for China's investment abroad.

Under the current situation of globalization, as a developing country, China can make use of FDI in its industrialization process, and introduce advanced production technology, operation principles, environmental protection awareness and social responsibility from industrialized countries, and coordinate these with independent innovation, removing constraints from resources and technology. At the same time, in order to break through restrictions on industrialization from its own resource and environmental capacity, it is also an effective solution for China to make use of global resources through the implementation of ODI. In order to make full use of the advantages of ODI and FDI and to avoid problems related to environment pollution and sustainable development at home and abroad, policy monitoring should be strengthened in the following aspects:

- ❖ Strengthen enterprises through institutional restrictions; raise environmental and technological standards for investment; and set up green principles for investment. On the one side, conduct Environment Impact Assessment of programs for foreign investment and

encourage the entry of enterprises and industries that are environment friendly. On the other side, promote the active cooperation between governmental departments and enterprises. By setting up guidance for green investment, urge enterprises to carry out their social responsibility by means of setting up environment terms in foreign investment programs, and in particular by realizing green investment and clean production in natural resource exploration fields, and lower the environmental and social impact to the host country.

- Enact policy directives for foreign invested industries, and carry out assorted guiding policy for FDI. Put into practice market entry policies in categories of restricted, limited and permitted enterprises based on their technological level, pollution level and environmental capacity of relevant invested regions. With the help of government policy, coordinate and strengthen the close relationship between economic development and environment, and promote orderly development of FDI and ODI with overall consideration for the national sustainable development strategy.
- Encourage Chinese enterprises to obtain international advanced managerial experiences and environmentally friendly technologies through their investment overseas or establishment of joint ventures in other countries. Such investment will strengthen the long-term competitiveness of Chinese companies in the international market. International organizations, NGOs and private companies should be encouraged to get involved in investment activities in the field of environmental protection. This will strengthen the management and monitoring of FDI so as to avoid erosion of natural resources and deterioration of the environment.
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(6) Strengthen China's participation in bilateral or multilateral environmental cooperation, and therefore impel the successful transformation of China's environmental strategy.

The exploration and utilization of resources by China is inevitably having a great impact on the world's environment. As the largest developing country, it is both a requirement for economic and social development for China and a contribution to the world to solve the issue of China's environment and development. Being a responsible nation in international affairs, it is important for the Chinese government to strengthen its international dialogue and cooperation in the following aspects:

- Promote the implementation of international environmental conventions through active participation in all types of implementation activities, learning from advanced implementation experience; setting up complete implementation mechanism, management system and framework of policies and regulations; and make use of these conventions to protect China's resource and environmental interests.
- Participate actively in the construction of the global environmental regime; adhere to the principle of common but dif-

ferentiated responsibilities; maintain the right for development of all developing countries including China; set up the international image of China as an active and responsible nation; shoulder international obligations within its capability; explore technological cooperation opportunities such as South-North cooperation, and carry out effective cooperation activities between South-South countries.

- Strengthen environmental governance from the perspective of production and consumption. Regulate market behaviour of Chinese enterprises that have investments abroad; upgrade environmental standards for investment; and improve environmental awareness of policy-makers and the public.

Chapter V

Policy Mechanisms to Achieve China's Environment Targets*

5.1 Introduction

At present, the environmental pollution in China is still increasing, with emissions of major pollutants exceeding environmental carrying capacity, but showing no sign of decrease. Environmental pollution has seriously constrained the sustainable social and economic development in China, and has affected the improvement of public health and living standards. To implement the scientific approach to development, the Chinese government developed the Outline of the 11th Five Year Plan for National Economic and Social Development (here in after referred to as the Outline). The Outline identifies the following binding targets: energy consumption per unit GDP should be reduced by 20% and the total emission of major pollutants by 10% by 2010 compared with that of 2005. Against this background, CCICED decided to establish the Task Force (TF) on Policy Mechanisms for Achieving the Environmental Targets of the 11th Five Year Plan. This TF has studied the policy implementation mechanisms for reducing emissions of major pollutants including COD and SO_2, and put forward measures and policy recommendations to the Chinese government for meeting the emission reduction targets during the 11th Five Year Plan period. Based on the investigation of local practice in many areas, and the study of the experience of developed countries in emission reduction, the TF has drafted the Report on Policy Mechanisms for Achieving Environmental Targets for the 11th Five Year Plan. This Executive Summary of the report will be submitted to the First Annual General Meeting of CCICED Phase IV.

5.2 Analysis of Current Emission Reduction Efforts in China

5.2.1 Achieving the pollution reduction targets is a difficult challenge.

(1) Energy saving and pollution reduction is an important strategy of the Chinese government to implement the scientific approach to development.

The implementation of the strategy on energy saving and emission reduction is an important means for the Chinese government to achieve the scientific approach to

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development, and to develop a socialist, harmonious society. It is also the necessary condition for building a resource-saving and environmentally friendly society, and is the only path for China to follow to facilitate economic restructuring and the transformation of the mode of development. In addition, it is the prerequisite for raising living standards and maintaining the long-term interests of the Chinese nation. The implementation of energy saving and emission reduction is the basic guarantee for achieving good environmental quality in functional areas, and a powerful means for facilitating the strategic adjustment of the economic structure and a fundamental shift in the mode of growth. It contributes to the promotion of technological advancement and resource saving; implementation of national industrial policies; the achievement of rational allocation of environmental resources, and the support of initiatives in the prevention and control of pollution. At the same time, with the mainstreaming of the emission reduction target into the national economic and social development plan, the total emission control system has become a tool for environmental protection departments to be involved in comprehensive decision-making processes.

(2) Pollution reduction is the top priority in environmental protection for China during the 11th Five Year Plan period.

It is expected that by the end of 2010, total emissions of COD and SO_2 will be reduced by 10% compared with that of 2005. This is the solemn commitment of the Chinese government to the Chinese people and the world, and they are binding environmental targets that must be met. This is well regarded by the international community. The key to meeting these targets lies in the integration and combination of approaches such as end-of-pipe control, consumption of energy and resources, clean production, technological advancement, industrial pollution control, supervision and management. The TF holds the view that pollution reduction is fundamentally not only an environmental issue but also a socioeconomic and political issue. Therefore, Chinese environmental policy mechanisms need to be reformed, focusing on total emission control in coming years. It means taking pollution reduction as a core task, and systematically establishing mechanisms that promote minimization of the consumption of resources and energy, and improve the quality of economic development and enhancement of industrial pollution control. In doing so, the reduction of total emissions will not be just a paper exercise.

(3) Meeting the pollution reduction targets is a difficult challenge.

The Chinese government has taken unprecedented policy and project measures to carry out emission reduction work in a balanced way since 2006. Environmental protection departments and local governments have made great efforts in this respect. However, the emission reduction target in 2006 was not met. Our study shows that the control of new sources of emissions should be the first priority in emission reduction. The main uncertainty in meeting emission

reduction targets stems from the uncontrollability of economic and social development. Initial emission reduction programs were based on the assumption of average annual GDP growth of 7.5%. If annual GDP growth is 10%, it means 350 million t more coal would be consumed and 1.8 million t more emissions of SO_2 each year compared with the 7.5% growth scenario. The corresponding changes in the emission reduction target, uncertainty about achieving the energy and resource saving targets, and the actual implementation of relevant policies are all factors that cannot be fully controlled, and therefore affect the achievement of the emission reduction targets. It is our judgment that the realization of pollution reduction targets is a very difficult task. We should not be blindly optimistic. The possibility of meeting the SO_2 reduction target is better than for COD.

(4) Addressing systemic problems in emission reduction is required.

At present, there are some structural defects in the emission reduction program. Three main factors affect the continuity of emission reduction, and some fundamental reforms are needed. 1) Government environment investment is inadequate. Problems exist in measuring environmental investments, the division of responsibilities, and performance management for environmental investment. Presently, the construction of pollution reduction projects is often behind schedule. The quality of projects is also a major concern. For example, support for COD reduction has not fully been in place, especially with public investments. 2) Government enforcement capacity and programs are not sufficient. Discharge/emission standards are not comprehensive and not fully enforced. This has major negative impacts on pollution reduction. 3) There are fundamental weaknesses in policy formulation and implementation, in particular the economic policies that ensure the operation and continuous emission reduction of the pollution control facilities, including both incentive and punitive policies. At present, some policies are in contradiction with the requirements of pollution reduction, and some pollution reduction policies are not strong enough to support continuous pollution reduction.

5.2.2 Pollution reduction is a socioeconomic and political issue.

(1) Environmental issues reflect social, economic, and environmental dimensions.

The continuous economic growth and urbanization in China over the last 30 years has been at the cost of the over exploitation of environmental and natural resources. The pollution load is directly correlated with population, per capita GDP growth rate, and pollution intensity (emitted pollutant per unit of GDP). To address environmental issues, we must seek the solutions in corresponding social and economic systems. Starting from the independent variables in the social and economic spheres, we can identify the right key to address the dependent variables in the environmental sphere. International experience shows that solutions to environmental issues can only be addressed in the context of the whole so-

cio-economic system. Pollution reduction indicators should be considered in relation to the social and economic dimensions. Greater efforts should be made in addressing the systematic, coordinated, and balanced relationship between the socio-economic and environmental systems, and the sustainability of their development using an integrated approach, rather than dealing with each issue in isolation. The responsibility of governments for pollution reduction should be further emphasized through performance assessment indicators. A comprehensive pollution reduction strategy should be implemented. Public participation should be promoted as part of these efforts. Only in this way can we avoid the situation where there are targets but no effective control, and emission reduction becomes a game of numbers for local environmental protection efforts.

(2) Pollutant emission indicators reflect the quality of economic development.

In general, pollutant emissions are indicators of the status and quality of economic growth. With rapid GDP growth, even though emission intensity of industrial pollutants shows some reduction, it is still far higher than that of developed countries. There has been no fundamental change in the mode of development featuring high input of energy and resources, and high consumption and heavy pollution, resulting in huge total emissions of pollutants and heavy loss of environmental resources. The main industries that drive China's GDP growth are those with high energy consumption and heavy pollution. In the first five months in 2007, the medium- and long-term loans from major financial institutions to six line industries characterized by heavy pollution and high energy consumption have increased by 21.8% than the corresponding period in 2006. Industries such as heavy chemicals, thermal power, metallurgy, and cement are still the biggest contributors to emissions. The technological level of these line industries is comparatively low, with few high quality products and low economies of scale. The construction of small-sized steel, cement, and power plants, which is prohibited or restricted internationally, is still booming in some areas, resulting in surplus production capacity. Meanwhile, heavy-polluting industries phased out by the eastern regions have been transferred to the western and other under-developed parts of China. In addition, the power industry is using the excuse of heat-electricity co-generation to expand its productivity, while supporting the fast development of the energy-intensive aluminum and coal sectors. At the same time, 33% of increased steel production is for export. Coke exports from China account for over 50% of the total export volume in the world. It is estimated that 26% of China's energy consumption is related to exports. China has suffered a huge environmental deficit while enjoying huge trade surplus – exporting huge amounts of products while leaving pollution in China is equivalent to importing pollution. For example, during the 10th Five Year Plan period, the annual SO_2 deficit was 1.5 million tons.

(3) Changing the mode of economic

development is a prerequisite for achieving the pollution reduction targets.

The emission reduction target could not be achieved in isolation from GDP, energy and water consumption, technological advancement and industrial structure. Pollution reduction is not necessarily a constraint on development. Rather it should result in sustainable and coordinated economic and social development. The change from an extensive mode of economic development must be achieved through the control of total emissions. The transformation of the mode of economic development is the prerequisite for the eventual achievement of the pollution reduction targets. From this perspective, the root cause of the failure to meet the environmental targets during the 10th Five Year Plan period lies in the quality of economic development. During the 10th Five Year Plan period, the average annual GDP growth rate was 9.5% with total growth of 58% in five years, 14.3% more than originally planned (average annual growth had been projected as 7.5% and total growth, 43.6%). The heavy polluting sectors of steel, cement, power, ethylene and paper increased by 175%, 68%, 84%, 61% and 149% respectively, much higher than the growth of GDP. From this perspective, the failure to meet the 10th Five Year Plan environment targets is understandable. At present, some local authorities still take emission reduction and economic development as two antagonistic objectives and have explicitly or implicitly resist emission reduction work. In such situations, the pollution reduction and economic development plans remain separate, with the latter much more stronger than the former.

(4) Pollution reduction has become a political issue facing the Chinese government.

China ranks first in the world for emissions of several pollutants (i.e. SO_2, COD, POPs, mercury, etc.), even though the per capita level is still low. Emission reduction is the solemn commitment of the Chinese government to the world and is well regarded by the international community. It has become a political issue that directly influences the development of a harmonious society in China, and coordinated regional development. The governments at different levels are the main entities responsible for the implementation of the pollution reduction. Progress in meeting the pollution reduction targets will be directly linked to the performance of local governments.

5.2.3 Achieving the "dynamic" emission reduction target is more difficult than achieving the "static" one.

(1) Reducing emissions by 10% compared to 2005 is a static target that does not take account of economic growth; when this is done, the reduction target is far higher than 10%.

The Chinese government's target to reduce by 10% the total emissions of COD and SO_2 by the end of 2010, compared with that of 2005, is a static and absolute target. If GDP grows at 7.5% annually on average from 2006 to 2010, and the energy saving target is met with environmental protection measures integrated into new projects, it is expected that this would generate an addi-

tional amount of about 1.87 million t of SO_2 and 3.1 million t of COD compared to 2005. The required reduction target would then amount to 4.9 million t SO_2 and 4.51 million t COD, equivalent to 19% reduction of SO_2 and 32% reduction of COD compared to the 2005 baseline. If annual GDP growth is 10%, it is expected that SO_2 and COD emissions would increase by 3.7 million t and 4.3 million t respectively. On this scenario, the required total emission reduction of SO_2 and COD would be 6.73 million t and 5.71 million t respectively, equivalent to 26% reduction of SO_2 and 40% reduction of COD compared with that of 2005. This is 16 and 30 percentage points higher than the static scenario. In other words, with a 10% reduction in existing pollution, China would have to reduce all incremental emissions from new development projects. The dynamic reduction target for most provinces and municipalities is 2～8 times higher than the static target. However, many provinces and municipalities still do not understand this. Instead, they just evenly divide the static emission reduction target allocated by the immediate upper level government authority among the 5 years. This will certainly result in the failure to meet the dynamic pollution reduction targets by the end of 11th Five Year Plan period.

(2) Controlling emissions from new pollution sources should be the first priority, followed by the reducing emissions from existing facilities.

International experience shows that environmental problems must be addressed in the context of the overall social and economic system. Over the past 30 years, the social and economic development of developed countries has been achieved with a stable consumption intensity of resources and energy. This is the physical prerequisite for reaching the "tipping point" when total emissions of pollutants is controlled and gradually reduced. Right now, China's mode of economic growth is still extensively involving the consumption of huge amounts of energy and resources in proportion to the increase of GDP. Therefore, it is very difficult to meet the energy saving and emission reduction targets. During the 11th Five Year Plan period, preventing the incremental generation of pollution at source by changing the mode of development mode will be more important than increasing pollution control at the end of pipe. This is the core of emission reduction work.

(3) The additional pollution generated by economic development will make achieving pollution reduction targets more difficult.

Rapid economic growth and difficulties in controlling consumption of resources and energy will generate additional pollution, and the dynamic pollution reduction target may exceed the pollution reduction capacity that was originally planned. Analysis shows that even if the energy saving target is met on schedule, with environmental protection measures for new projects in place, SO_2 emission will still increase by 771,000 t and COD by 675,000 t for each 1% growth of GDP during the 11th Five Year Plan period. If annual average economic growth during the 11th Five Year Plan period is higher than

10%, the required COD reduction amount would be larger than the planned reduction capacity, making it extremely difficult to meet the COD reduction target. If there is no fundamental change of the current mode of economic growths driven by heavy chemical industry and with economic growth at 10% annually, then energy consumption per unit of GDP in 2010 could only decrease by 15%～16% from the level of 2005. In short, as long as annual economic growth exceeds 10%, and goes beyond the assumptions of the originally designed pollution reduction program, it will be extremely difficult to meet the COD and SO_2 emission reduction targets. Additional policies and measures would be needed.

5.2.4 Achieving the energy saving target is essential for meeting the emission reduction target.

(1) The energy saving target is a soft constraint, linked to the rate of economic growth.

Energy consumption per 10,000 yuan RMB GDP – energy intensity – is a ratio. As long as the rate of growth in energy consumption is less than that of the GDP, then energy intensity will decrease. This can be achieved through technological advancement, higher energy efficiency, or a change in the energy mix. From the perspective of economic efficiency, the decline in energy and resource intensity is an inexorable trend. In China, the average annual decline of energy intensity was 4.5% from 1978 to 2004. There were only four years when the energy elasticity coefficient exceeded one (1989, and 2002-2004). At the macro level (nation wide and 5-year time span), the decline of the consumption of energy and resource is almost inevitable. The current energy saving target is just a quantification of this trend. Judging from the economic development trend during the 10th Five Year Plan period, it is expected that the energy saving target and water saving target will be probably be met automatically, even with higher-than-expected GDP growth. However, the absolute increase of energy and water consumption will exceed the expected figures. According to estimates, if China achieves a 20% reduction of energy intensity by 2010, total energy consumption will increase by 18% compared with that of 2005 (assuming annual GDP growth at 8%). Therefore, the pressure of energy consumption on the environment will continue, but with a reduced rate of increase.

(2) The emission reduction target is a rigid constraint, requiring an absolute reduction of total emissions.

Pollution reduction and energy saving are two binding targets set in the 11th Five Year Plan, with a close relationship, but fundamentally different in nature. The emission reduction target requires the absolute reduction of total emissions, and the subject is the total emission in a given period. Without a fundamental change in the mode of economic growth, faster economic growth and the larger size of total GDP size increases the pollution reduction challenge. SO_2 emissions will increase by 771,000 t and COD by 675,000 t for each 1% growth of GDP during the 11th Five Year Plan pe-

riod. The emission reduction target is a rigid constraint, which is a challenge to the "GDP-ism" prevailing in some areas. During the 10th Five Year Plan period, COD discharge per 10,000 yuan RMB GDP actually declined by 47%. However, the reduction of total emission failed to meet the target.

(1) The achievement of the energy saving target is a necessary but not sufficient condition for achieving the SO_2 reduction target.

Analysis shows that under a 10% GDP growth scenario, a 20% reduction of energy consumption would result in the equivalent of a 45% reduction of the required dynamic reduction target of SO_2 emissions. Supposing there is no change in the energy mix and annual GDP growth of 10% during the 11th Five Year Plan period, if no emission reduction measures are taken, meeting the 10% SO_2 emission reduction target would depend exclusively on energy saving. In this scenario, energy consumption per 10,000 yuan RMB GDP would have to decrease by 44% during the 11th Five Year Plan period. Obviously this is not feasible. If energy intensity is only reduced by 15%～16%, then SO_2 emission would increase by 1.035 million tons, close to the planned reduction capacity limit. If energy intensity is reduced by less than 15%, the SO_2 emission reduction target could not be met. If the energy saving and water saving targets are not met, it will be extremely difficult to achieve a 10% reduction in SO_2 emissions and in discharges of COD.

(2) There is uncertainty about whether the energy saving target will be met, posing a risk that the pollution reduction target will not be met.

Restructuring is often a positive factor for energy efficiency. However, the new round of industrial restructuring since 2002, involving the rapid development of the heavy chemical industry, has increased energy consumption, increasing the difficulty of achieving the energy saving target. The energy saving target in the 2006 pollution reduction scheme has not been met. This increases the difficulty of achieving the pollution reduction target in the later phase of the 11^{th} Five Year Plan period. For the 20% energy reduction target, each one-percentage point that it is not met results in 207,000 tons more SO_2 emissions. If the coal proportion of the energy mix increases by one percentage point, it would add 172,000 t more emissions of SO_2 each year. Study results shows that during the 11^{th} Five Year Plan period, if GDP grows at 10%, achieving the pollution reduction target would require all supporting policies such as the quality of economic development, energy saving, investment in pollution control, policy formulation and implementation, would have to be fully implemented. In a business-as-usual scenario, and with GDP growth over 10%, the pollution reduction target is unlikely to be achieved.

5.2.5 The existing emission reduction program cannot ensure that the emission reduction target will be met.

(1) The slow development of the urban sewage pipe network seriously hinders COD reduction.

At present, the development of urban sewage treatment plants across China is hindered by the size of the task, including the volume of investments required, and the long construction cycle. The demand for the construction of supporting pipelines further constrains normal operation of completed sewage treatment plants. To meet the target of new urban sewage treatment capacity of 45 million t per day under the plan, more than 160,000 km of new sewage pipelines need to be put in place. However, the total length of existing sewage pipelines across China up to the end of 2004 was only 78,000 km. The ability to construct 45 million tons of new urban sewage treatment capacity tons per day will directly affect the achievement of the COD reduction target in China.

(2) There is insufficient attention to sludge treatment at urban sewage plants.

Sludge treatment and disposal are not given enough attention in COD reduction work. In general, sludge accounts for 0.3%～0.5% of total treated sewage (by volume), or 1%～2% (by dry weight). In case of tertiary treatment, sludge amount would increase by 0.5～1 times. An additional treatment capacity of 45 million tons per day for urban sewage would result in an increase of at least 450,000 t sludge every day. In the absence of effective treatment, this will cause secondary pollution. In fact, it just transfers COD from the water to the sludge phase, with no actual discharge reduction.

(3) The reduction of COD at industrial enterprises has not been achieved.

Reducing COD in some heavy water-polluting industries such as paper and chemicals has not been plants are scattered across the country and there is no vertical management structure as in the power industry. According to the Program of the State Council on Comprehensive Work for Energy Saving and Emission Reduction, 50% of the task of reducing industrial COD depends on restructuring. China's experience during the 9th Five Year Plan and 10th Five Year Plan periods show that it is often difficult to implement the policy of phasing-out inefficient plants through industrial restructuring, due to local protectionism. This often leads to stop-and-start again production, or factories closing down but not stopping operation. The other 1.40 million t reduction of industrial COD depends on clean production and end-of-pipe treatment. However, the available environmental information mostly concerns well-established, large- and medium-sized industrial enterprises with relatively good performance. Less information is available on small industrial enterprises with high COD discharges, uneven performance in meeting the discharge standard, and poor or no treatment technology. As a result, they are often not subject to control. In addition, the existing industrial effluent discharge standards for some industries are rather

loose, and the total emission control target is not broken down for each industry, making it hard to achieve a sustained reduction in emissions. There are many industries with complex effluents where it is not easy to identify a good starting point for COD reduction. The Program of the State Council on *Comprehensive Work for Energy Saving and Emission Reduction* needs to specify more detailed requirements in terms of end-of-pipe treatment and emission reduction, in order to make it more workable.

(4) SO_2 reduction heavily depends on desulphurization equipment at thermal power plants.

During the 11th Five Year Plan period, power-generating units with a total capacity of 355 million kW will have desulphurization equipment installed according to the plan. Of this, 188 million kW will be newly built coal-fired power plants where the sulphur removing equipment will be installed and put into operation simultaneously with the power generation equipment. Existing coal-fired power plants with total capacity of 167 million kW account for the rest. This will represent a total SO_2 reduction capacity of 5.90 million t, accounting for about 70% of the total capacity of all reduction measures put forward by the Program on Comprehensive Work for Energy Saving and Emission Reduction. It is expected that the desulphurization rate of thermal power generating units in China will reach 64% by 2010. Taking account that about 10% of facilities cannot be retrofitted, the potential for further desulphurization coal-fired power plants will greatly decline. However, the authorities have only presented general principles regarding requirements for non-thermal-power industries that have close relations with the improvement of regional environmental quality, without any specific tools, objectives, measures and policies. The SO_2 reduction program during the 11th Five Year Plan period depends too heavily on desulphurization projects of big thermal plants. This makes the program rigid and vulnerable.

(5) The consumption of coal in non-power industries is underestimated, and it is difficult to maintain the current coal consumption of coal-fired industrial boilers.

If the energy-saving target is met and GDP grows at 10%, then energy demand will reach about 2.82 billion tones of coal equivalent by 2010, an increase of 540 million t in 5 years. Part of this study involved making an estimation of the breakdown of the increase in coal consumption in different sectors. It is expected that by the end of 2010, the total capacity of thermal power plants across China will reach 620 million kW, with annual electricity generation increasing from 2.04 trillion kWh in 2005 to 3.16 trillion kWh in 2010, and an increase in coal consumption of 477 million tons. According to the industrial development and energy plans, coal consumption in the steel, building materials and synthetic ammonia industries will increase by at least 170 million tons. The total increase of coal consumption in both coal-fired power plants and industrial production processes will be 647 million tons, almost equal to the entire

predicted increase. This indicates that the achievement of the SO_2 emission reduction is predicated on their being no growth in total coal consumption in non-power industrial boilers during the 11th Five Year Plan period. Clearly this is too optimistic. In 2005, total coal consumption in non-power industries accounted for 55% of the total. The annual growth rate of coal consumption in three major non-power industries of iron and steel, building materials and chemicals is 9%. Coal consumption for all industrial boilers across China went up from 320 million t in 2000 to 458 million t in 2005, with an annual average growth of 7.8%. Taking account of such factors as energy saving during the 11th Five Year Plan period, the coal demand of industrial boilers across China will increase by 126 million t. It is predicted that if there is no change in the present development plan, the total energy demand in China will go up to 3.02 billion tons of coal equivalent in 2010 with only a 16% decline in energy intensity compared to 2005. Taking the new increase in non-power industries into account, there will be no any spare room in the planned pollution reduction capacity. In a word, in the scenario of 10% GDP growth, achieving the energy saving and pollution reduction targets will require additional strong measures to curb the development of high energy-consuming industries and to strengthen pollution reduction in non-power industries.

(6) There is insufficient attention to coal washing for SO_2 reduction.

Analysis conducted for this study show that washing 100 million tons of coal could reduce emissions of SO_2 by 600,000～700,000 t, reduce transportation load by 10 billion t-km, and raise combustion efficiency by 10%～15% thereby generating substantial environmental and economic benefits. Strong demand has made the coal industry put more emphasis on quantity than quality. Necessary technological change has not been implemented for industrial kilns, boilers, and coal washing plants. Not enough capacity for loading, transporting, and storing washed coal has been established. Pricing and investment have not been used enough to encourage coal washing. All these factors have led to a situation where coal washing has long been neglected. The cost of coal washing per ton in China ranges between 12 to 15 yuan RMB (7-8 yuan higher than that of developed countries). There is no standardized classification system for coal, and no strict policy for linking the use of different categories of coal with their possible environmental impacts. In 2005, China produced 2.19 billion tons of coal, of which 703 million tons was washed. This amounted to 32% of the total, much lower than that in developed countries (55% in Germany, 75% in Australia, 95% in Canada, and 75% in UK). The ash content in commercial coal is about 20.5%. The coal consumption in non-power industries accounts for 50% of the total. Using unwashed coal in non-power industries has a severe negative impact on energy saving and pollution reduction. (1% ash content reduction in coking coal can result in a 1.33% reduction in the ash content of coke, and subsequently a 2.66% reduction in coke consumption, and a 3.99% increase in utilization coefficient of

the blast furnace.)

(7) Optimizing an energy mix dominated by coal is a big challenge.

90% of total SO_2 emissions are related to energy use. At present, coal accounts for about 69% of the primary energy mix in China (2005), 42% higher than the world average. In recent years, the development of other energy sources like hydropower, nuclear power and new energy sources has received more attention. At the same time, the installed capacity of thermal power has maintained a high growth rate over the past years. According to the latest development plan for the power industry, there will be no major adjustment to the power generation mix that will continue to be dominated by coal. It is also impossible to change the primary energy mix dominated by coal. In this context, China should facilitate the optimization of the energy mix and further strengthen measures for SO_2 emission reduction.

(8) Estimating the SO_2 reduction capacity is very uncertain.

The assessment of SO_2 treatment capacity in the Acid Rain Plan is derived from an estimate of the material balance. It is assumed that the coal sulphur conversion coefficient is 0.8, and average sulphur content of coal is 0.8%. However, some findings suggest that the percentage of coal with less than 1% sulphur level in China is only 20%. With the increasing depth of coal mining, the average sulphur content in coal will increase. In the past few years, the sulphur content in coal burned by the six largest power companies has been higher than 1%. The conversion coefficient of coal sulphur at the newly installed power generating units can reach 0.8～0.95. Thus combustion efficiency and coal sulphur content could generate at least 4 million t more SO_2 emissions in coal-fired power plants (or 1 million tons more after desulphurization in coal fired power plants) – increasing the risk of not achieving the pollution reduction target.

5.2.6 Implementation of the emission reduction policy will not result in sustained emissions reduction.

(1) There are clear weaknesses in the system of emissions standards.

For a long time, local emission standards in China have not developed sufficiently, while national discharge/emission standards cannot meet the special requirements of every region. The discharge/emission standards in some line industries have not been revised with the increasing requirements for environmental protection. There are many cases when the technology used in development project is out-of-date and subject to phasing out by the time the project is completed. Taking the paper industry as an example, existing effluent discharge standards for the paper industry are equivalent to the world average level in 1990s. In most pulp plants, the water withdrawal for per ton of pulp is two times of that in the developed countries. Only 2% of the paper and pulp enterprises reach the world average size. In many local areas, the contribution of the paper and pulp industry is less than 5%, whereas its contribution to COD discharge is as high as 50%. Some local industrial

parks (zones) have become "enclaves," where national law enforcement forces cannot enter, and are havens for enterprises that should have been prohibited or phased out according to national regulations. Some local authorities give the green light to new projects with high energy consumption and heavy pollution, making some industrial parks (zones) as "dirty places" that do not comply with national emission standard.

(2) There is lack of supporting policies for industrial restructuring.

In most cases, industrial restructuring has been implemented by administrative means involving short-term measures, implemented in a certain period of time and without supporting policies. This results in some cases where pollution has been moved from one place to another. The implementation of industrial restructuring is very difficult because it involves many factors such as shutting down polluting enterprises, finding new jobs for affected workers and a decrease of local tax revenue. Special attention should be paid to progress in shutting down small thermal power plants across China with a total capacity of 50 million kW, as it will have an impact on the achievement of the SO_2 emission reduction target. Except for the closure of small thermal power plants, China lacks compensation policies for other industries. In addition, the arbitrariness and lack of a long-term policy mechanism for some industries increases the cost of industrial restructuring.

(3) Some national policies go against the requirements for emission reduction.

Though the message on energy saving and pollution reduction is clear and strong, it has not been turned into price signals and more stringent law enforcement. The existing taxation system, which establishes VAT as the main revenue source and where enterprises pay tax to local government, has encouraged the development of high energy-consuming and heavy polluting industries. On one hand, a change in the mode of growth is required, but on the other hand, administrative intervention maintains resource-intensive growth and inhibits the development of market mechanisms. For example, recycling and efficient use of resources is called for, yet recycling companies often cannot get support and are discriminated against. The Chinese government is taking measures to stabilize the consumption price index (CPI) to improve the livelihood of the people. However, these policies limit the room for raising the price of resources and environmental services. Some findings show that the cost of complying with laws is 46 times the cost of non-compliance. The rate of pollutant discharge fee has long been under-assessed. Many enterprises prefer paying the discharge fee to acquire the right to discharge pollutants legally rather than to treat them. This is one of the reasons why laws are not fully observed or strictly enforced. The central government recently issued a policy to encourage a reduction in agricultural crop output and to raise the proportion of livestock output. However, if the authority does not put in place adequate control measures, it will aggravate pollution from livestock and fowl farms as well as agricultural

non-point pollution.

(4) Administrative policies should be reformed based on emission reduction requirements.

Though current emission reduction targets focus on total emissions control, there is still lack of a binding policy to control the total volume of emissions, which means that they primarily focus on pollution concentration. This not only means that there is insufficient information about total emissions, but also that pollution concentration is the focus during assessments at the construction phase. The system requiring polluting enterprises to treat pollution in a given period is also based on a concentration standard rather than a total emission reduction target set at regional level. In addition, the total emission targets in EIAs of new construction projects are not subject to an emission reduction target at regional level. There even exists where big thermal power plants have repeatedly used the emission quota of "closed-on-paper" plants to obtain emission quotas for new projects.

5.2.7 Insufficient public financial support is still a key factor constraining emission reduction policies.

(1) Lack of financial mechanism contributed to the failure to meet the emission reduction target during the 10th Five Year Plan period.

Various problems exist with public environmental finance that impedes the achievement of the emission reduction target: an insufficient amount, too many recipients, low efficiency and lack of government guidance in pollution control investment. Financing is one of the main factors constraining emission reduction target achievements. Emission reduction work cannot be completed without necessary investment. During the 10th Five Year Plan period, the Chinese government increased investments in environmental protection, with an accumulated input of over 68 billion yuan RMB from the central budget. However, the total investment and its focus were not sufficient to meet the demand for environmental control. During the 10th Five Year Plan period, of the 2,130 pollution control projects identified under the national plan, 1,378 were finished, accounting for 65% of the total. A total of 86.4 billion yuan RMB were made available, accounting for 53% of the total. The pollution treatment projects in the key river basins and regions, including the "three big rivers" and "three lakes," represented about 60% of the total. The development of desulphurization projects lagged behind the requirements of total emission control. The plan required the reduction of 1.05 million t SO_2, but only 70% of them were finished. Desulphurization projects lack financial and policy support. It is for this reason that the 10th Five Year Plan emission reduction target was not met. During the 11th Five Year Plan period, the demand for pollution control investment to achieve the pollution reduction target will be much larger than in the 10th Five Year Plan period.

(2) Investment for pollution control is not sufficient.

At present, the size of environmental investment is over estimated because some categories of investments with indirect environmental benefit, such as green areas and landscape projects, have been included in the government's statistics. This is quite different from the approaches developed by OECD and European countries, and it conceals the fact that the actual environmental investment is inadequate. If only investments in sewage treatment and garbage disposal are included as investments in urban environmental infrastructure, then this category of is only about 50% of the official figure. Thus, environmental protection investment using the most commonly used international definition is about 0.6% of the GDP, rather than the official figure of 1.3%. In general, China is still at the stage of acquiring "new debts" for environmental pollution and not at the stage when the historical debts are being repaid on a large scale.

(3) There are challenges securing funds during the 11th Five Year Plan period for emission reductions.

According to the 11th Five Year National Plan for Environmental Protection and the National Plan for Key Projects, total demand for investment in pollution treatment during the 11th Five Year Plan period is estimated to be approximately 1530 billion yuan RMB. (This is an increase of 82% relative to the 840 billion yuan RMB investment demand of the 10th Five Year Plan period.) This amounts to 1.35% of GDP for the same period (an increase of 0.16 percentage point over the 10th Five Year Plan period). This is about 3.06% of total government investment in social fixed assets (an increase of 0.26 percentage point over the 10th Five Year Plan period). In 2006, nominal environmental investment in China accounted for 1.23% of GDP, a relatively large drop compared with the past two years. At this level, it is apparent that the "paying old debts without creating new debts" requirement will not be met. At present, there is big gap in emission reduction investment, especially the allocation of government funds. Of the 150 billion yuan RMB fund that the Central government planned to allocate, only 35 billion yuan RMB have been allocated. The national budget does not include a special environmental protection fund. In many local governments, the "221" budgetary item for environmental protection is unfunded. Many pollution reduction projects are waiting for government investment.

(4) Enterprises have no feasible financing channel for pollution treatment.

According to the 11th Five Year National Plan for Environmental Protection, enterprises are required to raise 45% of the environmental investment of 690 billion yuan RMB. However, there are no feasible channels for enterprises to raise such funds, so it is difficult to guarantee the investments. There are two reasons for the lack of financing channels: 1) Enterprises find it difficult to attract funds for investment in pollution control projects, and it is often difficult to obtain bank loans. Enterprises with heavy pollution often have poor operations; and enterprises with lower profits often face more challenging emission reduction goals. Thus, such enterprises are in a situation of

"willing to treat pollution but unable to get loans." 2) In the past, enterprises were able to invest 7% of revenues for investment in environmental technology. The policy that allows enterprises to take a tax credit for five years for investments in pollution control and treatment is now meaningless, as this policy was established for most state-owned enterprises. The previous investment channels and policies have been ineffective and new investment channels, incentive policies, and supporting measures have not been established under the new financial and taxation system.

(5) Economic policies constraining emissions are not fully in place.

Existing policies on investment in and financing for emission reduction are not complete and cannot comprehensively support emission reduction work. At present, there are still problems such as the narrow scope of collections, incomplete and inconsistent implementation, low charge rates, weak enforcement abilities for fee collection and low efficiency of fund management in China. In addition, China does not have taxes encouraging environmental protection. Existing environmental taxation measures are not complete, providing only general requirements. For example, the newly introduced resource tax is limited, targeting only mineral resources. It does not collect tax for such resources as high sulphur coal, water and biological resources. Therefore, it is necessary to further strengthen efforts in reforming and improving the investment and financing policies for emission reductions.

(6) Lack of clarity about government responsibility and financing power for emission reductions.

First, there is some ambiguity of government authority. The government usually controls some functions with "rent seeking" interests that may be subject to market forces. But some basic public service functions that the government is supposed to provide have not been implemented effectively under the banner of "market reform." Governments often invest through "market mechanism" without paying enough attention to problems of market and policy ineffectiveness. Second, there is no clear division of the distribution of authority among different levels of government. The Environmental Protection Law in principle stipulates the scope of the central and local governments' responsibilities for environmental protection. However, there is no workable program that clarifies their authority in environmental protection. In fact, there is no evident difference in the environmental authority among government at all levels; leading to the phenomenon that no one is responsible for environmental protection. Third, there is a big gap between central-local government financial and taxation authority and the central-local government environmental authority. In 2004, local financial revenues accounted for about 45% of total national financial revenue. However, local expenditure accounted for 72% of national expenditure, indicating the inconsistency of local taxation authority and financial power. Under the current taxation regime, the financial authority has moved centrally, and the investment responsibility

has moved to the local levels. There is a severe imbalance between the local governments' taxation authority and investment responsibility of pollution control. These have aggravated the difficulty in facilitating emission reduction work.

5.2.8 Effectiveness of pollution abatement projects is lower than the designed capacity.

(1) The development of urban sewage treatment facilities is insufficient.

The Program of the State Council on Comprehensive Work for Energy Saving and Emission Reduction requires that new urban sewage treatment plants with a total capacity of 45 million tons per day be built during the 11th Five Year Plan period. This level provides the capacity to reduce COD by an additional 3 million tons per year. However, the program does not specifically require the reduction of 3 million tons of COD per year. This indicates that to turn the capacity into actual COD reductions, significant work is needed to improve the effectiveness of urban sewage treatment plants. Another issue is how to minimize facility downtime and wasted resources from ineffective environmental infrastructure, and address the issue of meeting the demands for sewage treatment (capacity becoming reality). The development of urban sewage treatment plants across China has accelerated since the 10th Five Year Plan period. However, the development of urban sewage treatment facilities lags population and economic growth due to a lack of available investment capital. At the end of 2006, 248 cities in China did not have sewage treatment plant. In at least 30 cities, more than 50 sewage treatment plants did not operate or operated at a load of less than 30%. In addition, the construction of pipelines to transport sewage significantly lagged the development of urban sewage treatment plants. This seriously hinders the effectiveness of sewage treatment facilities.

(2) Disorderly market competition affects the quality of desulphurization projects.

The relatively young desulphurization industry operates in an immature market with insufficient industrial standards, relevant laws and regulations, and market access, making it difficult to ensure the quality of desulphurization projects. Over the past few years, many companies with little experience or technology in desulphurization have entered the industry. This has led to lower prices and vicious competition. The market price of wet limestone desulphurization has been reduced to 200-300 yuan RMB/kW, which is too low to ensure the quality and effectiveness of desulphurization projects. The technical standards of some emission reduction facilities are low and the associated monitoring system provides poor reliability and accuracy. Some projects have such a long construction period that the technology is obsolete before the projects are completed, or when the desulphurization project is finished renovation is required. Equipment quality directly influences the emission removal efficiency and resulting benefits.

(3) There are insufficient policy measures to support long-term operation of pollution control equipment at maximum capacity.

The experience of some developed countries demonstrates that the cost of operating pollution controls will become more prominent with the completion of large amount of pollution treatment facilities. Because pollution control does not generate direct economic benefits, enterprises seldom set aside sufficient funds for the operation of pollution treatment facilities. Therefore, the government should emphasize supervision of the facilities' operations. In 2006, 24.49% of wastewater treatment enterprises lost money amounting to 148 million yuan RMB. The sewage treatment fee in many Chinese cities is lower than treatment costs. This has an impact on the effective operation of sewage treatment plants.

5.2.9 Difficulty Synchronizing Emission Reductions and Environmental Improvement

(1) There is no direct relationship between the total emission control target and environmental quality.

At present, urban air and water quality of many Chinese cities does not have a direct relationship with COD discharges and SO_2 emissions. In 2006, 7% cities in China failed to meet Grade III national particulate quality standard. The emission of large amounts of NO_x leads to complex impacts on NO_2 concentrations and O_3 concentrations in the troposphere. In some waterways, pollution from non-point sources exceeds pollution from point sources. Non-point source pollution is a key factor impairing water quality. However, existing policies for the reduction of both COD and SO_2 emissions are focused on the control of point sources. In particular, SO_2 reduction aims to control acid rain pollution by mainly focusing on the power industry, without considering SO_2 emissions from industrial boilers that have more impact on ambient air quality. This will influence the effectiveness of emissions reduction efforts. There are no systematic measures for the control of COD, nitrogen, and phosphorus pollution from non-point sources such as livestock, fowl farms and rural sewage.

(2) There is lack of systematic consideration of the ancillary costs of emission reduction projects.

Present emission reduction projects involve large-scale use of desulphurization equipment in coal-fired power plants and urban sewage treatment plants. Both end-of-pipe treatment approaches have similar challenges, including the market pressure on the price of raw materials for construction and operation, accurate on-line monitoring. They also have difficulty in ensuring the quality of emission reduction projects, and there is market saturation of the byproducts from pollution control, and secondary pollution from the stockpile of byproducts. At present, desulphurization equipment in most power plants employs a wet-limestone approach. This approach generates 2～3 tons of gypsum for each ton of SO_2 removed. Therefore, at least 11.80 million tons of gypsum will be generated each

year. If the gypsum is not used in products, it will be stockpiled, which could lead to secondary pollution as weather causes dust problems. The treatment and disposal of sludge byproduct from wastewater treatment should be an important element of COD reduction. The lack of proper disposal options for sludge byproduct will greatly reduce the net environmental benefits of COD reduction projects. There are no technical difficulties in the use of desulphurization gypsum or the treatment of sludge; the key lies in policy support.

5.2.10 Environmental Management Capacity Insufficient to Meet the Emission Reduction Challenge

(1) There is severe lack of regulations on the control of total emissions.

Total emission control, notification of pollutant discharge, and emission permits are common in developed countries. Laws require enterprises and individuals to truthfully report emissions and sign their name to ensure the authenticity of every report. Relevant laws also consider perjury to be a serious crime. However, many enterprises in China have not developed a culture of truthful pollution reporting, leading to inaccurate emissions data. It has been over 10 years since China first implemented the total emissions control system. However, there are no integrated regulations on the control of total emissions or emission permits.

(2) There are weak foundations for the "Three Systems" and a lack of supporting systems.

The emission reduction work reveals weak capacity in the three big environmental systems, i.e. environmental statistics, environmental monitoring and performance examination. In the near future, it will not be easy to change the limited capacity of these environmental systems, due to the recent initiation of these systems, the poor technological conditions, and limited local supporting funds. Funds for monitoring funds have not been allocated, apart from equipment for monitoring pollution sources for enforcement purposes. There are no relevant administrative systems supporting capacity building efforts for the "three big systems." For example, there is no strong technical support for assessing the optimal distribution of total emissions, optimal responsibilities for emission reduction measures, and effects of emission reduction. In general, the development of the database on pollution emissions and the environmental monitoring network represents a good beginning. However, there is a big gap between environmental statistics and the need for emission reductions. There are no unified examination or estimation methods for calculating emission reduction. Local authorities lack an appropriate understanding of the necessary incremental and net emission reductions of major pollutants, leading to a relatively large difference between the national estimated emission reduction data and local data.

(3) Emission reduction data may not be accurate and reliable.

Accurate and systematic statistical data for industrial point-sources, domestic garbage, urban emissions and rural emissions

do not exist. There is no accurate database for assigning emission reduction responsibilities and tracking results. 1) Point-source monitoring has just started. The monitoring scope, frequency, and technology are quite limited. Relevant policies for automatic monitoring are not in place, and there is no clear understanding of the different pollution sources. 2) Data collected by the government does not fully and accurately reflect environmental quality or emissions at source. The database of source emission and the monitoring network need to be enhanced and the monitoring methodologies need to be consistent. 3) Existing environmental data in environmental departments is in a state of disorder. There are many sets of data, such as enterprise self-reporting, environmental impact assessments, environmental inspections and environmental monitoring. The data sets are not correlated or compatible.

(4) The examination of reported emission reductions is superficial.

At present, some local governments play the "numbers game," treating the binding pollution reduction targets as a statistical exercise. This can lead to a situation of "meeting" the total emissions with no control; i.e., talking more but doing less. They have not put emphasis on the implementation of pollution reduction policies and measures, nor on the responsibility for quality and operational control of pollution reduction engineering projects. The Central government and local authorities are playing a game with emission reduction data; this directly affects the effectiveness of the emission reduction program. In some areas, the examination of emission reductions is still quite superficial without an assessment of the target allocation of pollution reduction and without clear targets for inspection. In most areas, local authorities adopt the "subordinates follow the example of their superiors" practice, which simply allocates the reduction task to the next level of government level. As a result, the allocation just focuses on administrative regions. The process of allocating to emission sources is not well implemented, especially for industries with large discharges of water pollutants.

(5) There is insufficient capacity for supervising the operation of reduction projects.

The experience in developed countries demonstrates that the installation of extensive pollution control facilities raises operation costs. Enterprises in China are not willing to spend large amounts of money on pollution control facilities that provide no direct economic benefit. Because of this, supervising the operation of pollution control equipment is critically important. Issues that need to be addressed include insufficient measures and capacity, inconsistent enforcement and insufficient penalties for lawbreakers. Key industrial pollution sources, especially coal-fired power plants with desulphurization equipment, do not have accurate on-line monitoring, which makes it difficult to supervise and operate them effectively. This affects the facility's long-term, stable operation. According to investigations, of 829 key industrial efflu-

ent sources under the national monitoring program in 2006, only 547 had stable discharges that met the standard.

5.3 Policy Recommendations on the Achievement of Emission Reduction Targets during the 11th Five Year Plan Period

5.3.1 Establish a Performance Examination System with Priority for Energy Saving and Emission Reduction Indicators

(1) Restrict environmentally damaging government behaviours through institutional reforms.

Environmental protection involves the "damaging hand," the "control hand," and the "shelter hand" of local governments. Information on emission controls is communicated primarily through speeches or documents. The root cause of many environmental pollution problems is the failure on the part of local governments to make decisions, and also their protectionist practices. Under China's current financial and taxation system, many local authorities prioritize the development and growth of industries with high energy consumption and heavy pollution. This creates local financial revenues, but is counter to the energy saving and emission reduction program of the Central government. To some extent, the environment for industries with high energy consumption and heavy pollution will exist for some time. In China, the game between local authorities and Central government is not an accidental phenomenon. The impact of the export-oriented industrial structure on emission reduction should not be ignored. Only with systematic and institutional reform can China truly curb the negative impacts of economic development on the environment. With financial, tax, and institutional reforms, the government can address the problem of the Central government vigorously advocating sustainable development but local governments only seeking economic growth without adequate environmental safeguards.

(2) Identify the institution responsible for emission reductions, and change the current situation in which economic growth and emission reduction targets are considered separately.

China's social and political systems will make it difficult for local officials to change their approach to development and focus on sustainable development, unless the Central government does not put a greater emphasis on environmental protection and emission reduction when assessing the performance of local government leaders. At present, many local authorities still consider emission reduction targets and economic growth separately. In addition, they treat environmental protection as a "loose" standard and economic growth as a "strict" target. It should be clear that emission reduction responsibilities lie with the local government, not the local EPBs. China should improve the responsibility and examination systems. In particular, China should strengthen the fragmented oversight of industry. China should also change the situation in which upper environmental protection departments examine the performance of subordinate environmental protection departments.

(3) Reduce the role of GDP growth in

the performance assessment of local party and government leaders.

Performance indicators for local officials should include scientific and green indicators, such as emission reductions and improved environmental quality. The primary focus should be emission reduction indicators. GDP growth must be based on achievement of the emission reduction and energy saving targets. The practice of giving preference to GDP growth should not be allowed. In situations where local governments do not meet energy saving and emission reduction targets, the government should take practical measures to cut economic growth. China should increase the importance of achieving emission reduction targets in performance examinations. If an emission reduction target is not met, the local officials should be assessed as "failing," regardless of whether or not other targets are achieved. Appropriate and practical environmental indicators should be included in the official performance examination system to avoid the superficial examination of these indicators. The binding GDP growth target should be waived for areas subject to national restrictions or development bans. Enterprises administrated by the Commission of the State-owned Assets Supervision and Administration should take the lead in carrying out the performance assessment system by prioritizing energy saving and emission reduction targets.

(4) Relevant Central government departments should take the lead to reduce emissions.

Based on each department's role in emission reductions, relevant departments of the State Council are urged to take the lead to develop workable policies to support energy saving and emission reduction. This may mobilize local governments to reduce emissions and create an environment where the whole society is involved in energy saving and emission reduction. Some important government departments like NDRC should take full account of the impacts of increased productivity on the environment when developing industrial development plans (e.g., electricity, petrochemicals and electrolytic aluminum). They should also take the lead in implementing the Law of the People's Republic on Environmental Impact Assessment. Financial departments should allocate 5%～10% of new incremental revenues for environmental protection and emission reductions, fully implement the financial functions for environmental protection, and supervise the use of funds for emission reduction. The Construction Department should integrate infrastructure, including sewage pipelines, into the reduction target, and assume responsibility for reducing the COD discharge from urban sewage.

5.3.2 Reduce Pollution in the Whole Production System with Emphasis on its Upstream and Midstream

(1) Implement an integrated emission reduction strategy.

The achievement of the emission reduction targets will require a shift in the mode of economic growth. Traditional development and end-of-pipe treatment cannot meet the requirements for total emission control.

China should develop an integrated approach including resource and energy consumption, energy and resource savings, technological advancement, pollution control, enforcement, incentive measures and higher efficiency. China should develop an integrated system for emission reductions covering the production, consumption and disposal processes. In particular, China should improve upstream emission reductions through structural adjustments and midstream reductions through technological improvements. Linking total emission reduction targets with socioeconomic development, should achieve the emission reduction targets through measures such as resource and energy conservation, industrial and economic restructuring, production technology improvements and emission reduction projects. China should develop policy incentives, project management systems and inspection systems. Emission reduction efforts should focus on controlling new sources of emissions, followed by the reduction of existing emissions. Reducing the emission increments upstream is more efficient than adding more end-of-pipe emission control. Therefore, the authorities should focus on the new increments first and then reduce existing emissions. Using this approach, the responsibility of local EPBs to monitor end-of-pipe and midstream emissions will decrease, while reduction efficiency and environmental benefits increase. The Chinese government should draft regulations and management policies to implement this shift to upstream pollution prevention.

(2) Strengthen the management of demand for resources and energy; control the unrestricted growth of resources and energy consumption; and implement upstream emission reductions.

Achieving the 20% energy saving target is a prerequisite for achieving the emission reduction target. Based on current energy and industrial development plans, achieving the energy saving and emission reduction targets will limit industrial coal consumption (not including the power sector) during the 11th Five Year Plan period to an additional 170 million tons, with no growth from coal-fired industrial boilers. This will be extremely difficult to achieve. Therefore, the government should control the consumption of energy and resources and emphasize upstream emission reductions. Enhanced management of resource and energy demand, combined with efforts to conserve energy and resources, should facilitate the overall reduction of resource and energy consumption. By utilizing the emission reduction approaches with the highest cost-benefit ratios, China could obtain multiple additional benefits aside from emission reduction.

(3) Improve the quality of development, implement midstream emission reductions and control new and additional emissions.

China should strengthen midstream emission reductions. Industrial enterprises must manage the whole production process; promote industrial restructuring, improve technology and “clean” production practices; and raise the quality of economic development, all in an effort to optimize social and

economic development.

Establish industrial policy and market access based on total emission control. China should revise and improve its environmental standards to control additional emissions. The government should speed up the development of emission intensity targets for key industries such as metallurgy, building materials, electricity and light industry. New development projects should be required to comply with emission intensity standards. China should develop policies to phase out specific industries and target pollution controls in different regions. In addition, China should gradually start to focus on the performance of emission reduction equipment.

Enhance efforts in industrial restructuring. With the adoption of such measures as administrative interventions and market regulations, China should expand efforts to ban new construction projects at the regional and industrial levels to constrain disorganized local investment and haphazard development. Achieving GDP growth targets should not be an excuse for poor performance in resource utilization and environmental protection. China should speed up development of a list of products with high pollution and high environmental risks; track the phase-out of small thermal power generating plants with a total capacity of 40 million kW; and track the development of industrial restructuring.

Raise the price of energy and resources and gradually increase charges for environmental pollution to include externality costs. The pollution discharge fee should at least cover or exceed the externality costs. It should also exceed the cost of controlling emissions.

(4) Take stricter local measures to curb the growth of industries with high energy consumption and high pollution.

China should strengthen its supervision of financing for industries with high energy consumption and high pollution and reduce the quota for those industries. Regulations, such as permits, bans, restrictions, and taxation should be more stringent to control growth in these industries. The government should enhance efforts to encourage the import and export of environmental-friendly products through direct subsidies, tax rebates or tax exemptions. The Central government should adopt administrative measures to constrain local development of industries with high energy consumption and heavy pollution. Using land as the constraining factor, the Central government should prevent the development of these industries through stringent land-use approval requirements and streamlining punitive procedures for land use by illegal development projects. The Central government should use market mechanisms, including controlling credit and loans. Measures that create loan conditions for industries with high energy consumption and heavy pollution, establish corporate environmental reporting and accelerate changes to export policies, should limit excessive investment in, and raise the financial cost of, such industries. In addition, the Central government should make full use of the economy-wide monetary and financing policies, appropriately control the speed and direction of

industrial development, ensure that economic growth targets are achieved, and avoid unhealthy development of selected industries.

(5) Promote regional emission reduction through EIA.

Measures requiring regional EIAs can help the Central government prevent environmental pollution and ecological damage and make more appropriate strategic decisions for industrial distribution and resource allocation. These decisions can effectively solve environmental problems resulting from concentrated or excessive levels of industries with high consumption of energy and resources, and heavy pollution but low efficiency in specific regions. Using regional EIAs will aid government decision making and economic development by optimizing environmental protection. The Commission on the Environment and Resources of NPC should inspect the implementation of EIA and draw attention to government plans that have not carried out EIAs.

(6) Establish a diagnostic mechanism for economic development and emission reduction.

The Chinese government clearly understands that environmental protection cannot be separated from social and economic development. Interactions exist among economic development, energy saving and emission reduction targets. China should set up a monitoring, analysis and early warning mechanism for the three indicators – economic development, energy saving and emission reductions – and regularly assess progress. The government should also identify and publicize problems that affect emission reduction and present targeted solutions. EPBs should emphasize the review and approval of new development projects, formulate standards and policies, and coordinate environmental policies and targets with national economy-wide policies. This can aid with the coordination and practicality of the economic growth and emission reduction policies. In the near future, China should establish a short-term diagnostic platform that assesses the environmental situation, including emission reduction trends, that strengthens data analysis and macro forecasting, and manages emission reduction efforts.

5.3.3 COD Reductions from Key Sectors and Industries

(1) The government should assume responsibility for addressing issues related to the treatment of urban sewage, and the construction and operation of pipelines.

Based on the historical experience of the United States, EU and Japan, the government at all levels should consider the construction of urban sewage treatment plants as a government priority to be supported with public financial resources. The government should not put undue emphasis on market mechanisms and ignore the government's responsibility to construct urban environmental infrastructure. The operation of the environmental infrastructure can be carried out by enterprises through gradual commercialization. Financial capital, espe-

cially from the central budget, should not be used to subsidize the operation of sewage treatment plants. But the central budget should be a key source of funding for the construction of sewage treatment plants in key river basins in the central and western part of China. The authority should also consider sludge treatment and the construction of relevant pipelines as an integrated part of sewage treatment facilities. During the review and approval of sewage treatment facilities, consideration should be given to performance (COD reductions) and the principle of pipeline infrastructure as a prerequisite. If a project does not meet the policy requirements, specific funds, such as central financial transfer payments, could be cancelled. The central budget funds should be considered a bonus, rather than subsidy, for the construction of sewage pipelines. These funds should be linked both to the total length of the pipeline and the treatment capacity and actual COD reduction potential. The government should examine the utilization factor of sewage treatment plants and the actual COD reductions and implement a policy of pro-active construction with greater subsidies. A comprehensive plan should be developed for the treatment and disposal of the sludge when designing sewage treatment facilities. The government should develop and improve relevant regulations and standards on the treatment and disposal of the sludge. The government should also promote the development of sludge treatment technologies, and establish sludge management funds for financing the development and upgrade of equipment for treatment plants taking the initiative to collect and reuse sludge. This will aid in the promotion of the sludge recycling and reuse industry.

(2) Develop emission reduction programs and measures for key industries.

According to the requirements of the Program on Comprehensive Work for Energy Saving and Emission Reduction, the Chinese government is required to facilitate the development of a comprehensive program for COD reduction, allocate COD reductions for each industry and identify detailed requirements for emission reduction of each industry. The government should accelerate the COD emission reduction program for the papermaking, chemicals, textile, food and beverage industries. The government should issue comprehensive, targeted industrial policies covering technical, economic and industrial policy. Case studies show that reducing COD pollution from the papermaking industry should focus on the distribution of the industry, adjustment of inputs in the papermaking process, the application of new technology and more stringent emission standards. Adjusting the inputs should focus on raising the percentage of wood fiber with a significant increase in the proportion of waste paper and a decrease in non-wood fiber. In other relevant industries, such as food and beverages, measures like water conservation and pollution reduction should be promoted. Learning from the experience of the EU and United States, China should publish instruction manuals for emission reductions for each industry. According to the requirements of the Program on Comprehensive Work for Energy

Saving and Emission Reduction, the government should urge local authorities to publicize enterprises that are required to phase out outdated production processes and link the program to the policy of restricting new development projects and the review of new construction projects.

(3) Improve the emission standard for industries with higher compliance rates.

China should encourage local governments to implement industrial emission standards that are more stringent than national minimum standards, especially in eastern China where pollution is heavy and the economy is well developed. Based on international experience, China should develop national emission standards using the best available technology and establish a system to review and revise industrial standards Priority should be given to revising the emission standard for the papermaking industry. If China modifies existing National Standards for the Discharge of Water Pollutants of Paper Making Industry (GB 3544 – 2001) – COD < 55 kilograms per ton of wood pulp and COD < 160 kg/t of grass pulp (applying international state-of-the-art technology) – it is expected that COD emissions will be 541,000 tons in 2010, assuming 35% growth. (The China Paper Making Association estimates paper output will reach 76 million tons in 2010.) This would amount to a total COD reduction of 1.06 million tons, accounting for 66% of COD discharges. In addition, China should strengthen the exchange of technical information and technology transfer and enhance research and development. It should strengthen enforcement, establish an implementation system that combines emission standards with permits, improve enforcement, and increase penalties for non-compliance. It should approve the implementation of the 11th Five-year National Plan for the Prevention and Control of Water Pollution of Key River Basins as soon as possible. Furthermore, China should encourage tertiary treatment of the treated wastewater from secondary wastewater treatment plants and require that the outlet water of urban sewage treatment plants in key river basins or sensitive regions meet the Grade A national surface water quality standard.

(4) Develop economic policies to support the reuse of treated urban wastewater.

The Chinese government should encourage the expanded use of treated wastewater. It should develop principles and guidelines for the recycling and reuse of wastewater, instruct local governments to plan, construct, and manage waste water recycling and reuse facilities, as well as develop technologies to facilitate sustainable use and conservation of urban water resources. China should invest more in projects that recycle and reuse urban sewage and provide preferential policies, such as credits, taxes and resource prices that encourage enterprises or industries that generate neutral water. Also, it should develop compensation mechanisms and price incentives to promote the substitution of natural water with treated water. Preferential pricing policies can encourage the use of treated water, providing a win-win solution for

energy saving and emission reduction. China should take measures to improve the use of treated water by large water consumers and require its use by select industries.

5.3.4 Systematic SO_2 Emission Reduction

(1) Systematically reduce SO_2 emissions in the life cycle of coal.

Based on the experience of the EU, United States and China, cutting SO_2 emissions must be a long-term task. The government should change its focus from end-of-pipe desulphurization equipment. A comprehensive cost-benefit analysis of control options can facilitate SO_2 emission reduction efforts by assessing the entire life-cycle of coal, from mining through combustion. The government should make efforts to adjust the structure of coal production by tightening the high-sulphur coal limit from 3% to 2.5% or 2% and by developing programs to encourage the utilization of low-sulphur, high-quality coal. The government should use energy-saving and emission-reduction funds to support coal washing and utilization of such coal; enhance quality of coals used by small- and medium-sized consumers; raise design standards for industrial boilers with higher combustion efficiency and optimize the energy mix. In addition, the government should enhance the monitoring and inspection of desulphurization projects, focus on pollution control for coal-fired industrial boilers, and make more efforts to use gypsum byproduct to avoid secondary pollution.

(2) Increase the use of washed coal.

China should, according to existing law, require new coal mines to establish coal washing facilities, streamline small coal mines, and shut down small coal washing facilities with low efficiency and heavy pollution. The government should restrict the construction of new coal washing plants with capacities less than 300,000 tons per year. China should also establish funds for coal washing, enhance the development and introduction of coal washing technology, address reliability and efficiency issues of domestically produced washing equipment and improve the design and management of coal washing technologies. China should establish policies to aid in the appropriate distribution of washed coal. Priority for the use of high-quality coal should be given to large cities and residential areas. High-sulphur coal should be restricted to power plants with desulphurization facilities. The government should take measures to promote the utilization of coal gangue and acid manufacturing to facilitate the sustainability of coal washing. The government should also develop coal price categories based on the type, grade and quality of coal, with the price of coking coal based on the ash percentage, and power generation coal based on the heat value. The government should lower the transportation cost of washed coal to encourage more utilization of washed coal.

(3) Implement policy measures for desulphurization at thermal power plants.

It is appropriate to focus on the power industry for SO_2 emission reductions during

the 11th Five Year Plan period, though this does pose some risks. The government should closely monitor implementation of the plan. The government should fully implement the existing policy that power plants with desulphurization facilities receive a higher price for electricity, and that the power grid shares the cost. New and expanded coal-fired power plants must construct desulphurization facilities in accordance with environmental regulations. These plants are encouraged not to construct flue gas bypass pipes. Coal-fired power plants should maintain records of the operation of their desulphurization facilities, including operation and maintenance, continuous monitoring data, generation load, coal sulphur analysis, limestone consumption, power consumption, disposal of desulphurization byproducts, use of bypass pipes and accidents and relevant responses. These records should be subject to inspection by relevant authorities. When coal-fired power plants install desulphurization facilities, automatic on-line monitoring system must be installed, and the real-time monitoring data should be submitted to EPBs and the power grid authority.

(4) Develop policies for comprehensive utilization of the byproduct gypsum.

The government should develop policies that encourage the use of desulphurization gypsum in products. This will reduce the need to mine natural gypsum. The government should also expand the market for products, implement preferential policies on comprehensive utilization of resources, and reduce or exempt the value added tax for enterprises that use desulphurization gypsum. The government should also intensify enforcement efforts to ensure the normal operation of desulphurization equipment at power plants and consistent supply of raw materials for enterprises that utilize byproduct gypsum. The government should encourage efforts to develop technologies combining desulphurization and sulphur extraction. In doing so, the problem of large stockpiles of desulphurization gypsum and the import of sulphur for acids can be reduced.

(5) Improve the operation of desulphurization facilities at power plants.

At present, most coal-fired power plants use the wet-limestone method to remove sulphur. Although this method is reliable and provides high removal rates, it is unlikely that Chinese desulphurization equipment manufacturers developed the necessary experience in this field in less than 5 years. The government should develop national specifications on the design of desulphurization projects in coal-fired power plants as soon as possible, formulate engineering and construction standards, and strengthen the supervision of franchised equipment manufacturers. This may help avoid the scenario of recently completed desulphurization facilities being deemed ineffective and in need of reconstruction.

5.3.5 Central Government Should Exert Authority in Emission Reduction Through Financial Power

(1) The central government should

take the lead to exert "authority based on financial power" for emission reduction.

At present, there is a gap between the central and local government financial and tax systems and environmental policy implementation. It is recommended that the central government exercise authority on emission reduction to a level consistent with its financial power. The experience of the United States and Japan are examples where the Central government exerts authority through dedication of national level staff and specified approval procedures for special plans and programs. In view of the urgency and long-term nature of emission reduction, it is recommended that China learn from the American practice of helping to finance the construction of urban sewage and garbage treatment facilities by the federal government. Specifically, the central government should increase the budget in sectors where environmental protection is a priority, develop more proactive national policies on investment in environmental protection infrastructure, and dedicate 5%～10% of any new financial revenue increments to environmental protection. Financial transfers from the Central government should include environmental protection considerations. China should establish budgetary funds for emission reduction environmental infrastructure similar to the Japanese Environmental Group financing procedures, or create revolving funds for sewage treatment, as in the United States. During the 11th Five Year Plan period, environmental infrastructure investment in 10 key projects is estimated to require 150 billion yuan from the central budget. This is equivalent to 30～40 billion yuan annually. This investment represents about 10% of total environmental investment. The Chinese government should support these investments as soon as possible.

(2) Local governments should assume their responsibilities and make more efforts in emission reduction.

China should amend the Environmental Protection Law. First, the guiding role of the government for environmental investment should be specified, and a base line for financial investment established. Second, identify the proportion of environmental funding within any financial budget growth in order to ensure adequate support for "211" projects and sufficient funds to meet the emission reduction target. At the same time, the Chinese government should develop and adopt statistical methods for measuring pollution abatement and control expenditures in keeping with international practices. According to methodologies used by OECD and Eurostat, investment in green and garden areas as well as construction of natural gas heating infrastructure with indirect environmental benefits, should no longer be classified as environmental investments.

(3) Develop and issue an investment and financing policy for corporate pollution management under a new financial and taxation system.

The existing policies on the 9 financing channels for enterprise environmental protection, issued by the central government in 1984, should be reformed as soon as possi-

ble. China should study and issue an environmental investment policy under the new financial and taxation system. Various financing channels should be assessed and mechanisms for raising funds for pollution control identified. Enterprise expenditures for environmental protection equipment, energy savings or emission reduction should be tax-deductible. The income tax resulting from the sale/application of new state-of-the-art environmental protection equipment, reformed technology investment and adjustment of industrial processes, could be reduced by a certain amount or exempted completely. The government should apply preferential policies for corporate pollution control projects in terms of loans, interest rates, and loan repayment conditions. It should also accelerate the pace of policy development regarding land use, the price of energy for pollution treatment projects, and accelerated depreciation.

5.3.6 Strengthen Enforcement and the Capacity of Environmental Authorities to Ensure Facilities Play Their Role in Emission Reduction

(1) Enhance the legislative and coordination mechanisms for emission reduction.

The government should issue regulations on the control of total emissions of major pollutants as soon as possible, in order to provide a legal basis for emission reduction. Focusing on emission reduction, the government should enhance and integrate environmental management practices including streamlining assessments and approvals, licensing, environmental impact assessment and timely inspection and decision-making upon project construction completion. In areas where appropriate, the government should implement pilot projects to implement independent and vertical management of environmental monitoring and enforcement in order to control the poor environmental behaviour of local governments. Learning from the Japanese experience, the government should establish a factory on-site environmental supervisor system, under the dual leadership of the enterprise and local EPB. Professional certification programs should be developed for environmental monitors and supervisors. The government should carry out a trial regular inspection and environmental performance reporting system with key polluting enterprises. As in Canada, the government should identify relevant enterprises in three categories: up-to-the-standard, subject to risk management, and advanced, with corresponding administration methods. China should strengthen national enforcement functions and tools while enhancing the independence of local EPBs in decision making and implementation. The local EPB's capacity to participate in comprehensive policy making should also be enhanced. The government should beef up the development of an effective environmental law enforcement system and standardize law enforcement down to the prefecture and county levels. In addition, it should amend the components of relevant laws and regulations that are vague in identifying legal responsibilities. An aggressive enforcement campaign should be initiated. Punishment for envi-

ronmental infringements should be raised to a level where any advantage to pollute is removed.

(2) Strictly supervise the operation of on-line monitoring equipment to ensure effective operation of pollution treatment facilities.

The government should supervise monitoring facilities in order to ensure their smooth operation. It should strengthen the management of on-line monitoring equipment, and establish and improve the specifications for on-line monitoring in terms of testing, checking, acceptance, networking and data use. It should specify the legal validity of on-line monitoring data. In addition, China should raise the quality standards for on-line equipment, further streamline the market for introducing on-line monitoring products, develop a regulatory framework for the commercial operation of on-line monitoring equipment, and promote third party verification. The government should promote the introduction, operation and networking of on-line monitoring equipment into the process of managing sewage treatment plants and coal-fueled power plants. In addition, it should accelerate the implementation of a national plan to build capacity for environmental enforcement and compliance and put in place the finance necessary to implement the plan. It should enhance the capacity of regional environmental protection supervisory centers to enforce emission reduction according to the law.

(3) Facilitate the sharing of information about emission reduction and enhance public participation.

China should speed up the establishment of a database on the emissions of major pollution sources under a national control program. This database would make public information about the emissions and reduction strategies of specific polluting industries and enterprises across China. It should document case studies that encourage local government to make public information about emission reduction by key enterprises and their progress in meeting total emission control targets. China should adopt more "mixed" policy measures such as CACs, MBIs and VA tools. Learning from the experience of OECD countries where there is a "mixing and matching" of individual environmental policies for achieving optimal outcomes, China should integrate various policy instruments to address the problems during the pollution life cycle. It should verify emission reduction outcomes by qualified third parties and enhance public participation in reviewing the results. China should facilitate public involvement in all aspects, including decision making, supervision, and management of emission reduction initiatives. Public awareness in emission reduction will promote the sustainability of emission reduction.

(4) Strengthen the integration and dynamic management of emission reduction data.

The government should strengthen and better integrate emission reduction data to provide a better basis for environmental management. China should establish the basic capacity to analyze background and baseline emission levels, and emission re-

ductions. Efforts should be made to set up an accurate, comprehensive database of key pollution source emissions. Based on monitoring, enforcement, emissions and EIA data, a scientific check could be conducted on the data collected for key national pollution sources. Through sample monitoring, the central government could directly control this data to ensure accuracy and avoid possible interference. It should strengthen the implementation of emission reduction projects, while analyzing the dynamic relationship between reductions in emissions from old pollution sources and incremental increase from new sources. It should combine the administration of emission permits, with point source quantitative management and appropriately assess emission reduction for each source. The three data forms – emission fees, environmental statistics, and emissions notification – should be reconciled.

5.3.7 Accelerate the Establishment of Long-term Policy Measures for Emission Reduction

(1) Further promote reforms of the pricing and taxation of resources and environment.

Prices should integrate the full environmental costs of water and coal resources usage. Using the pricing lever, China should establish and implement the environmental pricing mechanism where the "polluters pay." Following the example of differentiated price for power generated from facilities with desulphurization capacity, a differentiated electricity and water price policy should be adopted for heavy polluting industries such as pharmaceuticals, chemicals and papermaking. The government should raise the emission fee standard, expand the range of environmental charges and increase fee collection efforts. The current SO_2 emission charge of 0.63 yuan/kg should be raised to 1.26 yuan/kg, so that the charge covers the treatment cost. It is also recommended that the government should raise the current sewage treatment and COD discharge fees of key river basins and regions to over 0.80 yuan/t and 1.20 yuan/kg respectively by the end of 2008. In addition, products made with heavy pollution and high energy consumption should also be taxed at the consumer level. The resource tax rate for coal, petroleum and natural gas should be raised.

(2) Introduce incentives to support emission reduction.

The State should continue to provide incentives for power plants with desulphurization equipment. The government should assess energy saving in relation to electricity generation. The government should further implement preferential policies for power generated from desulphurization units. It should give economic compensation to enterprises that shut down or experience reduced productivity because of environmental measures. It should establish a database on the environmental performance of key polluting enterprises and strengthen information exchange about environmental protection measures. Tax, bank policies and loans should reward environmental performance enhancing initiatives. The government should award and commend, in an ap-

propriate way, those enterprises that achieve the emission reduction task ahead of time, or have a good environmental performance. It should establish a reward fund for total emission reduction results, and openly recognize those enterprises or local governments contributing to emission reduction. It should adjust the loan structure for a region where the cumulative impact of new development projects is a concern. Also, it should cancel the preferential taxation policy and reduce any subsidies to those enterprises that have not met their emission reduction targets, or continue to discharge pollutants against the law. China should learn from the American experience, and actively implement pilot projects on tradable permits. If the trial is successful, emissions quota and tradable rights should be extended to enable enterprises to benefit from emission reduction. The development of a power market system should consider an emission reduction requirement. The government should extend the power generation license system, power generation tradable rights, and green power quota trade. That is, it should adopt market-based approaches to promote the shut-down of small thermal generation plants, which would result in energy savings and emission reduction.

(3) Advocate green consumption and promote emissions reduction in all of society.

Learning from the new "Energy Policy Act" of the United States, China should adopt incentive measures, such as reduction (exemption) of tax and direct consumer subsidies for energy saving and emission reduction products. This will encourage the whole society to participate in energy saving and emission reduction activities. Government should make more efforts in the procurement of green products, energy saving in buildings, water conservation and emission reductions at their facilities.

5.4 Strategic Outlook on Emission Reduction for the 12th Five Year Plan Period

It is expected that by 2020 China will achieve the goal of a *Xiaokang Society* in an all-round way, with economic development reaching the world average. This is the second-stage objective of China's "three stage" strategy. Environmental protection has become an important component for the development of the *Xiaokang Society* in an all-round way. Therefore, environmental protection and the selection of an effective emission reduction strategy during the 12th Five Year Plan period are of vital importance.

5.4.1 Emission Reduction Still Long-term Task for Environmental Protection

(1) Implementing total emission control in China will be significant before 2020.

It is expected that the consumption of energy and resources in China will peak by 2020. In 2020—2030, it is expected that environmental pressures will gradually decrease due to technological advancements and the transformation of China's economic structure and consumption patterns. The re-

lationship between economic growth and consumption of raw materials will ease with a consequent decline in the emission of major pollutants. By the year 2050, when China realizes a development level equal to intermediate developed countries, it is expected that environmental problems may be addressed in an all-round way. However, before the decrease of pressure on resources, energy, population and industrialization, China will experience pressure from social and economic development resulting from environmental concerns. Total, cumulative emission reduction will be a long-term, onerous and complex task.

(2) Emission reduction will become more difficult during the 12th Five Year Plan period.

With the completion of initial emission reduction projects during the 11th Five Year Plan period, it is expected that further emission reductions across China during the 12th Five Year Plan period will be a bigger challenge. Identifying emission reduction strategies requires more consideration of proactive, technical and economic feasibility issues to ensure rational decision making. Local governments should be given guidance for the total control of such major pollutants such as ammonia, nitrogen and NO_x. Environmental quality should be integrated into the local government performance assessment system. In doing so, it sends a clear message to enterprises about emission reduction through the linkage of emission reduction with environmental quality.

(3) Promote the "five shifts" in emission reduction.

It is recommended that CCICED establish a new TF to develop a strategy for emission reduction during the 12th Five Year Plan. This TF should start in 2008 to support the long-term emission reduction strategy of the Chinese government. The emission reduction strategy during the 12th Five Year Plan period should reflect shifts in the following 5 aspects: 1) shift from an exclusive focus on reduction of total emissions to one that combines total emission reduction with an improvement in environmental quality; 2) shift from an over-dependence on the reduction of emissions from key industries to a reduction of emissions from all industries; 3) shift from increasing the capacity of emission reduction projects to improving their quality and achieving real environmental outcomes; 4) shift from depending on administrative intervention into utilization of long-term tools that have rational economic cost-effect ratio; and 5) shift from the total control of single pollutants to the coordinated control of many pollutants.

(4) Pollution control is not total emission control.

When promoting total emission control and emission reduction, care must be taken to not assume that pollution control is total emission control, and that the problem will be solved as long as total emission control is implemented. As a system, total emission control has its conditions and prerequisites. Pollutants suitable for national total emission control must meet the following conditions: 1) regional pollutants rather then local;

2) measurable, checkable and could be included in statistics with certain foundation; 3) primary pollutant, preferably not a mixed, composite pollutant; and 4) options available for emission reduction are controllable in terms of technological and economic aspects. Therefore, the pollutants suitable for total emission control at national level are rather limited.

5.4.2 Strengthen Implementation of Total Emission Control

(1) Actively facilitate the application of more legal and scientific approaches for total emission control.

Through legal amendments, the government should shift from existing total emission control to environmental quality control with supporting legal responsibilities, including the development of more laws and regulations. Regional differences should be considered when identifying total emission targets that are related to the environmental capacity. The government should study national strategy on total emission control, based on environmental capacity. Using a scientific basis, coordination of regional development and industrial development could be handled more appropriately, minimizing fragmentation and achieving the total emission target. The government should further focus on the examination of emission intensity (pollutant emission per unit GDP), and transfer relevant experience across the country. It should provide leadership, and promote the shift in development while facilitating technical progress. At the same time, it is possible for some local areas with available environmental carrying capacity and good environmental quality to experience an increase in total emissions compared with that of 2010. This reflects an administrative flexibility to deal with different regions or industries. Generally, however, emission intensity must continue to decline.

(2) Implement a targeted system for total emission control and improvement in environmental quality.

The improvement of local environmental quality should be taken into account when examining the performance in emission reduction. The government should gradually promote achieving the targets for both total emission control and improving environmental quality. It should improve its capacity in the identification and comprehensive analysis of result-based data. Total emission reduction targets need to be linked to other environmental performance indicators and supported by monitoring and enforcement. In doing so, all indicators will form part of an integrated system that facilitates the achievement of national environmental policy objectives.

(3) Strengthen the workability of total emission control target at local level.

National government will continue to set the base control targets for the country. Local governments should be encouraged to adopt their own total emission reduction targets that address special, local conditions. The government should take bottom-up, total emission control plans as the foundation for national total emission reduction work. It should promote the implementation of

LEAP and SIP initiatives that involve the participation of all local stakeholders. Government should encourage the identification of reduction options with more rationality and innovation in the decision-making process. In addition, the government should develop alternative emission reduction options, creating competition among options in order to lower the cost of emission reduction. In doing so, it will shift from a binding management mode to a sustainable mode.

(4) Implement demonstration projects to control several pollutants at the same time.

The benefit of controlling several pollutants from a source is higher than that of single pollutant control. Experience has shown that the control of a pollutant could lead to an incremental increase in pollution in another medium – just a transfer of the problem. A trade program taking into account more than one pollutant may stimulate polluters to seek a comprehensive, lower-cost emission reduction solution. Because of the dominance of coal in the energy mix, and the emission of several pollutants from such plants, demonstration projects to exploit synergies in the control of SO_2, NO_x, Hg and CO_2 should be carried out. Coal-fueled power plants in well-developed regions should be the focus of these demonstration projects during the 12th Five Year Plan period. From mid- and long-term perspectives, SO_2 tax covering the full treatment cost should be collected.

5.4.3 Change the ways of reducing SO_2 emissions.

The large amounts of coal-fueled industrial boilers across China causing heavy local pollution should be the focus of emission reduction during the 12th Five Year Plan. It is expected that total demand for primary energy in China will reach 3.2 billion t coal equivalent by 2015. The installed capacity will reach 10,500 billion kW, and coal-fueled power plants will be 8,400 billion kW (6,200 billion kW in 2010). Consequently, coal consumption of power plants will increase by 477 million t coal over that of 2010. With the assumption that the coal sulphur release rate is 0.9, and the sulphur removal rate 0.81, it is expected that coal-fueled power plants will emit 1.6 million t more SO_2 by 2015. This increase must be compensated by a reduction of other pollution sources. Total SO_2 emission from coal-fueled industrial boilers during the 11th Five Year Plan period was 6 ～ 7 million t. If there is no reduction requirement for coal-fueled industrial boilers during this period, it is expected that these boilers will emit 10 million t more SO_2 by 2015. Therefore, total SO_2 emission control targets must include coal-fueled industrial boilers during the 12th Five Year Plan period. Coal fueled industrial boilers, in particular the small capacity coal fueled industrial boilers, should use clean fuel. Measures such as coal washing, processing, shaping, gasification and liquidization should be utilized to further enhance clean combustion. China should develop preferential policies on providing “good quality coal” to coal fueled industrial

boilers, develop a more stringent emission standard for such industrial boilers, and adopt a more stringent emission standard for the design and manufacture of coal fueled boilers in order to improve their performance.

5.4.4 Develop new indicators for total emission control.

(1) Implement total NO_x emission control in thermal power industry.

The power industry is the most significant sector for NO_x emissions, accounting for 5.632 million t, or 35% of the national total. It is expected that NO_x emissions will increase by at least 2.5 million t by the end of 2010. NO_x from thermal plants is emitted from high chimneys, and consequently can move to distant areas, contributing to regional acid rain. By increasing the combustion temperature, and concentrating flue emissions, it is relatively easy to install NO_x pollution treatment equipment for boilers in power plants. This has been shown to be the most effective way to curb NO_x emissions from this source. At present, there are many mature, low NO_x combustion technologies available in the world. In addition, the experience of developed countries such as the United States, Germany and Japan in the control of NO_x emission shows successful NO_x reduction experience at thermal power plants. Based on this experience, the focus of NO_x emission control in China should be coal-fueled power plants. Specific recommendations include: (1) China should establish NO_x emission monitoring and statistical analysis methods for the thermal power industry by the end of 2010. (2) Revise and issue new NO_x emission limits for thermal power plants. To effectively control NO_x emission of thermal power plants, it is necessary to implement new and more stringent emission limits for thermal power plants in 2012. By meeting the emission limit of less than 200mg/m^3 for new power plants, and phasing out old plants that do not meet the standard, NO_x emissions from thermal power plants in China will not continuously increase after 2020. (3) Carry out demonstration projects on nitrogen removal of coal-fueled boilers in sensitive areas. Relevant national departments should actively organize resources to conduct relevant research on flue de-nitrification technologies, including introduction of foreign technologies. Also carry out trial work on flue de-nitrification devices such as SCR and SNCR and combined desulphurization and de-nitrification technology for boilers of power plants in key cities (including those in the Beijing-Tianjin-Tangshan region, the Pearl River delta and Yangtze River delta) to facilitate the development of a domestic flue de-nitrification industry. (4) Actively promote the extension and application of advanced clean coal technology. More efforts should be made to develop clean coal combustion technology, including the demonstration and commercialization of advanced clean-coal power generation technologies such as CFBC, PFBC and IGCC. (5) Develop and implement a unified NO_x control plan with supporting policies. It is recommended that relevant departments should work out a unified NO_x control plan and schedule as soon as possible. Economic

policies encouraging emission reduction should be adopted. The NO_x emission charge rate should be raised and the on-grid price of electricity from production plants with de-nitrification facilities should be given a differential rate. (6) Adjust and optimize the geographical distribution of thermal power. Most coal-fueled power plants in China are located in the central and eastern parts of China. These areas are heavily populated, have fast economic growth, are high in their pollution load, but relatively weak in buffering ability for acid precipitation. New power plant construction should take into account the existing carrying capacity of these developed regions. In addition, NO_x emission from the transportation sector has exceeded 30% of the total national emissions and this figure is expected to continue rising. It is recommended that all light vehicles implement Euro IV emission standard during the 12th Five Year Plan period in order to address NO_x from these sources.

(2) Choose key river basins and lakes to carry out total ammonia/nitrogen control.

The total emission control targets for water pollutants during the 10th Five Year Plan period mainly focused on COD. Other pollution indicators like ammonia and nitrogen were included in the total emission control list but not as binding targets. However, the No.1 pollutant of many waters in China now is ammonia/nitrogen. China is currently carrying out a national investigation on pollution sources, and it is expected that ammonia/nitrogen discharges will be better understood by the end of the 11th Five Year Plan period. It is recommended that the Chinese government include, on a priority basis, the ammonia/nitrogen level into the total emission control and performance assessment system of the 12th Five Year Plan. This will enhance efforts to reduce this pollutant. It is also recommended that all new, reformed, expanded and built urban sewage treatment facilities within key river basins and regions finish the construction and upgrading of nitrogen and phosphorus removal facilities as soon as possible. This will enhance the comprehensive treatment of effluents from key industries that discharge nitrogen and phosphorus pollutants.

(3) Carry out trial work on the control of total nitrogen and phosphorus levels in some sensitive lakes and reservoirs.

International experience in the control of total nitrogen and phosphorus shows that it is a long-term and arduous process. Experience has shown that it is more difficult to control than COD. The sources of TN and TP pollutants are complex and most of them come from non-point sources. At present, China does not have the scientific and technological information to implement basic management practices for total nitrogen and phosphorous emission control. It is recommended that China carry out trial work on the control of total nitrogen and phosphorus concentration in sensitive lakes and reservoirs. Such trials should include the control of total nitrogen and phosphorus contaminants from inflowing rivers. According to

nitrogen and phosphorus control mechanisms, lakes or reservoirs like Erhai Lake could be selected to carry out basic investigations. Work could be started in 2009 to understand the baseline situation, trial the total emission control, and establish relevant demonstration sites.

5.4.5 Gradually expand the scope of COD reduction.

Assess alternative methods for controlling non-point emissions in some areas. According to the bottom-up philosophy, efforts should be made to carry out trial work on the control of non-point sources in selected areas. The purpose should be to investigate alternative approaches and understand baseline conditions. The authorities should develop monitoring and statistical methods that focus on typical industries (e.g. livestock and fowl breeding) in the trial areas. China should establish a national, non-point, COD pollution reduction strategic system, including systematic rural environment management plans. EIA procedures should be revised to accommodate non-point pollutants. Successful international experience in the control of non-point pollution by organic and chemical fertilizers, as well as pesticides, should be investigated. This will be an important area for China in emission reduction work. China should strive to gradually mainstream the control of non-point pollution into the total emission control programs in the future.

5.4.6 Actively pay attention to emerging environmental issues.

Put new pollution problems on the agenda. Certain prerequisites must be met to carry out a total emission control program. Strengthened environmental control does not necessarily fully depend upon the implementation of total emission control. During the 12th Five Year Plan, special attention should be paid to emerging pollutants of interest in the Chinese environment, including mercury, POPs, greenhouse gases and VOCs. With proactive prevention and control measures, the government will be able to create fundamental conditions for the implementation of total control of the above pollutants at a specified future date.

5.5 Policy Recommendations

The Chinese government set the binding target of reducing total emissions of major pollutants by 10% by 2010 as compared with 2005. This is a key part of the Chinese government's strategy to implement the scientific approach to development in a balanced way, and is well regarded by the international community. The Task Force believes that achieving the emissions reduction target will be a major challenge for China. The challenge is particularly difficult, due to relatively weak mechanisms for implementing an emissions reduction policy in the context of rapid economic growth, excessive dependence on desulphurization at coal-fired power plants to achieve SO_2 reduction, insufficient progress in constructing urban sewage pipelines, and lack of an ef-

fective program for reducing industrial COD.

It is very difficult to improve environmental quality at the same time as experiencing rapid economic growth. Gradual reduction of emissions will be a long-term task. Overall, it is difficult to be optimistic about achieving the immediate emissions reduction target. To make further progress, China needs to improve mechanisms for policy implementation. At a strategic level, China should establish a performance monitoring system that priorities energy saving and emissions reduction, and promotes the reduction of pollution in the whole production cycle with emphasis on its upstream and midstream. At a tactical level, China should further optimize and improve the programs and policies for COD and SO_2 reduction. At the same time, the Chinese government should strive to change the current situation where appropriate investment, enforcement, management, and economic policies are not in place, and start work soon on a study of emission reduction in the 12th Five Year Plan period in order to ensure that new, fundamental policy reforms with the five shifts are implemented.

5.5.1 Establish a performance monitoring system that prioritizes energy saving and the emission reduction target.

(1) Change the current situation where economic growth and emission reduction indicators are considered separately.

Emission reduction indicators are measures of the status and quality of economic and social development. The achievement of emission reduction targets is closely related to economic growth, energy consumption, water consumption, technological progress and industrial restructuring. Total emissions in China remains high and far exceed the absorptive capacity of the environment. Economic growth is driven by heavy and chemical industries, those industries with high energy consumption, high pollution and resource consumption. China is experiencing a "resource and environment deficit" within its territory due to the high volume of inefficient production, while enjoying a huge foreign trade surplus. In many regions, local authorities still consider the emission reduction and economic growth targets separately, focusing on the latter and neglecting the former. The authorities should better understand the essential linkages between emission reduction and the overall level of economic and social development. They should start from economic and social "variables" to seek solutions to the environmental "dependent variable." They should strive for harmony, balance and sustainability amongst social, economic and the environmental systems, and facilitate coordinated economic and social development through emission reduction.

(2) Fully emphasize the direct impacts of the pace of economic development on the achievement of the emission reduction target.

If China's GDP grows 10% annually during the 11th Five Year Plan period, there will be an incremental amount of 3.7 million t of SO_2 and 4.3 million t of COD produced. This suggests that for the attainment of the 11th Five Year Plan pollution reduction targets,

the actual reduction of SO_2 and COD required would be 26% and 40% of the total emission amount of SO_2 and COD in 2005 respectively. This is far higher than the 10% reduction of 2005 stockpile. It is estimated that if the average annual growth rate of GDP is higher than 10%, then every additional 1% GDP growth would bring an additional increment of 771,000 t SO_2 and 675,000 t of COD to the total. Analysis shows that if there is no fundamental change in the mode of growth driven by heavy and chemical industries, and with 10% growth of GDP, the required SO_2 and COD reduction will reach the maximum potential of emission reduction program foreseen in the 11th Five Year Plan. If economic growth exceeds 10% without a fundamental change in the mode of growth, the Chinese government will have to take further policy measures to reduce emissions to achieve the target. Economic growth in the first three quarters of both 2006 and 2007 exceeded the assumptions of the original scenario and the emission reduction plan of the 11th Five Year Plan, creating substantial uncertainty about achieving the emission reduction target.

(3) Further reduce the weight of GDP when assessing the performance of local party and government leaders, and effectively manage governmental actions that are not supportive of emission reduction.

It must be made clear that responsibility for emissions reduction lies with local governments rather than local Environmental Protection Bureaus (EPBs). Higher-level environmental protection departments should not assess the performance of subordinate departments. The achievement of the binding emission reduction target should be a prerequisite for achieving projected GDP growth. If the energy saving and emission reduction targets are not met, local governments should cut the GDP increment above what had been predicted. In areas with heavy pollution, the "one vote rejection"[1] system should be strictly enforced. Efforts should be made to identify environmental protection indicators when assessing the performance of officials, and to increase the weight of emission reduction. For protected areas, the GDP target should not be binding. Enterprises under the administration of the Commission of the State-owned Assets Supervision and Administration should take the lead in implementing the performance assessment system taking energy saving and emission reduction as a priority.

5.5.2 Reduce Pollution in the Whole Production System with Emphasis on Its Upstream and Midstream

(1) Implement an emission reduction strategy that considers the whole production system.

To achieve the emission reduction target, China should change the mode of economic growth. It should reduce pollution in the whole production cycle, targeting the consumption of resources and energy and the generation of pollutants, and systematically promote energy and resource saving, technological advancement, pollution control, enforcement, incentive measures and higher efficiency. China should develop a comprehensive emission reduction program cover-

1 The Environmental Protection Department can exercise the veto in the approval procedure on a project, based on the EIA re-

ing production, consumption and circulation, and stress the guiding role of the government. In particular, it should strengthen emission reduction through structural adjustment and technological progress. Reducing pollution at source is more efficient than reducing emissions at the end-of-the-pipe. Accordingly, the government should first aim to reduce emissions from new investments, and than reduce emissions from the existing capital stock in order to meet the emission reduction target.

(2) Strengthen the management of demand for resources and energy; control the unrestricted growth of resources and energy consumption; and implement "upstream" emission reduction.

On a 10% annual GDP growth scenario, and assuming the 20% energy saving target is achieved, then total energy consumption in 2010 would increase by 18%, and SO_2 would be reduced by an amount equivalent to 45% of the required total reduction. In the case of no emission reduction measures, no change in the energy mix, and meeting the 10% SO_2 reduction target only by the conservation of energy and resources, energy consumption per 10,000 yuan GDP would need to be reduced by 44%, which is not feasible. The energy and water conservation targets are relative targets expressed in per cent, whereas the emission reduction target is a "rigid indicator" requiring an absolute reduction in the total amount of emissions. Achieving the target of a 20% reduction of energy and resource consumption is a necessary but not sufficient condition for meeting the emission reduction targets. Based on the current energy and industrial development plans, achieving the energy saving and emission reduction targets would require an increase of coal consumption in the non-power sector to be limited to 170 million tones during the 11th Five Year Plan period. It would also require zero growth in coal consumed in all coal-fueled industrial boilers. Both of these objectives would be extremely difficult to achieve. Accordingly, the government should control the consumption of energy and resources in an appropriate manner and create the basic conditions for emission reduction.

(3) Control the growth of "high energy consumption and high pollution" industries to improve the quality of development, and reduce pollution at the midstream of the production cycle in order to control incremental increases in emissions.

The government should make stringent environmental requirements for investment in industries, and improve the independence and capacity of environmental protection departments to participate in comprehensive decision making for economic development and environment. It should implement industrial policies based on total emission control, and promote integrated policies for economic development and emission reduction. It is recommended that the National People's Congress examine the implementation of EIA on planning developed by government departments and improve the capacity of local governments to implement environmental policies. The Chinese government should continue to implement administrative measures such as restricting/banning new industrial projects,[2] enhance the monitoring and con-

2 The development of new industrial projects may be banned in certain areas, river basins, and line industries where the total pollutant emission has reached its ceiling. The ban can be lifted only when the total pollutant emission is going down by taking effective pollution control measures.

trol of credit for industries with high energy consumption and high levels of pollution, and reduce the export quota for such industries. Instruments such as licenses, bans, restrictions, credit and taxation should be used more stringently. The government may make use of direct subsidies and tax exemptions in line with the principles and policies on public finance for the import and export of environmental-friendly products. It is recommended that a joint early warning mechanism for economy-energy emission reduction should be established. In the near future, China should establish a platform for diagnosing the short- to medium-term situation of economy-energy-environment emission reduction linkages, and carry out regular analysis of and macro predictions for these indicators, in order to provide a technical support platform for decision making on emission reduction.

5.5.3 Significantly reduce COD discharges from key sectors and industries.

(1) The government should invest in the construction and operation of urban wastewater treatment facilities and pipelines.

Based on the experience in the United States, the EU, and Japan, government at all levels should prioritize the construction of urban sewage treatment plants—a public service that requires sufficient public fiscal resources. The government should not try to avoid the responsibility of constructing environmental infrastructure by placing excessive emphasis on market-based approaches for infrastructure investment. However, the operation of urban environmental infrastructure could be gradually commercialized through the involvement of private operators. Government resources, especially the central budget, should not be used to subsidize the operation of sewage treatment plants. But the central budget should remain a primary resource for the construction of sewage treatment plants in key river basins of the central and western part of China. At the same time, the government should consider sludge treatment and pipelines as a necessary part of sewage treatment facilities, taking a holistic view of the construction of sewage collection and treatment, and sludge disposal. During the review and approval of sewage treatment facilities, the government should take full account of COD reduction system performance and strictly require that sewage pipelines be constructed as a first priority. The central government should take account of the actual treatment rate and implementation of the sewage treatment policy when prioritizing financial support. When a local government does not meet policy requirements, funds, such as the central transfer payment, could be partly cancelled. Central government funds should be considered as a bonus, not a subsidy. Allocation of government funds for the construction of sewage pipelines should not only consider the total length of the pipeline, but also the treatment capacity and the actual COD reduction. The government should assess the load factor of a sewage treatment plant and the actual COD reductions, and implement the policy of "early construction with more subsidies."[3]

(2) Develop a COD discharge reduc-

3 This is to encourage local government to complete the construction of their planned urban wastewater treatment infrastructure as early as possible, and obtain more subsidiary funds from the central government budget.

tion program and measures for key industries.

The Chinese government should develop a comprehensive program to reduce COD from major polluting industries, establish individual COD reduction goals for each industry, and create detailed, industry-specific requirements and measures to reduce discharges. First, it should accelerate the COD discharge reduction program in the paper making, chemicals, textile, and food and beverage industries. It should issue comprehensive industrial policies covering technical, economic, and industrial issues. Learning from the experience of the United States, the EU and other developed countries, China should publish industry-specific guidance manuals for reducing COD discharge. According to the requirements of the *Program on Comprehensive Work for Energy Saving and Emission Reduction*, the government should urge local authorities to publicize the name of enterprises that are required to phase-out outdated approaches to controlling discharges in a given time, and link these requirements with the measure of "restricting or banning new industrial projects" and the approval process of new construction projects.

(3) Develop more stringent discharge standards for some industries, and promote greater compliance.

China should encourage local governments to implement industrial discharge standards that are more stringent than national standards, especially in Eastern China where pollution levels are high and the economy is well developed. The government should establish a system to regularly review and revise national discharge standards for selected industries. Priority should be given to revising the discharge standards for the paper making industry. In addition, it should facilitate the exchange of technical information and transfer of technology, and enhance the role of science and technology to promote discharge reduction. China should strengthen enforcement, establish an implementation system that combines emission standards with permitting, make greater efforts to punish non-compliance, including excessive pollutant discharges, and enable more enterprises to meet emission standards. Furthermore, it should approve the implementation of the 11th Five-year National Plan for the Prevention and Control of Water Pollution of Key River Basins as soon as possible.

5.5.4 Focus on system-wide SO_2 reduction.

(1) Reduce SO_2 emissions from mining and utilization of coal.

The Chinese government should aim to achieve continuous, system–wide control of SO_2 emissions. Efforts should be made to tighten limits on high-sulphur coal mining, reducing them from a maximum of 3% sulphur content to 2.5% or 2% sulphur content, and facilitate the development and utilization of low-sulphur, high-quality coal. The government should employ energy saving and emission reduction funds to enhance quality management of the coals used by small- and medium-sized consumers, and raise the design standards for industrial boi-

lers requiring improved combustion and energy efficiency, and an optimized energy mix. In addition, the government should enhance supervision and post-construction assessment of desulphurization projects, focus on pollution control from coal-fired industrial boilers, and expand efforts to promote the utilization of gypsum from desulphurization equipment at power plants in order to avoid secondary pollution.

(2) Increase the use of washed coal to reduce SO_2 emissions.

First, according to law, China should strictly require coal mining enterprises to set up coal washing facilities when developing new mines, streamline small coal mines, and shut down small coal washing facilities with low efficiency and heavy pollution. The government should restrict the construction of new coal washing facilities with an annual capacity less than 300,000 t. Second, China should establish the earmarked fund to support the development and introduction of advanced coal washing technology, address the issues of poor reliability and low washing efficiency of domestic-designed equipment, and improve the design and operation of coal washing and processing technologies. Third, distribute in an appropriate way the flow of washed coal. High quality coal should be used first in combustion sources in cities and for domestic purposes, while high-sulphur coal should be mainly used in power plants with desulphurization equipment. Fourth, take measures to address such issues as the utilization of coal gangue and acid manufacturing to facilitate the sustainability of coal washing. Fifth, develop coal prices based on the type, grade, and quality of coal, with the price of coking coal based on the ash percentage and that for power generation based on the heat value. At the same time, the government should lower the transportation cost of washed coal and encourage greater use of washed coals.

(3) Implement improved policy measures for desulphurization at thermal power plants.

The power industry is the appropriate focus for SO_2 emission reductions during the 11th Five Year Plan period. However, there are some risks. The government should carefully oversee the implementation of the policy measures. The government should issue national specifications for the design of desulphurization projects for coal-fired power plants, establish engineering and construction standards, normalize the markets for construction and operation of desulphurization equipment, and improve the supervision of franchised desulphurization equipment providers. The government should enforce existing rules that desulphurization equipment must meet a minimum removal rate in order for the power plant to qualify for preferential "green" pricing for the electricity supplied to the grid. Restrictions on the use of exhaust gas bypass should be encouraged in new (or expanded) coal-fired power plants. These coal-fired power plants should maintain records on the operation of desulphurization facilities and provide on-line reporting from the monitoring system to the national, provincial, and city level.

(4) Develop a policy for the compre-

hensive utilization of byproduct gypsum from desulphurization equipment.

The government should develop policies to encourage the use of byproduct gypsum in products; limit the mining of natural gypsum; expand the market for products using byproduct gypsum; intensify the policy support for the utilization of byproduct gypsum; improve and implement policies to encourage the comprehensive utilization of byproduct gypsum; and reduce or exempt the value added tax for enterprises that use byproduct gypsum from desulphurization equipment. In addition, the government should intensify its supervision of desulphurization equipment at power plants and the supply of raw materials to enterprises that employ byproduct gypsum. At the same time, efforts should be made to actively develop the technology combining desulphurization and generation of raw material for acid making. In doing so, China can reduce the problems of stockpiling and disposing of byproduct gypsum and the import of large amount of sulphur for acid making.

5.5.5 The Central government should use its fiscal power to meet emission reduction requirements.

(1) The central government should take the lead in using its fiscal power for emission reduction.

At present, there is a large gap between the central- and local-level financial and tax distribution system and the central- and local-level environmental oversight system. The central government should expand its authority over emission reductions based on its fiscal power over the local governments. The experience of the United States and Japan could be followed, where the central government is responsible for developing and approving the special planning for programs, and bears the related cost. In view of the urgency and long-term need for emission reductions, China should adopt the United States' practice of central government financial contributions for the construction of urban sewage and garbage treatment facilities. The central government should increase the share of the budget devoted to environmental protection where it is a priority, develop more effective national policies on investment in environmental protection, and use 5%-10% of incremental fiscal revenues for environmental protection. Fiscal transfer payments should also be used more for environmental protection. The necessary financial resource from the national budget should be provided to adopt practices similar to that of the Japan Environmental Corporation and the revolving loan funds for sewage treatment in the United States. These funds could provide the foundation for emission reductions and the development of environmental infrastructure.

(2) Local governments should meet their environmental responsibilities and enhance efforts to reduce emissions.

China should amend the Environmental Protection Law to include provisions for environmental protection investments, clarify the role of the government in environmental investment, and ensure the investment of a baseline amount for environmental protection.

It should identify the proportion of environmental funds in government budgets and the growth rate of investment in environmental protection, ensure the financial resources in the national budget for environmental protection, and guarantee sufficient funds to finish the emission reduction activities. At the same time, the Chinese government should develop methods for categorizing environmental protection investments for pollution control that reflect reality. According to international practices, such as that of the EU, projects with indirect environmental benefits, like investment in green and garden areas and the construction of the infrastructure for natural gas heating, are not counted as environmental investments.

(3) Develop and implement investment and financing policies for pollution treatment under the new financial and taxation system as soon as possible.

The central government's 1984 policies on nine financing channels for enterprises' environmental protection cannot adapt to the current situation. China should issue a new environmental investment and financing policy under the new financial and taxation system, and expand the financing channels and mechanisms for raising funds for pollution control. Enterprises' investments in environmental protection equipment for saving energy and reducing emissions should be deductible from income taxes. Income resulting from the application of state-of-the-art environmental protection equipment, upgraded technology and adjustment of the product mix should be taxed at a lower rate or exempted from taxes. The government should provide preferential policies for enterprise pollution control projects in terms of loans, interest rates, and loan terms. It should accelerate the pace of development and implementation of supporting policies for pollution control projects on such aspects as land use, electricity pricing, and accelerated depreciation of pollution control equipment.

5.5.6 Strengthen enforcement and the capacity of environmental authorities and ensure that facilities play their role in emissions reduction.

(1) Strengthen the legislative framework and coordination mechanism for emission reduction.

The government should issue *Regulations on the Control of Total Emissions of Major Pollutants* as soon as possible, to provide a strong legal basis for emissions reduction. Focusing on emissions reduction, the government should enhance and integrate environmental management activities, including streamlining and linking licensing and permitting, and environmental impact assessment and inspection. The independent and vertical administration of environmental monitoring and enforcement affairs[4] should be exercised on a trial basis in some regions where conditions exist. Drawing on Japa-

4 The environment monitoring station and enforcement department at lower level should be directly under the leadership/administration of the monitoring station and enforcement department at higher level, not administered by the government at the same level.

nese experience, the government should establish an environmental supervisory system, with responsibilities allocated to both enterprises and local EPBs. A professional qualification system should be established for environmental supervisors. Pilot schemes for environmental inspection and reporting on the environmental performance and emissions reduction of key polluting enterprises should be implemented. Drawing on Canadian practice, the government should assign relevant enterprises to one of three categories, and allocate enforcement resources accordingly: regulatory driven, risk-based, and leading edge.

(2) Strictly supervise the operation of on-line monitoring equipment; ensure the continuous operation of pollution treatment facilities.

The government should treat the operation of pollution treatment facilities as an important component of environmental enforcement. It should monitor and facilitate the smooth operation of such facilities. It should strengthen the management of on-line monitoring equipment, raise the access standards for on-line equipment provider, promote third party verification of data, and clarify the legal status of on-line monitoring data. The government should strengthen the treatment of emissions reduction data, establish the capacity to analyze background and total emissions, and set-up facilities to provide needed data. In addition, it should accelerate the implementation of the National Plan for Capacity Building in Environmental Inspection, including financial and other implementation mechanisms. It should enhance the capacity of regional environmental centers, and strengthen their inspection and law enforcement functions, especially enforcement of legislation related to emissions reduction.

(3) Enhance the transparency of and accessibility to information on emissions reduction, and promote public participation.

China should speed up the establishment of a database on emissions by pollution sources under a national control program. It should make information available to the public about emissions and reductions in emissions of key pollution sources and major polluting industries and enterprises across China. It should adopt "mixes" of policy measures including command-and-control, economic and voluntary tools. It should implement pilot projects to reduce emissions through the involvement of third-party and social forces, and link emissions reduction to public environmental interests by enhancing public participation.

5.5.7 Accelerate the introduction of long-term policy measures for emission reduction.

(1) Further promote the reform of pricing and taxation for resources and environment.

The pricing mechanism, which takes the environmental cost into account should be established for water resource and coal. Following the example of a differentiated price for power from coal-fired power plants with desulphurization, the price of water could be

linked to discharges from heavy polluting industries such as pharmaceuticals, chemicals and paper making. The government should increase discharge fees, expand their range, and strengthen fee collection efforts. It should include products with heavy pollution and high energy consumption into the scope of consumer taxes, and increase the resource tax rates for coal, petroleum and natural gas. When developing an independent environmental tax program, the government should focus on products associated with large emissions, for example gasoline or cars.

(2) Strengthen incentives to achieve emissions reduction.

The government should strengthen the price differential for electricity supplied by coal-fired power plants with desulphurization equipment meeting specified standards. It should provide compensation to enterprises that are required to shut down because they cannot achieve pollution reduction targets at a reasonable cost. It should establish a database on the environmental performance of key polluting enterprises; strengthen information exchange between environmental protection, and taxation authorities, as well as with the banking system; and establish energy-saving, emission-reduction and environmental performance as important prerequisites for preferential policies and granting of loans. It should give appropriate recognition to those enterprises that achieve emission reduction targets ahead of time or with a good environmental performance. The appropriate adjustment should be made on loan policy in areas where the approvals of new industrial projects are strictly restricted. It should cancel the preferential taxation policy and reduce subsidies to those enterprises that have not finished their emission reduction task or that illegally discharge pollutants. It should draw on American experience, and actively implement pilot projects for tradable permits, gradually extending the scope of the scheme and enabling enterprises to benefit from emission reduction.

(3) Encourage consumers and the whole society to participate in emissions reduction efforts.

Learning from experience with the new "Energy Policy Act" of the United States, China should adopt incentive measures such as tax exemptions and direct subsidy to the consumer to facilitate the production and consumption of energy-saving and low-emission products, and encourage the whole society to participate in energy saving and emission reduction. The government should make more efforts to promote government procurement of green products. It should establish criteria and provide incentives for green government procurement, energy saving in buildings, water conservation and emission reductions.

5.5.8 Continuously promote emissions reduction during the 12th Five Year Plan period, 2011-15.

(1) Achieve "five shifts" in emission reduction.

It is expected that the pressure of economic and social development on the environment will not be fundamentally alle-

viated in the next 20 years. These pressures will continue, and it will be a long-term and arduous task to reduce emissions in China. Starting from now, and during the 12th Five Year Plan, the Chinese government should implement a new "five shifts" strategy for emission reduction: 1) shift from an exclusive focus on reduction of total emissions to one that combines total emissions reduction with an improvement in environmental quality; 2) shift from an over-dependence on the reduction of emissions in key industries to the reduction of emissions from all industries; 3) shift from the total emission control of single pollutants to the coordinated control of many pollutants; 4) shift from increasing the volume of emission reduction projects to improving the quality of emission reduction projects and achieving real environmental outcomes; and 5) shift from depending on administrative measures to a greater use of market-based tools.

(2) Choose a strategic path for emissions reduction during the 12th Five Year Plan period.

The Chinese government should actively facilitate the application of more legal and scientific approaches to control the total emissions of pollutants. It should set up and implement an indicator-based system focusing on both total emission control and environmental quality improvement. It should strengthen the feasibility of total emissions reduction at local level; carry out emissions reduction of coal-fired industrial boilers as part of the strategy to reduce SO_2 emissions; gradually implement total NO_x emission control from the thermal power industry; choose key river basins and lakes to control the total discharge of ammonia/nitrogen; select some sensitive lakes and reservoirs to pilot test approaches for the control of total nitrogen and phosphorus discharges; assess approaches for the control of non-point pollution sources in some areas; actively prevent and control emerging environmental problems such as POPs, mercury and VOCs; implement demonstration projects for issues such as the remediation of polluted sites, the treatment of contaminated soil, and environmentally friendly disposal of electronic waste.

Chapter VI

Major Issues and Policy Framework for Environmentally Sound and Strategic Management of Chemicals in China*

6.1 Introduction

6.1.1 Chemicals: Their Hazards and Risks

There are about 7 million chemical substances produced in the world with more than 70,000 in common use. Some 1,000 new substances are introduced each year. There are 45,000 substances listed in the 'Inventory of Existing Chemical Substances in China' and about 100 new substances are added into the inventory every year. Chemicals are an indispensable means of production of consumer goods in the modern world, and are used in medicine, pesticides, fertilizer, plastic, textile fibre, electronic chemical, domestic decoration material, soap and laundry powder, cosmetics, and food additive applications. However, many chemicals harm human beings and the environment to different degrees. Misuse, abuse, chemical accidents or improper disposal during production, storage, distribution, transportation, usage and waste disposal may bring negative influence to human health and environment.

It took a long time for the environmental and health hazards of chemicals to be well understood. Along with the development of human civilization, many chemicals have been are produced and widely used, which has led to local and global environmental and health hazards and occupational safety issues, such as persistent, bioaccumulative and toxic chemicals (PBTs), endocrine disrupting chemicals (EDCs), accidental leakage of hazardous chemicals, transboundary movements of hazardous wastes and their disposal and ozone depletion substances (ODS), and others. Hazards of unintentionally produced toxic and hazardous chemicals such as dioxin also emerged. According to the WHO, global cancer rates have increased so fast since the last century that today 4～5 million people die from cancer, which accounts for about 12%～25% of the total number of deaths; and chemical factors account for 80% of the total factors for cancer.

6.1.2 Demands for Environmental Management of Chemicals in China

In China, as traditional pollution problems are gradually addressed, the demand

* The Chapter is based on the outputs of Special Policy Study on Chemicals Management in China. Co-chairs: Hu Jianxin, Ulrike Kowalski; Members: Liu Jianguo Li Zhengyu Mao Yan, Silke Schmidt, David van Hoogstraten, and others.

for environmentally sound management of chemicals is gradually increasing.

(1) Change of Governance Conceptions

In 2006, he Chinese government confirmed its determination to achieve three transformations: (a) to change from emphasizing economic growth while ignoring environmental protection to stressing both environmental protection and economic growth; (b) to change from environmental protection lagging behind economic development to environmental protection progressing simultaneously with economic growth, to paying back the old debts without accumulating new debts, and change the situation that treatment follows pollution and destruction accompanies treatment; (c) to change from depending mainly on administrative measures for environmental protection to comprehensively taking legal, economic, technical and necessary administrative measures to solve environmental problems. The 'Decision of the State Council on Implementing the Scientific Development Concept for Strengthening Environmental Protection,' Part Five, which concerns establishing and improving a long-term effective mechanism for environmental protection, points out that necessary environmental regulations and standard systems on chemical pollution should be improved.

(2) Adjust the Industrial Structure to Meet the Demands of Economic Development and Sustainable Development

According to the 'Outline of the 11th Five Year Plan for National Economic and Social Development,' China will speed up the change of the economic growth model. Resource conservation should be considered as a basic national policy of China, to promote recycling and reuse, protect the environment, promote a resource conserving and environmentally friendly society, take a practical new road to industrialization, clean and safe development, and finally, realize sustainable development. Chapters like 'adjustment of industrial distribution,' specify a development plan to help optimize the structure of the chemical industry, including basic chemical feedstock, and fine chemicals, while eliminating pollution-intensive chemical enterprises.

(3) Demand of International Environmental Protection

Since 1970, developed countries have established legal systems related to chemical management and have also urged relevant UN bodies to establish and implement several global conventions and concepts successively, such as: Convention Concerning Safety in the Use of Chemicals at Work; Prevention of Major Industrial Accidents Convention; Basel Convention on Control of Transboundary Movements of Hazardous Wastes and Their Disposal; Rotterdam Convention on International Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade; The Stockholm Convention on Persistent Organic Pollutants; The Globally Harmonized System of Classification and Labeling of Chemicals; and the Strategic Approach to International Chemicals Man-

agement, etc. While developed countries and regions have established comparable improved chemical management systems, there is a big gap in chemical management between a majority of developing countries, including China, and the developed countries. Therefore, Environmentally Sound Management of Chemicals (SMC hereafter) has become a requirement for economic development and social progress for developing countries, especially for China, which is a large producer and consumer of chemicals.

(4) Demand of International Trade

China has become one of the world's largest exporting countries. Foreign trade is an important driver for continuing increases in the national GDP. China faces a challenge meeting WTO requirements. However, in recent years, China has encountered stricter technical barriers to its export trade (hereafter TBT) from developed countries, and especially 'green barriers' to trade. According to an investigation by the Ministry of Commerce, in 2002, the year China joined the WTO, exports in the six sectors including the agricultural product sector were frustrated severely by TBT constraints. About 71% of export enterprises and 39% of export products encountered the foreign TBT limit, which caused a loss of about $17 billion USD, equivalent to 5.2% of the total exports. Until now, nearly 90% of food and agricultural products were blocked, resulting in a $9 billion USD loss. Laws and standards related to chemicals and their marketing in China still do not sufficiently protect human health and the environment.

(5) Existing Problems in Environmentally Sound Management of Chemicals

SMC is weak in China. Relevant laws and regulations include: the *Law on the Prevention and Control of Environmental Pollution by Solid Wastes*, the *Regulations on Safe Management of Hazardous Chemicals*, and the *Regulations on Pesticide Management*. Involved departments include environmental protection, commerce, safe production and customs. However, the environmental management of chemicals in China cannot fundamentally safeguard the environment and human health. Major problems include: (a) lack of a clearly defined national policy and/or strategy; (b) the legal system (laws and regulations) not being well established; (c) inadequate capacity of administrative organs, law enforcement and supervision capacity; (d) lack of public participation; (e) a technical support system for management not being well established, and insufficient integrated management measures.

6.1.3 Fields of Environmental Management of Chemicals

The management of chemicals includes environmental management of chemicals, management of protection of consumers of chemicals, and management of worker safety and health. Environmentally sound management of chemicals is quoted from chapter 19, subject 11 of Agenda 21, programmatic document for the international environmental management of chemicals, where six programme areas are proposed: (1)

expanding and accelerating international assessment of chemical risks; (2) harmonization of classification and labeling of chemicals; (3) information exchange on toxic chemicals and chemical risks; (4) establishment of risk reduction programmes; (5) strengthening national capabilities and capacities for management of chemicals; and (6) prevention of illegal international traffic in toxic and dangerous products – moreover, the International Forum on Chemical Safety (IFCS) and the Inter-Organization Programme for the Sound Management of Chemicals (IOMC) are proposed to be created here. The aim is to develop management of chemicals from an environmental viewpoint in order to protect the environment and human health.

6.2 Chemical Industry and the Main Environmental Issues

6.2.1 General Situation of Chemical Industry in China

Since the 1990s, the annual rate of production value of the Chinese chemical industry has increased more than 30% in China. According to the national standard classification of the national economy (GB/T4754-2002), the Chinese chemical industry includes 10 sectors: chemical ore mining, basic chemical raw materials, chemical fertilizers, chemical pesticides, paints, inks and dyes, synthetic materials, specialized chemical products, rubber products and chemical manufacturing equipment. The basic chemical raw materials and synthetic materials sectors account for 20% of the total production value of chemical industry, the fine chemicals, rubber products and chemical fertilizer sectors each account for 10%～15% respectively. These five sectors account for about 85% of the total. In 2005, the total production value of the chemical industry in China was 2.1 trillion RMB (or $257.7 billion USD), which is 8.4% of the total GDP. The total value of import and export of chemicals in China was $133.5 billion USD in 2005. The value of exports is $48.1 billion USD, and the value of imports is $85.5 billion USD. There are about 4.1 million employees and more than 21,000 enterprises (with annual sales value of more than 5 million RMB) in the chemical industry, while 90% are small- and medium-sized enterprises.

At present, there are more than 20 kinds of chemicals with the world's leading production and consumption in China. Production capacity of sulphuric acid, ammonia, other basic chemical raw materials, chemical fertilizers, dyes, and synthetic fiber ranks the first in the world; production of chemical pesticides and painting output ranks second and third in the world respectively; production capacity of the main type of synthetic resin and synthetic rubber ranks the fourth in the world; and consumption of pesticides, synthetic rubber and other chemicals ranks first in the world[1,2]. According to the OECD, the annual increase in the rate of global production value of the chemical industry will be 2.6% to 3.5%. Considering China's economy and chemical industry development trends, future production and

1 Tuyuqin, China's pesticide Industry before entering the WTO, World Pesticide, 2001.

2 Feng Shiliang (China Association of Petroleum and Chemical Industry), the Economic Situation and Outlook on China's Petroleum and Chemical Sectors in 2005, Economic Analysis on China's Petroleum and Chemical Industry, 2005.

consumption of chemicals in China will keep rapidly increasing, and will have a significant impact on the global production and consumption of chemicals.

Chemical enterprises in China are mainly located in Eastern China (Shanghai, Jiangsu and Zhejiang, Anhui, Fujian, Jiangxi and Shandong Provinces) and the central region (Henan, Hubei, Hunan, Guangdong, Guangxi and Hainan Provinces), which accounts for 71% of the total chemical enterprises. Under the dual pressure of the need for environmental protection and industrial structure adjustment, chemical enterprises in China began to transform and restructure to collectivization and large-scale production in recent years, and have established many chemical industrial parks for centralized chemicals production. At present, more than 60 chemical industry parks have been approved by the government above the provincial level.

The widest applications of chemicals include medicine, pesticide, fertilizer, plastic, textile fibre, electronics, domestic decoration material, soap and laundry powder, cosmetics, and food additives.

6.2.2 Environmental Issues of Chemicals in China

As a developing country, the technology of chemical industry and risk management of chemicals in China is still far behind developed countries. Many harmful chemicals, banned or severely-restricted by the international community or that are being phased out in developed countries, are still produced and consumed in China.

Scientific monitoring shows that the concentration of DDT and other chlorinated pesticides, which have been banned internationally for nearly 30 years, is above the international standard of risk assessment in the Pearl River Delta region sediment. Concentration of POPs pollutants like DDT and BHC in tea and aquatic products like fish and shellfish, are relatively high in some regions. Concentrations of DDT and BHC in breast milk are still significantly higher than in developed countries, due to the wide use of synthetic detergent nonylphenol in the Beijing-Hangzhou Grand Canal and water in Jiangnan, and is detected in tap water in Shanghai. Recent monitoring shows high concentrations of toxic organic pollutants in the lower reaches of the Yangtze. The detection rate of PCBs, HCB and lindane approaches 100%. In Chongqing waters of Three Gorges, there are 178 persistent organic pollutants detected, and 18 of these substances are on the 'black list' of preferred controlled pollutants in water by EPA.

Many environmental incidents that take place involve toxic chemicals. According to a SEPA report, the total number of environmental incidents was 1,406 in 2005, including: 693 water pollution incidents, 538 air pollution incidents, 19 ocean pollution incidents, 48 solid waste pollution incidents, and 108 other pollution incidents. Direct economic loss from pollution is about 105.15 million RMB (excluding the Songhua River incident). The polluted area reached 46.91 million m^2, including 43.1891 million m^2 of crop area, 3.455300 million m^2 of water ponds, and 266,800 thousand m^2 of nature reserve. In the November 13, 2005 explosion incident at Jilin Petrochemical

Company of Petro China, six people died, 60 people were injured, and more than 10,000 people escaped in an emergency evacuation. The explosion caused about 100 MT benzene substances to be released into the Songhua River, seriously polluting its lower and middle reaches. Millions of coastal residents have been affected.

According to national statistics reports, from 2002 to 2004 there were 435 non-explosive hazardous chemical incidents that occurred in Beijing, Chengdu, Chongqing, Guangzhou, Harbin, Nanjing, Qingdao, Shanghai, Shenyang, Wuhan, Xi'an and Zhengzhou. In these, 189 people died, 390 people were injured and 962 people were poisoned. Among the 435 hazardous chemical incidents, 70 happened in production enterprises near urban areas, resulting in heavy poisoning and evacuation. One such incident was the chlorine tank explosion on April 16, 2004 in the Chongqing Tianyuan chemical plant, which led to an evacuation of 150,000 residents near the Jiangbei District. Existing information indicates that these problems are getting worse. The whole society is facing increasing environmental and health risks from chemicals.

6.3 Safety and Environmental Management of Chemicals in China

6.3.1 Legislation on Safety and Environmental Management of Chemicals

China has promulgated a series of laws and regulations on safe management of hazardous chemicals, pesticides, pharmaceuticals, and animal medicine, as listed in Annex 1, tables 1 and 2. Relevant ministries of the State Council also establish corresponding departmental rules and regulations for implementation. China has also promulgated a series of safety standards on classification of hazardous chemicals, storage, transportation, packaging and labeling, environmental standards for the control of chemical pollutant discharges and hazardous waste disposal, and occupational health standards.

China has established supervisory agencies for safe and environmental management of hazardous chemicals within the central government and at the local level. At the State Council level, they include State Environmental Protection Administration (SEPA), State Administration of Work Safety (SAWS), Ministry of Health (MoH), State Food and Drug Administration (SFDA), Ministry of Agriculture (MoA), General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ), Ministry of Communication, Ministry of Railways and General Administration of Aviation, and the Ministry of Public Security (MPS). A description of their tasks is given in Annex 2.

Under the authority of relevant national laws, regulations and the State Council authorization, the National Development and Reform Committee (NDRC) is authorized to establish environmental-friendly industrial policies, including cleaner production and recycling and reuse, and restriction or elimination of outdated production techniques, equipment, and products, as well as production licenses for some pesticides. The Ministry of Foreign Affairs (MoFA) has authority to engage in international negotiations on chemicals convention implementation. The

General Administration of Customs (GAC) is authorized to inspect and audit the import/export of hazardous chemicals. And the Ministry of Commerce, the Ministry of Science and Technology (MoST), and other ministries have authority over the import/export of chemicals and research and development of pollution prevention technologies.

SEPA has set up administration of solid waste and toxic chemicals specializing in registration of hazardous wastes, and review work on registration of import and export of toxic chemicals and reporting and registration of new chemical substances. The Bureau of Environmental Supervision is responsible for guidance and cooperation in the settlement of major local, departmental, trans-regional and inter-basin environmental problems; and for establishing emergency response plans in response to serious environmental pollution accident and environmental damage. The Division of International Cooperation is responsible for external negotiations of environmental conventions, coordinating with MoFA and managing implementation of environmental conventions related to chemicals.

Relevant ministries of the State Council have set up special agencies for management and technical support, such as the SEPA Chemical Registration Center and the Solid Waste Management Center. Under the direct guidance of respective administrations, they are responsible for specific functions such as registration of new chemical substances, environmental management, registration of import/export of toxic chemicals, and safe registration of hazardous chemicals and pesticides.

There are local supervision and management institutions of hazardous chemicals and environmental management in China. The environmental protection bureau, production safety bureau, health bureau, agriculture bureau, quality and technical bureau in the provinces (autonomous regions and municipalities), municipal districts and the county government are in charge in their respective areas of supervision and management of hazardous chemicals and pesticides for safety and environment protection. The relationship between local government departments and relevant superior departments is generally one of operational guidance. For example, local environmental protection bureaus in the people's governments above the county level are under the guidance of government of the same level, and also accept operational guidance from higher levels of environmental protection departments. There are local environment monitoring stations and environmental science research institutes in the local governments' environmental protection agency.

China has adopted 'Rules on Management of Hazardous Chemicals' and established a multi-sectoral system framework for national management of hazardous chemicals, which contains the full process of production, management, storage, transport, usage and waste disposal of hazardous chemicals. To coordinate supervision and safe management of hazardous chemicals by relevant ministries of the State Council, and approved by the State Council, an inter-ministerial meeting system for safe production supervision of hazardous chemical

was set up in June 2007. It includes the following 16 ministries and committees of the State Council: SAWS, NDRC, MPS, MoST, Ministry of Finance (MoF), Ministry of Construction, Ministry of Railways, Ministry of Communication, State Administration for Industry and Commerce, AQSIQ, SEPA, CAAC, All China Federation of Trade Unions, Ministry of Labor and Social Security, MoH, SASAC, and the Information Centre Legislative Affairs Office of the State Council.

China also has established the National Coordination Group for Implementation of the Stockholm Convention (NCG), consisting of 13 ministries and agencies: SEPA, MoFA, NDRC, MoST, MoF, the Ministry of Construction, Ministry of Commerce, MoA, MoH, the General Administration of Customs, the AQSIQ, and others.

6.3.2 Major Environmental and Safety Management Regulations and Their Implementation

The NPC Standing Committee and the State Council issue laws and regulations on management of drugs, cosmetics, food and food additives, feed and feed additives, pesticides and other specialty chemicals. This system of safety evaluation and production permit on special chemicals is outlined in Annex 1, Table 3. Supervision and management of other industrial chemicals used as industrial raw materials and raw materials of chemicals for daily use are primarily in accordance with the 'Regulation on Management of Hazardous Chemicals' issued by the State Council.

In May 1994, China began implementing environmental management of the import and export of toxic chemicals. SEPA placed the hazardous chemicals controlled by the 'Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides Under the Rotterdam Convention' onto the list of toxic chemicals banned or severely restricted in China, and implemented registration of environmental management for import and export, and implemented the PIC procedure. In June 2005, SEPA together with GAC, issued the 'List of Toxic Chemicals Banned or Severely Restricted in China (the second group),' and added seven highly toxic chemicals to the management list, within the scope of import/export list of environmental management, which came into effect on July 10th, 2005. In December 2005, SEPA together with the GAC issued the 'List of Toxic Chemicals Severely Restricted on Import and Export in China', which came into effect on January 1st, 2006, and the number of restricted chemicals on the list increased from 34 to 188.

To prevent and control the hazard and risk to human health and the environment by industrial chemicals at the source, SEPA issued and implemented 'Measures for Environmental Management of New Chemical Substances (Order No.17)' on October 15th, 2003, and then began to implement the declaration and registration of new chemical substances before import or production. Based on the identification and assessment of health impacts and environmental hazard of new substances, it approves the registration and permits the production and import of new chemical substances that meet the

risk evaluation standards, while taking measures to ban or restrict production and use of chemicals with high risk to human health and the environment.

Since the registration system of new chemical substances was put into practice in 2003, SEPA has established and updated the 'inventory of existing chemical substances in China.'[3] After the fifth supplement and update, identification information exists for 45,000 chemical substances.

To identify and evaluate hazards and environmental risks of new chemical substances, SEPA set up an accreditation committee of experts on new chemical substances, consisting of technical and management experts on chemistry, toxicology and ecological toxicology, environmental science and safety science. The committee engages in physical, health, environmental hazard and environmental risk assessment for each new chemical substance based on 'the guidelines for the hazard evaluation of new chemical substances (HJ/T154-2004),' and makes recommendations on scientific management.

In the environmental management of construction projects for chemical production, China has made great progress in the strict environmental impact assessment (EIA) management of industrial construction projects and in strengthening capacity for management of responses to environmental emergencies. In past years, the implementation rate of the EIA report (questionnaire) for large- and medium-sized chemical construction projects remained at over 98%. Since 2005, SEPA has required that the project sites meet national industrial policy, plan and environmental requirements, and choose environmentally friendly production technology and product programs. New projects are required to reduce pollutants in the region. Expansion and reconstruction projects are required to implement 'carrying the old with the new technologies' and generally achieve 'increased production without new pollution' or 'increasing production and reducing pollution.'

After the explosion in China's Jilin chemical plant in November 2005 caused serious pollution in Songhua River, SEPA issued the 'notice on strengthening the management of environmental impact assessment, environmental risk prevention [UNCED (2005) 152],' requiring the strengthening of EIA and planning of chemical and petrifaction industries, preventing environmental risks from the source of decision-making, strict review of the projects, strengthening the environmental risk assessment management of construction projects and comprehensive investigation, and supplementing and improving the preventive measures for environmental risks.

Based on the 'national emergency plan for the environment' issued by the State Council in 2005, the Environmental Monitoring Bureau of SEPA issued relevant emergency response procedures, and guided the provincial environmental protection departments to formulate and improve the lo-

3 Existing chemical substances means that the substance is already included in the name list, "inventory of existing chemical substances in China." The existing chemical substances used to be produced or imported in China.

cal environmental contingency plans and emergency response systems.

In accordance with 'Regulation on Safe Management of Hazardous Chemicals' issued by the State Council, since 2002, the SAWS carried out the system of licensing for the safe production, for operation production and safety registration for enterprises that produce, store and use hazardous chemicals. It also established an emergency planning system for hazardous chemical facilities listed as major hazard sources, and established a national emergency rescue command center for safe production of hazardous chemicals and a local emergency rescue center.

6.3.3 Management List of Chemicals and Management Focus

Of the 45,000 chemical substances that China has produced or imported from 1992 to 2005 that are listed in the SEPA 'Inventory of the existing chemical substances in China,' there are, according to the State Council's 'Regulation on safe management of hazardous chemicals,' 3,700 hazardous chemicals on the 'List of hazardous chemicals (2002 edition)' issued by SAWS.

By September 2006, there were more than 1,000 banned or severely restricted chemicals on the control list of safe and environmental management issued by relevant ministries of the State Council (see Annex 1, Table 4).

According to the 'Regulation on safe management of hazardous chemicals' by the State Council, the objects of management of hazardous chemicals in China are chemicals on the 'Name list of dangerous goods,' acutely toxic chemicals, production and storage facilities of major hazardous sources of chemicals. Priority chemicals to be managed are chemicals with explosive, flammable, oxidizing, corrosive and acute toxic characteristics.

The environmental management of chemicals by SEPA is mainly focused on the supervision and management of toxic chemicals with acute toxicity. Management by SEPA is mainly focused on life cycle emissions of chemical pollutants, end of pipeline control and disposal of toxic chemicals released into the environment, and the environmental management on import/export of toxic chemicals.

6.3.4 Technical Support for Management of Chemicals

Under the jurisdiction of the national and local environmental protection, public health, agriculture, quality inspection, industrial, technological and educational departments, there are thousands of national and local research institutes for research of environmental monitoring of chemical pollutants, monitoring of pesticide residues, research and development of pesticide alternatives, standards establishment, pollution prevention and control, prevention of diseases and poisoning, information management, and others. They provide the government departments with technical support.

Environmental monitoring in China is a four-grade monitoring and management system consisting of general station, provincial, the city and county stations. The gener-

al and provincial environmental monitoring centers (stations) are equipped with large-sized advanced analytical instruments, better specialized technical personnel, and capabilities for detection and analysis of chemical pollutants. China has established a number of laboratories testing physico-chemical, toxicological and ecotoxicological properties of chemicals. Most of these laboratories belong in relevant research institutions of ministries or large enterprises.

There are 8 ecotoxicological testing laboratories under the SEPA system, including the key laboratory of ecological effect and risk assessment of chemicals, Chinese Research Academy of Environmental Sciences, and others that may engage in assessment and test of environmental hazards.

There are 25 health toxicology testing laboratories under the MoH and the SFDA, including the occupational health and poison control stations of Chinese Disease Control and Prevention Center, etc., which may engage in testing research of acute toxicity, chronic toxicity, carcinogenicity, mutagenicity, reproductive toxicity, safety pharmacology and toxicokinetics of drugs, cosmetics and other chemicals.

There is a pesticide testing laboratory system consisting of hundreds of pesticide laboratories under the MoA, including the centers for agrochemical, biological and environmental technology, institute for the control of agrochemicals, MoA, which may engage in testing and evaluation projects of pesticide residues, pesticides toxicology, environmental toxicity, pesticide efficacy, and biological testing.

There is a group of testing and evaluation laboratories engaging in industrial chemicals, cosmetics, electronics chemicals, and food under the AQSIQ system, including the institute of industrial product inspection, the Chinese Academy of Inspection and Quarantine, and there are 10 testing laboratories for hazardous characteristics of chemical combustion, explosion and other physico-chemical properties being built currently.

As for the certification and supervision of chemical testing laboratories (good laboratory practice, GLP), they are supervised by different related ministries respectively. According to the 'OECD chemical testing criteria' and the GLP, SEPA promulgated 'the guidelines for the testing of chemicals – test method for chemicals (HJ/T153-2004)' and the 'guidelines for chemical testing good laboratory practices (HJ/T155- 2004)' in 2004, and began to develop management of ecotoxicology laboratory and inspection of qualified laboratory GLP.

SFDA issued 'information on promoting the implementation of quality management criterion for non-clinical drug research' in November 2006; and since January 1, 2007, the notice requirements indicate that for Chemical Raw Pharmaceuticals and its preparation, biological products, traditional Chinese medicine injection that are not in the domestic market should have their non-clinical safety research and evaluation in GLP certified laboratories. Otherwise, their applications for drug registration will not be accepted. At the same time, a list of 22 GLP certified pharmaceutical laboratories was also issued.

MoA issued the 'good laboratory prac-

tice for toxicological safety evaluation of pesticide' in 2003, and implemented the 'measures on evaluation management of good pesticide laboratory' in November, 2006, and began to carry out GLP inspection and evaluation of pesticide testing laboratories.

The MoH promulgated the 'criterion of management of identification of toxicity of chemicals' in 2001, and raised regulatory requirements to the identification of toxicity of chemicals and identification agencies. However, it didn't implement GLP criterion management to the safety evaluation laboratories of cosmetics and toxicological testing laboratories under its supervision. The National Certification and Accreditation Regulatory Committee declared a 'General requirements for the competence of calibration and testing laboratories' and 'criteria for laboratory accreditation evaluation' in 2006. In accordance with international standards of 'General requirements for the competence of calibration and testing laboratories (ISO/IEC17025: 2005)' and national standard 'General requirements for the competence of calibration and testing laboratories (GB/T15481: 2000),' they begin to develop evaluation and certification of laboratories based on their capacity and qualifications.

China is not a member of OECD. It does not fully adopt the internationally accepted 'OECD guidelines for testing of chemicals' and 'principles of good laboratory practice' on criteria for evaluation of new chemical substances, qualified laboratories assessment, certification and review, and supervision and management of labs. Whether or not the testing methods, management program and management requirements in the majority of chemical testing laboratories accord with international management criteria must still be determined. Evaluation and certification management of chemical testing laboratories in China is in the beginning stages, and laboratory testing ability and management cannot meet the domestic demand for safe and environmental sound management of chemicals. Therefore, chemical test results are not recognized and accepted by other countries.

6.4 Regulatory systems and good practices on SMC in developed countries and international policies

From the 1970s to 1980s, as a result of the significant impact of and general concern over environmental issues caused by certain synthetic chemicals like DDT and PCBs, chemical legislation was widely established in developed countries. As a result of such chemical legislation, regulatory systems on environmentally sound management of chemicals were set up step-by-step, with risk assessment and risk management as the basic idea, whose core content is to carry out notification, evaluation and authorization of newly produced chemicals imported and entering into market. The system will then carry on hazard testing, risk assessment and risk management of existing chemicals in the market, according to special priority principle and order. Meanwhile, developed countries have established a number of basic systems on pollution control, accident prevention and emergency response during the

life cycle of hazardous chemicals to control their environmental and health risks. The processes of information, collection, evaluation and risk assessment concerning hazards and risks of existing chemicals have been slow. Thus, since the beginning of the 21st century, in order to accelerate the information collection, evaluation and risk management processes of hazard and risk information of existing chemicals, some developed countries have further reformed the current system on risk assessment and risk management for existing chemicals. They have pursued chemical testing, evaluation and priority chemicals risk management system by taking the “precautionary principle” and extending risk responsibility of chemicals’ manufacturers as main content, such as the EU REACH legislation. In addition, a number of effective new chemicals environmental management approaches were implemented to accelerate the process of existing chemicals hazard risk assessment, and to continually identify, screen, and eliminate the PBT chemicals and other hazardous chemicals with high environmental risks.

6.4.1 Basic Systems of Chemical Environmental Management

(1) New Chemical Substance Notification System

The new chemical substance notification system is a basic system for environmental management of chemicals. New chemicals manufacturers or importers notify the basic property and hazard information of new chemicals to the state administrative departments, and the appropriate departments carry on assessment and authorization of chemicals hazards and environmental and health risks. They take management measures (such as notification, prohibition or restriction, etc) according to the actual condition before placing on the market or importing new chemicals. From the 1970s to 1980s, most developed countries had established new chemicals notification systems by legislative acts specifically for chemicals, e.g. "Chemical Control Act" of Japan in 1973, Toxic Substances Control Act (TSCA) of the United States in 1976, and 79/831/EEC Directive for dangerous substances classification, packaging and labeling (the sixth amendment of EU 67/548/EEC) in 1979.

In the EU, the volume for notifications of new chemicals marketed or imported was divided into three grades and the higher the marketed/imported volume of new chemicals, the stricter and more detailed the data required. The EU requires declarers to provide various heath and environmental hazard data consistent with the OECD’s Good Laboratory Practice (GLP) requirement and the testing guidelines. The OECD developed a unified minimum data requirement for new chemicals notification generally followed by EU and other OECD countries, the so-called Minimum Data Set, and its contents are basically consistent with the Base Set shown in Annex 3.

TSCA can be divided into 4 parts: (1) general information, including types, molecular formulas, composition and purity of new chemicals, preparation process, production/import volume, use and the occupational safety notes of new chemicals; (2) human

exposure and environmental release information, including operating rules, occupational exposure assessment and protection measures, environmental exposure assessment and control technology information; (3) appendix safety and testing information, including material safety data sheet (MSDS), existing health and environmental toxicity data, physical and chemical nature test data (optional); (4) information that is optional to provide, including related information of pollution prevention. The extensive health and environmental hazard information of chemicals evaluated and reviewed under the US new chemicals notification system is shown in Annex 4. Unlike the EU, data in connection with new chemicals notification under TSCA, the US statute, is based on existing data and usually additional testing is not mandated.

For new chemicals proven to have unreasonable health and environmental risks after the evaluation, new chemicals notification system prescribes to take risk management measures, such as the prohibition or restriction of their production, use, import and export.

(2) Risk Assessment and Risk Management System on Existing Chemical Substances

"Existing chemical substances" are the chemical substances which were produced, sold and used in the market during a certain time in the past (EU) or from a certain time until now (US). In 1993, EU promulgated "Regulation EEC (No) 793/93 on the evaluation and control of the environmental risks of existing substances," requiring the manufacturers and importers of chemicals for information notification who had produced or imported in quantities in excess of 10t/y by stages before 1998, and prescribing the manufacturers and importers of HPV chemicals that are produced or imported in quantities in excess of 1,000t/y, to submit a few sets of chemical risk assessment data. This would include the approach to environment and fate, eco-toxicity, acute toxicity, sub-acute toxicity and so on. The EU established an inventory of existing chemicals named "**EINECS**[4]**: E**uropean **I**nventory of **E**xisting **C**ommercial **S**ubstances," and started in 1993 an existing chemicals priority risk assessment and risk management plan for EU countries, in order to gradually assess and control the environmental and health risks of existing chemicals.

In TSCA, EPA may request the chemical producer or importer to provide hazard testing information of a chemical substance, and take regulatory measures in the form of prohibiting the manufacture of the substance, or of strictly regulating its use. Both measures could be taken when the chemical substance presents an unreasonable risk of harm to health or the environment or the amount of the chemicals could cause significant human or environmental exposure, when the data for basic risk evaluation was lacking

4 "EINECS" means the European Inventory of Existing Commercial Substances. This inventory contains the definite list of all substances deemed to be on the Community market on 18 September 1981, see Article 2 paragraph, 1 lit. h) Council Directive 92/32/EEC (OJ L 154 p. 3, 5 June 1992.

and toxicity testing was necessary. TSCA also authorized the establishment of a testing advisory committee for EPA to provide priority chemical substance list for testing, evaluation and risk management of existing chemicals.

Given the large number of existing chemicals and the complexity of chemicals risk assessment, priority risk management has become the basic policy for the risk assessment and management of existing chemicals. This has led to institutional or systematic hazard testing for the high production volume chemicals (HPV, production volume> 1,000 tons / year), which generally means high exposure probability, and risk management measures being taken according to specific standards for certain high-risk or priority chemicals. An example is to prohibit or restrict the production or use of certain "priority toxic chemicals," such as PBT, CMR or vPvB chemicals. Priority risk management is also reflected in the new EU-REACH system that requires manufacturers and importers of substances in quantities of 10 tonnes or more per year to assess the risks arising from the "identified" uses of their substances.

Risk assessment and risk management of existing hazardous chemicals, risk information notification, necessary testing and risk assessment, and risk management principles for priority chemicals, can enable governmental managers to obtain the basic information on hazards and risks of existing chemicals. Based on that, risk management actions, including prohibition or restriction of the production and use of certain priority chemicals with high environmental and health risk, can be reasonably conducted by the governmental authorities, and the environmental and health risk of existing chemicals may be gradually reduced. Therefore, risk assessment and risk management system for existing chemicals has become another basic tool of chemicals environmental management, and the EU's REACH legislation can be considered its reinforcement. REACH aims at companies doing their risk assessments themselves. In addition, it provides mechanisms for the authorities to introduce European-wide risk management measures for substances with unreasonable risks, by adopting restrictions and using the authorization system.

(3) EU-REACH System (2006/2007)

In December 2006 the EU adopted its "REACH-Regulation," which entered into force on 1st June, 2007. The REACH-Regulation replaces a number of regulations on environmental management of major chemicals that had been established since the 1970s. The purpose of it is to "ensure a high level of protection of human health and the environment […] as well as the free circulation of substances on the […] [EU] market while enhancing competitiveness and innovation." Thus, it combines economic growth and the protection of human health and the environment. Also the precautionary principle has been taken into account when the REACH Regulation was developed and its requirements were fixed, and the principle now "underpins" the provisions of the Regulation.

REACH, amongst other things, aims to resolve the problem of lacking information

on existing chemical hazards and risks, and to accelerate the existing chemicals risk management process. REACH reverses the burden of proof for existing substances from the authorities to the enterprises, so that it is up to them to perform the risk assessment for the "identified" uses of the substances they manufacture or import, above a certain quantity, and to communicate the results to the authorities and downstream user-customers. The REACH system includes the main contents as in Annex 5[5].

(4) Pollution Control and Right-to-Know System—TRI or PRTR System

Pollutant Release and Transfer Register (PRTR) is the list or registration book for the release and transfer of toxic chemical pollutants from various sources to the environment, which includes the release data of toxic chemical pollutants from various of pollution sources to air, water and soil, and the transfer data of them to the pollution control facilities or disposal sites. It also includes the integrated report of the total situation of the toxic pollutants release to the environment.

The Toxics Release Inventory (TRI) system is a major original version of the PRTR system. The United States passed the "Emergency Planning and Community Right-to-Know Act" (EPCRA) in 1986, which established a TRI system, stipulating that all enterprises releasing certain toxic chemicals are regulated in the inventory up to a certain amount, and should annually report the amount released into the environment. At present, more than 600 toxic chemicals are reported in the TRI system. At the same time, EPCRA requires EPA to gather the above data, form a TRI report and publish it annually so that it is publicly available. The TRI system has been very effective with respect to pollution control and the prevention of major accidents of hazardous chemicals. Gathering the release information of toxic chemicals provided the basic support for identification of the risk, the evaluation of the effectiveness of the pollution control measures, and then the environmental management decision-making.

Though the name and form of PRTR systems vary in different countries, it usually has the following basic elements: chemical pollutants are reported, according to a toxic chemicals list; industrial enterprises report; total release and transfer report; the fate of various of environmental media (air, water, soil) report; periodic report (annually); unified data reporting formats and database systems; information open to the public (subject to protection of certain confidential commercial information); and improve environmental quality and promote cleaner production technology. Currently, PRTR systems have been established in most OECD countries. At the third meeting of IFCS, establishing a PRTR system was listed as one of the major targets of the chemicals management action of the international community after 2000. In May, 2003, 36 European countries jointly signed a "PRTR Protocol" to build a unified PRTR system in the international community.

(5) Environmental Standards and Monitoring System of Toxic Chemical Pollutants

In 1972, the "Clean Water Act" (CWA)

5 For more information, please see Annex 5.

issued by the United States put forward the "prohibit large emissions of toxic substances" policy, requiring EPA to publish a list of toxic pollutants, and establish an adequate safety margin standard. In 1977, the Clean Water Act amendment formally proposed a standard control inventory, including 129 priority toxic pollutants, requiring EPA to establish corresponding emission standards of toxic pollutants for the temporal 21 types of industrial sources. Currently, water quality standards established by the United States, Europe and the WHO generally have more than 50 indexes, most of which are toxic pollutants. Current drinking water standards in the United States contain more than 50 kinds of toxic organic pollutants and more than 10 kinds of heavy metals and other inorganic toxic pollutants. Meanwhile, toxic pollutants are usually the important indexes in environmental standards of drinking water sources and hygienic standards of drinking water quality. In 1990, the United States put forward the toxic pollutant inventory, including 189 species in the Clean Air Act, requiring EPA to establish and enact the emission and control standards for 41 categories of pollution sources. Till 1996, EPA had established the water pollution emission standards for 52 industries and the toxic air pollutant emission standards for 47 types of pollution sources.

In the EU, under the Water Framework Directive, a list of EU priority substances will be established[6], EU drinking water standards are also fixed in a Directive[7], and there are also rules on air quality[8].

Because of the many types of toxic chemical pollutants, they are often difficult to monitor on a day-to-day, routine basis, but in developed countries toxic pollutants are always included in the annual environmental quality report. For example, the United States annual report on environmental quality has a specific chapter, Toxic Chemicals, reporting the actual results of toxic pollutants environmental monitoring throughout the country. Monitoring and reporting of the environmental pollution of certain priority hazardous chemicals is the basic work of chemicals environmental risk identification, assessment, and risk management.

(6) Major Hazard Sources Management and Emergency Response Plan

A major hazard sources management and emergency plans system is a chemicals management system established especially for prevention and emergency disposal of major hazardous chemicals leakage accidents harming the environment and public health. In 1993, the International Labor Organization (ILO) organized countries all over the world to sign "Convention on the Prevention of Major Industrial Accidents" (Convention 174), to make the major hazard sources management system be universally established in the world. According to the definition of Convention 174, major hazard sources refer to the facilities used for permanent or temporary production, processing, transit, use, disposal or storage of one or more than one kinds of hazardous chemicals

6 http://ec.europa.eu/environment/water/water-framework/ priority_ substances.htm
7 http://ec.europa.eu/environment/water/water-drink/index _en.html
8 http://ec.europa.eu/environment/air/index.htm

whose volume exceeds the threshold value. Convention 174 regulates that member states should establish, implement and periodically review the national policy on protection of workers, the public and environment, and the prevention of major accidents risks in accordance with national legislation, conditions and norms.

Major hazard sources identification standards and safety reporting system are basic elements of a major hazard sources management system. The "Directive on Prevention of Major Accident Hazards of Dangerous Substances (96 / 82 / EC)" (Seveso Directive II), was established in 1996 by the EU, and is shown in Annex 6. It illustrates that this major hazard sources identification standard compartmentalizes the harmfulness of hazardous chemicals in accordance with the hazardous character and hazardous degree, which especially includes an environmental harm index. The EU major hazard sources identification standard is divided into two threshold levels, taking the management measures of different degree according to different magnitudes and differences in corresponding hazardous degrees. The EU classification identification standards of the major hazard sources have broad significance, and ILO has established the major hazard sources identification threshold for 180 species (categories) of chemicals according to the Seveso Directive for reference by all countries in the world. The safety reporting system means that the enterprises with major hazard sources must first report various information and data related to major hazard sources to the governmental authorities, in order to carry on dynamic information management. Seveso Directive II respectively adopts the so-called "safety notification book" system and "safety report" system according to different magnitudes and corresponding different hazardous degrees.

An emergency response plan is a plan or scheme established in advance of the possible major accidents or disasters, to ensure to that rapid, orderly, effective emergency and rescue actions are taken to reduce accidents and losses. It is an integrated and detailed arrangement based on the identification and assessment of potential major hazards, accident types, the possibility of occurrence, consequences of the accidents, and the severity of the impact, that elaborately designate the response agencies and duties, personnel, technology, equipment, facilities, materials, rescue actions and their command and coordination. In general, the emergency response plan creates a systemic emergency response mechanism in which enterprise, government, community and the public all play an active role. Most government agencies are involved, such as public security, fire protection, environmental protection, medical care, sanitation and the media. In the United States EPCRA places toxic chemical accident emergency response plans within the legal system. In the EU, emergency response plans are part of the Seveso II Directive.

In 1993, the International Labor Conference passed "Convention on the Prevention of Major Industrial Accidents" also list emergency plans as necessary measures for prevention of major accidents.

6.4.2 Non-regulatory Measures and Actions on SMC in Developed Countries

Voluntary Agreement (VAs)

Since the 1990s, voluntary agreements signed between the government and the chemical industry in order to implement risk assessment and risk management of chemicals is developed widely in developed countries, and it has become an important means of environmental management policies on chemicals in many countries. European Commission statistics showed that among the more than 300 Voluntary Agreements on environmental management signed by European governments and businesses, the proportion of the VAs between the government and the chemical industry is nearly 30%, while the remaining several industries are around 10%. There has been greater use of VAs in chemical environmental management in the US and they have become a major means of implementing chemical environmental management policies and strategies. The 33/50 Plan is a VA plan developed by EPA to reduce the polluting emissions of 17 species of toxic chemicals. In 1998, the US government issued a motion called "Chemical Right-to-Know" in order to accelerate the test of environmental and health hazard caused by chemicals and the publication of the risk information, and initiated the "HPV Chemicals Challenges Plan" (HPVCCP) and "Voluntary Child Chemicals Evaluation Plan" (VCCEP), which have succeeded in establishing a working relationship among government, the chemical industry and public interest groups. Many community stakeholders voluntarily committed the hazardous test and risk assessment of most existing chemical substances and some preferential high risk toxic chemicals in more than 2800 HPV chemicals. In January 2006, EPA and 8 companies agreed on the "2010/15PFOA responsibility management plan," in order to reduce and eliminate PFOA and its related precursors step by step before 2015.

(1) Responsible Care (RC)

"Responsible Care" is the chemical industry's voluntary action, hammering at improving the environmental, safety and health information and performance in technology, throughout a chemical's life cycle, publicizing the information, communicating and cooperating with community stakeholders, prompting chemical businesses to take responsibility for chemical management in chemical industry and supply chain, and to protect the environment and human health.

The ideas of RC were first initiated by the Canadian Chemical Producers Association in 1985, and were then adopted by the US Chemical Manufacturers Association and the Chemical Industry Association of the EU and Japan. Later, under the promotion of the International Council of Chemical Associations (ICCA), they have been adopted in 52 countries around the world. The production volume of those enterprises taking part in them is close to 90% of the global total. ICCA specially set up the RC leading group responsible for the cooperation with the national chemical industry organizations, developing and improving the rules of RC, and continuing to promote the wider use of the RC norms. The RC opera-

tions are mainly implemented by chemical industry associations. ICCA/RCLG developed 8 terms of RC core criteria, which should be followed by all of the countries. Also, chemical companies must sign a formal commitment protocol and take corresponding actions. RC movements were recognized by UNEP at the Johannesburg Conference on sustainable development in August 2002.

(2) Green Chemistry

The Green Chemistry project is aimed at establishing extensive partnerships among the government, scientific and technological circles, and industry's research institute to develop the innovation design of environmentally friendly products, and the process, reduce environmental and health risks from chemicals. In 1991, EPA pollution prevention and toxic substances office (EPA/OPPT) launched the "pollution prevention substitutive synthetic route" plan. Its four main areas include: (1) Green chemistry research projects; in 1992 and 1994, EPA / OPPT signed a memorandum of understanding with the National Science Foundation (NSF) to build a partnership establishing a "sustainable environmental technology" Assistance Program – a jointly funded green chemistry research. The Presidential Green Chemistry Challenge Program is an annual award scheme for outstanding performance of the chemical industry in promoting green chemistry awards, and honors those who promote green chemistry. Under the Green Chemistry Education Program, EPA and the American Chemical Society (ACS) establish partnerships and promote green chemistry education among chemical engineers, students and research staff in university or scientific research institutions. Under the Green Chemistry scientific communication plan, the "green chemistry" project provides funds to various industries, policy makers and the scientific community for green chemistry science, technology advocacy and popular activities.

6.4.3 Basic Principles and Policies in SMC in Developed Countries

Based on the systems and general practices of environmentally sound management of chemicals in developed countries, several basic principles and policies could be summarized as follows.

(1) Prevention and Precaution

There are many chemicals that had been produced largely and applied widely, but lately were testified harmful to the environment and human health, such as DDT, PCBs in 1970s and PFOS recently. They have caused countries to introduce systems that require a generation of information before new substances are produced or placed on the market (this is prevention). Furthermore to protect the environment, every country should take appropriate precautionary measures. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not cause a country to delay cost-effective measures to prevent environmental degradation. This basic approach is embodied not only in the basic policies and systems of environmental management of chemicals

in developed countries, but is also reflected in the US toxic chemicals regulatory regime. This is with respect to the notification systems of new chemicals, and the risk assessment and risk management systems of existing chemicals, and it also underpins the new REACH Regulation. A balance was found in the new Regulation between the burden that enterprises will have to face and the amount of information to be generated on the hazards and risks of substances on which the risk management measures will be based.

(2) Priority Management

At present, there are probably over 100,000 industrial and commercial chemicals circulating on the market. Many countries, therefore, adopt "priority management" as the basic policy and principle of environmental management of chemicals, and first manage the chemicals that have higher health and environmental risk, such as HPVCs, PBT, vPvB and CMR. "Priority management" is not only carried out in every basic system of environmental management of chemicals, such as environmental monitoring of toxic chemicals, PRTR, control of major pollution, but is also embodied in international treaties such as POPs and PIC.

(3) Polluter Pays, Burden of Proof, and Sharing Responsibility

During the strategy and system reformation of the environmental management of the chemicals in Europe in recent years, the responsibility of chemicals environmental management has been mainly devoted to manufacturers and importers. In REACH, downstream users are included as well, however the main burden with regard to the generation of information on hazards and risks lies with the manufacturers and importers. The REACH Regulation takes a different approach than United States, where the government is mainly in charge of hazards test as well as risk assessment. REACH requires that the chemical manufacturers and importers are mainly responsible for hazard testing and risk assessment.

(4) Public Participation

PRTR systems as well as VAs and RC action are widely pursued by chemical environmental management in developed countries to promote public participation.

6.4.4 International Policies and Actions on Environmentally Sound Management of Chemicals

At the 1992 Rio Conference on Environment and Development, the sound environmental management of chemicals was written into the sustainable development of human society programmatic document, Agenda 21. Since the 21st century, international chemicals management activities developed in three areas especially: the gradual promotion of the Globally Harmonized System of Classification and Labeling of Chemicals (GHS); the extensive subscription of the chemical environmental management conventions; and the Strategic Approach to International Chemicals Management.

(1) Globally Harmonized System of Classification and Labeling of Chemicals

Human society has developed a gradual awareness of hazards caused by chemicals. A classification system for hazardous chemicals was first applied by the United Nations Exports Committee on dangerous goods in the 1950s. It produced the concept of hazardous chemicals, and divided them into explosives, compressed gas/liquefied gas, flammable liquid, flammable solid, spontaneous articles/contacting water-flammable materials, oxidizers/organic peroxides, drugs, radioactive materials and corrosion materials in a total of eight classes. As human understanding of the hazards caused by chemicals expanded, particularly for chronic, potential health and ecological hazard, the EU adopted the Directive 92/32/ EEC (the 7th Amendment of 67/548/EEC) to amend the existing classification system, expanding the classification of harmful chemicals from 8 to 15, and mainly adding health and environmental hazard categories of sensitizing, carcinogenic, mutagenic, toxic for reproduction, and dangerous for the environment. In 1992, the establishment of GHS became an important element of international chemicals environmental management strategies in Agenda 21. In 2003, GHS was completed and published. The basic classification system is shown in Annex 7. The international community has made the promotion of GHS in 2008 a basic strategic goal of international chemical management actions. GHS will become the future uniform classification system for hazardous chemicals generally followed by countries, and will greatly promote the process of international chemicals management.

(2) Chemical Environmental Management International Conventions

In 1998, the international community came to an agreement on "Rotterdam Convention On the Prior Informed Consent Procedure for certain hazardous Chemicals and Pesticides in international trade". In 2001, it reached agreement on “Stockholm Convention on persistent organic pollution”. UNEP and other international organizations are also active in their continued assessment of mercury and endocrine disrupting chemicals globally.

(3) Strategic Approach to International Chemicals Management (SAICM)

This global voluntary initiative is built on the concept that chemicals or chemical uses that pose an unreasonable and otherwise unmanageable risk to human health and the environment (based on a science-based risk assessment and taking into account the costs and benefits as well as the availability of safer substitutes and their efficacy), are no longer produced or used for such uses. In 2002, the World Summit on Sustainable Development (WSSD) developed an Implementation Plan to push the world forward on achieving sustainable development goals of a 21st Century Agenda. The Implementation Plan sets a strategic and time-specific goal to achieve environmentally sound management of chemicals. It is to achieve the sound management of chemicals throughout their life cycle, so that by 2020 chemicals are used and produced in ways that lead to the minimization of sig-

nificant adverse effects on human health and the environment.

From February 4 to 6 2006, through the common efforts of the international community, the "Strategic Approach to International Chemicals Management" was identically passed in the international chemicals management convention and at the 9th special conference of UNEP council global environment ministerial conference held in Dubai, United Arab Emirates.

SAICM and WSSD both help to achieve the objects of minimizing chemicals' environmental and health risks, bringing forward collective policy strategies and a series of unified strategies and action schemes, with time lines to synthesize and harmonize existing international chemicals safety management actions. This includes risk reduction, knowledge and information, public treatment, capacity building, and technology cooperation.

6.5 Gap Analysis of SMC Between China and Developed Countries

6.5.1 Differences in Guidelines of Environmental Management of Chemicals

(1) Guiding Principles for Environmental Management of Chemicals

Safe production of hazardous chemicals in China must ensure the safety of people's life and property, and prevent accidents and environmental pollution. According to the regulation on safe management of hazardous chemicals, the supervision and management scope includes the production, placing on the market, storage, transport, use and disposal of hazardous chemicals, but the regulation places particular emphasis on labor production safety and prevention of chemical accidents, while it does not emphasize health and environmental safety. The environmental supervision and management of chemicals by SEPA focuses particularly on hazardous chemicals with acute toxicity. Environmental management also particularly stresses the end of pipe treatment of discharged chemical pollutants.

The decision-making with respect to safe and environmentally sound management of chemicals in China is made according to certain inherent properties of a chemical and the degree of potential hazard, but considers to a lesser extent its exposure scenarios and risks. For example, China implements a very strict license management system for acutely toxic chemicals, including systems on purchase voucher, purchase license, record-keeping and registration and record of users, etc. The 335 acutely toxic chemicals listed in the List of Management of Acutely Toxic Chemicals in China are determined entirely by the acute toxicity of chemicals to mammals. Determining indicators do not involve the chronic toxicity health harm factors directly related with chemicals, such as the possible chronic toxicity, especially for carcinogenicity, mutagenicity, reproductive toxicity and other special toxicities caused by long and repeated exposure to chemicals, environmental fatalness including biological toxicity, persistence and bioaccumulation, volume and methods of use and so on in the long-term and repeated exposure to chemicals. China

still lacks a set of comprehensive and scientific policies and guiding principles for the environmentally sound management of chemicals.

(2) Key Objects of Chemicals Environmental Management

Environmentally sound management of chemicals should establish clear objectives and management focus to spend the limited resources on priority areas for improvement. Hazardous chemicals under key management in different countries generally have the following characteristics: (i) chemicals with carcinogenic, mutagenic properties and those toxic to reproduction, teratogenicity (CMR chemicals); (ii) PBT chemicals with persistence, bioaccumulation and toxicity; (iii) chemicals with dangerous characteristics, such as toxicity, flammability, explosiveness and hazardous to the environment, and which may lead to a major hazard installation when their production or storage volumes exceed a certain threshold value.

Safe management of hazardous chemicals in China doesn't distinguish between specific key objectives and general objectives. For any hazardous chemicals, no matter how serious the hazard, use volume, and possible exposure, relevant departments must implement registration management of it, and review and issue safe production licenses or operating licenses to relevant production and operating units. Currently there is no prioritization mechanism for the numerous existing chemical substances produced and marketed. Neither is there any requirement for production enterprises to carry out tests for determining inherent hazards and risks, nor are there any measures for identifying and managing PBT and CMR chemicals, which are chemicals of very high concern.

(3) Social Responsibility for Enterprises

Inherent dangers and risks information of a chemical substance is important not only for proper risk control of chemical, but also for protection of environment and human health, accident prevention and emergency rescue. In developed countries, chemical manufacturers and importers have the clear responsibility to provide chemical safety information to the government, company staff, customers, and consumers. Enterprises which cause chemical contamination risks should be responsible for carrying out proper classification, packaging and labeling of the hazardous chemicals that they produce, providing the safety evaluation data of chemicals that they produce and sell, assessing the risks and identifying appropriate measures to control the risks, and for monitoring the risk management, the prevention and control of chemicals pollution taken by the competent departments of government.

Competent chemical departments in China lack understanding of the importance of requiring manufacturers and importers of chemicals to establish and report chemicals safety data by the laws and regulations implemented to identify and manage chemical risks. Although China follows the "polluter pays principle" and implements the pollution discharge system, the establishment and report of chemical safety information are not

taken as the unshakable social responsibility for production and import enterprises in the chemicals management. Existing regulations like "Regulation on safety management of hazardous chemicals" do not require enterprises to develop tests of chemicals that they produce or import and to submit testing data and risk assessment reports. Furthermore, given the insufficient analytic ability of the testing laboratories for the supervision and management of chemicals, most of the industrial chemicals produced in China, including high volume chemicals, are not required to undergo hazard testing and assessment and cannot be classified and labeled properly, and consequently their risks are not managed adequately.

6.5.2 Differences in Regulations and Management Systems

China lacks a comprehensive basic law or administrative regulation by the State Council on environmental pollution prevention and control and the management of industrial chemicals. The main differences in regulations of environmental management of industrial chemicals and corresponding management system in China and developed countries are outlined below.

(1) Gaps in Control of New Substances

China began to implement the notification system of new chemical substance in October 2003. On the basis of identification and evaluation of health and environmental risks of new substances, the new substances, in accordance with the standards of hazard evaluation, are required to register before production and import, while chemical substances with high health and environmental risks are banned or restricted with respect to production and use.

Implementation of the report and registration system of new chemical substances is still at the beginning stage. Methods of assessment of new chemical substances are based on hazard evaluation, so there are many aspects of exposure evaluation and environmental risk assessment that need improving. The “Provisions on the Environmental Administration of the New Chemical Substances,” issued by SEPA, is a ministerial rule. Due to its low legal position, the executive implementation is quite unsatisfactory. There is also a big gap in implementation of “Notification and Review System of New Chemical Substances” in China compared to developed countries.

(2) Gaps in Control of Existing Substances

Considering the numerous existing chemical substances produced and sold before chemical safety legislation was developed, and because there is no requirement for testing, evaluation, and assessment of risks of most existing chemical substances, it is difficult to achieve accurate hazard classification and safety management. Starting from the idea of risk prevention and control for chemicals of high concern and the implementation of key safety management, developed countries have universally established the priority chemical test, evaluation and assessment system. Priority chemicals are chemicals, which may cause

or are likely to cause serious adverse effects to human health or the environment, and are listed on the priority list by competent authorities for testing and evaluation to impose controls.

China has no regulation for prior testing and evaluation system of existing chemicals. There are no legislative provisions for screening of chemicals for potential health and environment risk, and relevant risk assessment in existing laws and regulations for safe management of chemicals. At present, China has established a system on prohibition or restriction of production and use of the chemicals under such international agreements as the POPs Convention and PIC Conventions. However, it is difficult for its national competent authorities to take timely countermeasures to forbid the production and use or limit the use of other chemicals of very high concern.

Chemicals of very high concern may be exported from developed countries to China, which might lead to a significant increase in risk relevant to hazardous chemicals and safe production in addition to the domestic safety problems.

(3) Report and Emergency Plan of the Major Hazardous Installations – Gaps in Control of Major Installations

In China, hazardous chemicals only include four categories of dangerous substances – those with explosive, combustibility, reactivity and acute toxicity characteristics. They do not include carcinogenic substances and environmentally hazardous substances, and there are only 142 substances in the control list, but due to the lack of any category criteria, it is impossible to identify other key sources of dangerous substances. Because many such substances are not included in the national standards on identification of major hazard installations, and the report and emergency plan system of major environmental hazard installations is not established, it is impossible to ensure effective implementation of prevention and emergency management of accidents of environmentally hazardous chemicals.

(4) Register System of Pollutant Release and Transfer: Gaps in Emission Control

Since the early 1990s, according to the authorization of environmental laws and regulations like Law on Prevention and Control of Water Pollution, Law on Atmospheric Pollution Prevention and Control, and others, China has promulgated and implemented the "Provisions on administration of report and registration of pollutants discharge." There are 12 pollutants (COD, oil, cyanide, phenols, arsenic, mercury, cadmium, hexavalent chromium, smoke, dust, sulphur dioxide and industrial solid) that have controlled discharge, but other chemical pollutants are not included in the system. Implementation of the system enables environmental protection departments of the government to acquire discharge information of major pollutants from national enterprises, for environmental management purposes including checking the basis of pollution discharge, environmental statistics, analysis of pollution sources, and environmental planning, etc. The information acquired by report and registration for pollu-

tion discharge is regularly published in the *Annual Statistic Report on Environment in China* by SEPA for public inquiry usage.

There is no PRTR system for environmental management of chemicals in China, and the existing system of pollution discharge reporting and registration is very different from the international PRTR system. Because it is hard to master and announce information on production, use, discharge and pollution prevention of environmentally hazardous chemical substances of high concern on health and environment, environmental management of chemicals is not fully reflected in pollution prevention regulations and management policies.

(5) Classification and Labeling System of Chemical Hazards: Gaps in Classification Management

Classification and labeling of chemicals is an important means for hazard communication of chemicals. Developed countries have generally established and perfected communication systems for the classification, labeling and material safety data sheet (MSDS) of chemicals. China has already established a classification, labeling and MSDS system of hazardous chemicals. Hazardous chemicals in the existing 'Name list of chemicals' refer to the list of hazardous chemicals in the UN recommendations on the transport of dangerous goods. Chemicals in the current classification system of the UN's 'Globally Harmonized System Classification and Labeling of Chemicals (GHS)' with other health and environmental hazard are not included within the scope of hazardous chemicals in China. There are very few or no chemicals of high concern with CMR and PBT characteristics within the scope of safety management in China.

The existing "List of Hazardous Chemicals" in China was also established in accordance with the list of hazardous goods in the UN's recommendation on the transport of dangerous goods, and only includes about 3,000 hazardous chemical substances. For substances or preparations for marketing that are not included in the list of hazardous chemicals, manufacturers are not required to make risk assessments and carry out classification and labeling of other hazardous chemical substances or preparations. It is urgent to revise and perfect the category of classification and management of existing hazardous chemicals according to the United Nations GHS classification standards.

6.5.3 Differences in the Supervision and Management Methods

In order to prevent and control chemical risks, developed countries take many measures and countermeasures including (i) testing chemicals to identify their inherent properties; (ii) carrying out classification and labeling of dangerous chemicals and making dangerous warning marks; (iii) establish exposure scenarios and assess the risks; (iv) transferring and notifying hazard and risk information of chemicals by establishing MSDS and notifying information to the authorities; and (v) taking measures to ban or restrict use of chemicals when there is no appropriate way to control their risks.

In China, the competent departments favor command and control license man-

agement system and methods of registration management, but rarely consider other means to encourage and facilitate enterprises to voluntarily participate in the safe management of chemicals. Many leaders of domestic enterprises regard chemical safety and environmental protection as what the country requires and what they must deal with, rather than as a social and ethical responsibility of the enterprise. There are great gaps in the right-to-know and participation of the public on chemical safety and environmental protection decision-making between China and developed countries.

Considering the gaps mentioned above, priority area of Environmental Management of Chemicals in China should include the following aspects.

6.5.4 Insufficient Regulations and Standards System of Environmental Management of Chemicals

China has established management of special chemicals like pesticides, pharmaceuticals, veterinary drugs, and food additives, which keeps up with the international management program and standard of safety assessment of in-kind chemicals, but needs a set of laws or regulations on pollution control of environmental safety for industrial chemicals. There are many blank spots and imperfections in the aspect of industrial chemicals risk identification and assessment, authorization management system and pollution control standards. Compared with the international chemical safety management system, there are great differences in chemical health and environmental risk assessment and management, and the hazardous chemical classification and labeling system in China.

Current laws on environment prevention, such as 'Law of prevention and control of atmospheric pollution,' the 'Law of prevention and control of water pollution,' and the 'Law of prevention and control of environmental pollution by solid waste,' place particular emphasis on end-of-pipeline controls on chemical pollution. Therefore, it is necessary to establish a set of laws or administrative regulations of the State Council on pollution control of industrial chemical environment safety, and take measures of risk prevention and management to solve the pollution prevention problems of environmentally hazardous chemicals.

In order to identify and evaluate risks to human health and the environment caused by chemicals, chemicals risk assessment guidelines, standards, environmental standards (such as quality standards of atmospheric environment, water environment, and pollutant discharge standards), and management technology standards are needed.

6.5.5 Lack of Clear Principles and Guidelines for Environmentally Sound Management of Chemicals

There is no comprehensive and scientific management policy and guiding principle for environmentally sound management of chemicals in China. For the following series of problems involved in national environmentally sound management of chemicals, the clear policy guidance should be suggested by research. (1) What are the posi-

tions and importance of environmentally sound management of chemicals within the overall strategy on national environmental pollution prevention and control? (2) What are the objectives and guiding principles of environmentally sound management of chemicals? (3) What are the similarities and differences between environmentally sound management of chemicals and safe management of chemicals? (4) Which categories of chemicals should be subject to environmentally sound management? (5) How to screen priority test substances from huge quantities of existing substances, and assess to determine the list for priority management chemicals? (6) How to strengthen capacity building for environmentally sound management of chemicals?

China cries for more international cooperation, and needs to establish environmentally sound management of chemicals by referring to the successful management experience and effective practices of developed countries.

6.5.6 Strengthening Enforcement and Supervision Abilities of Environmental Protection Administrative Departments

Although there are a series of environmental laws and regulations on management and prevention of environmental pollution of chemicals in China, the numerous management links of production, management, usage, import/export, prevention of pollution from hazardous chemicals, and lack of personnel and necessary measures and experiences for evaluation and supervision, lead to insufficient safety and environmental supervision and management by some administrations. Especially in cities and towns with districts under the provincial administrations, many laws and regulations are not effectively implemented.

As a developing country, people's standard of living in many areas is low and China needs to develop the economy to resolve social problems such as food and clothing scarcity. For the consideration of economic benefit, some local administrations provide poor supervision, which leads to ineffective supervision and management of chemicals. It is urgent to enhance the understanding of people at all levels of environmental protection administrative departments on the importance of environmentally sound management of chemicals, and strengthen the capacity building of executed supervision and management mechanisms.

Secondly, building a system for the environmentally sound management of chemicals in China is still in the initial stages. With respect to environmental pollution prevention, there are neither clear guidelines for environmentally sound management of chemicals, nor for the establishment of chemical risk assessment, risk management systems, and technical guidelines that are in accord with international initiatives. China also lacks the experts needed to support a system of environmental risk assessment of chemicals and to develop the necessary evaluation and supervisory capacity.

At present, the focus of national pollution prevention is still on prevention and control of problems caused by “three wastes” at the end of the pipeline of industrial production, and environmentally sound

chemicals management has not yet been added as an important item on the environmental protection agenda. The State has not yet developed definite principles of environmentally sound management of chemicals policies to establish environmental risk assessment, risk management systems, and technical guidelines that are in accordance with what the international community has done. The state also lacks the ability to support a chemical risk management system and to evaluate and monitor management.

Third, enforcement managers of environmental protection lack the necessary training. The lack of experienced, well-trained hazardous chemicals environmental managers and professional and technical personnel is also a constraint on effective implementation of supervision and management.

The reform of the State Council and local governments and the reduction of personnel in all levels of environmental departments, would result in a great change of personnel and great changes in management posts. Currently, the protection agencies of environmental protection bureaus at the provincial and city levels only have 1 or 2 part-time management officials in charge of prevention of environmental pollution from toxic chemicals. Both of the discordant management capacities of managers and their unfamiliarity with relevant laws and regulations on environmental management of chemicals restrict supervision and management.

It is urgent to strengthen the technical training of environmental protection managers at all levels, improve their understanding of the importance of environmentally sound management of chemicals and improve their ability to manage, supervise and enforce.

6.5.7 Insufficient Technical Supporting System of SMC

The establishment of a technical support system for environmentally sound management of chemicals is the important technical support for and guarantee of safe management of chemicals. The technical supporting system includes the criteria of a qualified laboratory system for testing and analysis of chemicals, guidelines for testing and evaluation, principle of qualified laboratory and risk assessment, and safety information management system of chemicals.

There is no unified, qualified laboratory standard for testing and evaluation of chemicals in China. Most of the laboratories are not testing according to the internationally agreed “Qualified Laboratories Norms Principle of OECD,” and they are not certified by national bodies, so they cannot ensure the reliability of testing results and meet the domestic demand of testing data for safe, environmental management of chemicals. The administrative departments of environmental protection, health, agriculture, safe production, and their technical supporting units have established their own chemicals registration and management database systems, and carried out related information queries through a chemicals safety database system established by foreign authorities, such as the RTECS database of NIOSH, USA, Hazardous Substances Data Bank

(HSDB) of USA medical libraries, the INCHEM database of IPCS of UN, Search System for the International Chemical Safety Cards, and others. However, it is still difficult to obtain basic information on domestic production; use; location of production equipment and the storage; transport and disposal of chemicals; pollution hazards to human health and the environment by exposure of hazardous chemicals; hazard characteristics; toxicity; environmental fate; and potential effects on health and the environment of related chemicals and chemical products. It is difficult for the public to obtain information on classification indicators, fire protection, leakage disposal, and safety protection and pollution prevention of hazardous chemicals Therefore, establishing and perfecting the management and notification system of safety information on chemicals is also an important issue in strengthening capacity building when it comes to environmental management of chemicals in China.

6.6 Recommendations for Policies and Regulatory Framework Building for SMC in China

With increased globalization, developed countries have been facing various environmental problems step by step, while today developing countries have to face these problems simultaneously. In China, environmental pollutions are characterized as "multiplex and compressed." China is facing either the traditional or the first generation of environmental problems like city air pollution or lake eutrophication and so-called "new" or "second-generation" environmental problems like environmental issues of chemicals at the same time. Attention as well as understanding of environmental issues and environmental management of chemicals has always been insufficient. In addition, the current chemical management system is a traditional chemical hazard classification system, which has great limitations both in management scope and goals. Chemical management in China so far, in fact, is primarily focused on the occupational safe management of specific hazardous chemicals with highly active physical and health hazards, i.e. flammable, explosive, and acutely toxic chemicals, and there are many gaps in environmental management for a large number of chemicals with potential and long-term hazards to human health and the environment. Because of the lack of a basic legislative and administrative foundation, the SMC in China requires improvement. The current environmental management related to chemicals is primarily limited to end of pipe treatment of a few toxic chemical pollutants, rather than pollution prevention measures, which does not reflect the basic principles and methods of environmental management of chemicals, like precaution and risk management.

While the environmental management of chemicals is underdeveloped, China is facing increasingly serious pollution from chemicals: many hazardous chemicals widely controlled internationally, are still produced and used without restriction in China. In addition, accidents involving hazardous chemicals happen frequently. Due to this, the ecological and health risks

caused by chemicals in China are increasing. Besides, since the beginning of the 21st century, the developed countries have been constantly strengthening their environmental management of chemicals. Results are mainly reflected in legislation and a variety of measures to speed up testing, evaluation and management of health and environmental risks of chemicals. The international community vigorously pushes forward the global agenda on environmentally sound management of chemicals, which was always an important component of the global strategy of sustainable development, and has put forward a strategic goal and the corresponding strategic action plan – SAICM. The SMC is directly related to environment safety and human health in China. China is committed to reforming the industrial infrastructure and building an environmentally friendly society. Environmental management of chemicals was sure to be put on the agenda of national environmental protection in the context of scientific development.

Based on an integrated analysis of the situation of environmental management of chemicals in China and the experience of developed countries and international policies, the following suggestions are put forward regarding policies and regulatory framework for the SMC.

6.6.1 Establish a National Strategy on SMC

Generally, all future measures on SMC should become a part of the national strategy.

Recommendations

A. The strategy of SMC in China should define the basic guidelines, principles, policies and overall strategic objectives of the nation's SMC, which should comprehensively consider the precautionary approach and the basic national situation of chemical industry and consumption of chemicals and set reasonable strategic objectives.

B. The strategy shall be consistent with scientific development. In order to promote recycling and reuse, to protect the environment, to promote a resource conserving and environmentally friendly society, clean and safe development should be considered in the strategy.

C. The manufacture and management of chemicals shall follow the ideas of clean production and green chemistry.

D. Chemicals with high risks to health and environment should be replaced first, provided economically feasible alternatives are available.

E. The strategy of SMC in China should establish a national plan of capacity building on SMC including the legislative system, institutional functions, technical supporting systems, information exchange and public participation mechanisms, etc.

F. Chemicals management strategy should include a long-term action plan for risk assessment and risk management of existing chemicals with set deadlines, following national specific priority principles to collect information on hazards of existing chemicals, carry on risk assessment and risk management actions, gradually reduce and eliminate the production and consumption

of chemicals with unreasonable risk to the environment and human health, and last but not least, achieve China's environmentally friendly environment. The strategy chosen must be WTO compliant.

G. For development of the national strategy of SMC, one national coordination group should be established from environment and human health protection basis to insure the drafting strategy to reflect on interests of the stakeholders.

6.6.2 Establish a Law or Administrative Regulation on SMC

In light of current national legislation in regard to chemicals management, establish a specialized law or an administrative regulation on SMC as the fundamental way to fill most of the existing gaps in SMC in China.

Recommendation

The law or the administrative regulation of SMC should comply with the approach of risk management, establish hazard testing requirements, adopt the GHS for classification and labeling of chemicals to contribute to effective risk assessment and risk management of chemicals, include the GLP requirements for new tox and ecotox tests, establish basic SMC systems, mainly including new chemical substances notification, risk assessment and risk management of existing chemical substances, environmental monitoring system for priority toxic chemical pollutants, information gathering and a right-to-know system for the release of toxic chemicals, a major environmental accident prevention and emergency response system, which should be coordinated with the current relevant legislation on occupational safety and public health management.

6.6.3 Priorities for Basic Administrative Framework (System Building) on SMC

(1) Implementation of GHS as Soon as Possible in Accordance with Internationally Agreed Goals

A scientific and comprehensive system of classification and labeling of chemicals is a fundamental condition of chemical hazard identification to contribute to effective risk assessment, information communication and risk management of chemicals. The currently used classification system from hazardous chemicals in China does not fully reflect various potential environmental and health hazards and risks of chemicals, which severely restricts the development of SMC in China.

Recommendation

Comprehensively implement the GHS for the classification and labeling of chemicals as the basis for new chemical substances notification, risk assessment and risk management of existing chemical substances, and major hazardous installation management system, MSDS system and other systems. This requires manufacturers and downstream users of chemicals to classify, label and communicate information on the hazards of chemicals according to the GHS, in order to effectively control environmental and health risks of certain chemicals.

(2) Promote and Improve the New Chemical Substance Notification System

New chemical substance notification is a basic element of SMC. Developed countries have established such a system through specialized legislation in the 1970s, and built up a system with comprehensive guidelines, procedures and good technical and institutional supporting systems. By contrast, the new chemical substances notification system in China was established only three years ago and was launched by a ministerial rule.

Recommendation

Raise the legal status to strengthen enforcement and establish a specialized legislation for SMC containing the system proposed above. Take full advantage of advanced experience from developed countries to further improve the enforcement procedure and the cooperation mechanism among relevant government departments. Create obligations to improve domestic cooperation and information exchange in both ways between relevant ministries and authorities horizontally and vertically. Improve the corresponding technical guidelines and institutional supporting systems, such as GLP criteria and the international mutual recognition of test data, etc., so that the new chemical substance notification system is in accordance with international systems. Streamline procedures and introduce mechanisms to reduce bureaucracy for cases of less concern, such as chemicals in very small quantities or samples. Pay special attention to those chemicals with high risk to health and the environment.

(3) Establish the System of Risk Assessment and Management of Existing Chemical Substances

A system of risk assessment and management of existing chemical substances is the basis of collection of risk information of existing chemical substances and risk management. It is also the emphasis of current environmental management of chemicals all over the world. Because of the deficiency of the system, the Chinese government had little awareness of current domestic environmental and health risks of chemicals, did not conduct administrative measures for chemicals with high risks, and always lagged behind the international chemical management approaches.

Recommendation

Build upon a system of risk assessment and management of existing chemicals close to the requirement of testing and data corresponding to new chemical substances notification, which will mainly include: establishment of a system of priority setting and a system of collection of hazard and risk information of existing chemical substances. Regulate the obligation of the producers or importers on hazard testing and information notification, whose production or import of existing chemical substances is above a specific volume and collect the hazard and risk information on existing chemical substances in the market. Put forward basic principles, policies and regulations of priority risk management (e.g., prohibition or restriction of production, use, import and export on priority chemicals, such as PBT, CMRs and vPvB, etc.). Carry out classification and

labeling of existing chemical substances according to GHS. Determine the implementation mechanisms of the system of risk assessment and management of existing chemical substances; and establish specialized legislation for SMC containing the system proposed above is the appropriate way forward.

(4) Establish National Criteria for the Prioritization of Chemicals of High Concern

National criteria for the prioritization of chemicals of high concern shall be established according to domestic situation of the chemical industry, while taking account of international criteria.

Recommendations

A. Set criteria and procedures for prioritization of chemicals of very high concern while taking into account international criteria for prioritization of toxic chemicals, types (number of chemicals), and volumes of domestically produced and imported existing chemicals. Nationally prioritized chemical types may include PBT, vPvB, CMRs and EDCs, etc.

B. The risk management of priority chemicals should be based on their different features and their potential risks and hazards towards environment and health. It should take into consideration the exposure during production, utilization and distribution of those prioritized toxic chemicals. Establish national principles for risk management of priority chemicals. Based on this approach, reformulate risk management policy and systems for prioritization of chemicals of very high concern, such as PBTs.

C. Draft a risk management strategy and action plan, in a step-by-step manner to reduce, restrict or ultimately ban the production and consumption of those chemicals of very high concern to promote the implementation of the Stockholm Convention and other international agreements and arrangements on chemicals management.

(5) Establish a System of Release Recording and a Publication System for Toxic Chemical Pollutants

The PRTR is a model for gathering emission statistics on toxic chemical pollutants and informing the public. This type of system acts as a control of environmental pollution of toxic chemicals, prevention of accidents, information publicity, and public participation in many countries.

Recommendation

A. Make suggestions to assimilate successful experiences from abroad, adopt specific principles of priority management, rationally determine the extension of inventory, industry and enterprises of toxic chemicals, which are needed to notify, establish corresponding management information system of collection and publication of data, and gradually establish the system of collecting emission statistics of toxic chemical pollutants and informing the public in China.

(6) Establishment of Environmental Monitoring System for Emissions of Priority Toxic Chemical Pollutants

Recommendation

Establish a system for the monitoring of priority toxic chemical pollutants, such as PBTs, and commensurate with the capacity of the existing Chinese environmental and hygiene monitoring system. Carry out institutionalized and systemic environmental monitoring of the chemicals with high ecological and health risks. Compile and release an annual report on the monitoring of national priority toxic chemical pollutants to enable the government and community to understand the situation of environmental pollution from chemicals, and their ecological and health risks, and provide the basis of decision-making for the efficient promotion of environmental management.

(7) Improve the System of Registration and Reporting of Major Hazard Installations

Recommendation

Revise standards of identification of major hazard installations (especially the need to add corresponding categories and standards of environmentally hazardous substances). Improve the current mechanism of implementation and supervision of the registration and reporting system for major hazard installations. Enhance data sharing and the responsibilities and rights of supervision and implementation in the system of registration and reporting of major hazard installations. Strengthen the law enforcement ability of relevant organizations, and sufficiently prevent serious leakage accidents of hazardous chemicals and their environmental effects. Improve the relevant legislative system for the management of existing major hazard installations by reference to relevant international rules and practices of management of major hazard installations, such as ILO, EU Seveso Directive and EPCRA.

6.6.4 Capacity Buildings

(1) Build Upon Existing National Administrative Functions and Organizations for Environmental Management of Chemicals

Recommendations

A. Build upon the national system of administrative enforcement of environmental management of chemicals, supervision and management by setting up a coordination mechanism among all national level authorities responsible for chemicals management.

B. Elevate the role of SEPA within the Chinese chemical management system including increasing the capacity of relevant divisions and departments. Set up specific administrative functions (departments or divisions) for chemicals management and increase the number of staff involved in environmental management of chemicals in central and provincial organizations for environmental protection, including additional relevant managerial departments and officers.

C. Reinforce corresponding staff training.

(2) Establish a Comprehensive National Information System for Chemicals

Availability of information on hazards of chemicals and risks is necessary for environmental management.

Recommendations

A. Carry out centralized collection, arrangement and publication of various relevant national information on environmental and health risks of chemicals, based on systems such as notification of new chemical substances, risk assessment and risk management of existing chemical substances, environmental monitoring of priority toxic chemical pollutants and their emissions, and registration and reporting of major hazard installations, consistent with the protection of confidential business information.

B. Link existing national chemical information sources and management system such as those concerning existing and new chemical substances, as well as occupational health and safety issues.

C. Further enhance global information exchange on chemicals.

(3) Strengthen National Capacity on Testing, Evaluation, Research and Monitoring of Chemicals

Promote cooperation among departments including those managing national environmental protection, public health, science and technology.

Recommendations

A. Increase capacity for testing of environmental and health hazards of chemicals by establishing laboratories for testing and evaluation of chemicals in accordance with OECD/GLP guidelines and by introducing GLP monitoring and other programmes, such as mutual acceptance of data (MAD).

B. Increasing capacity to conduct basic research on and to monitor the environmental and health components of risk assessment, particularly with respect to priority high-risk and toxic chemicals.

C. Develop international cooperation related to hazard testing and risk assessment of chemicals, learn and adopt international chemical risk assessment practices to continually improve capacity in China.

6.6.5 Strengthen Environmental Governance on Chemicals

(1) Promote and Support Policies for Voluntary Risk Management of Chemicals

While gradually improving the governmental management system, promote participation of all chemical stakeholders, especially the wide participation of the chemical industry as the basis for successful implementation of state environmental policies for the sound management of chemicals. Voluntary Agreements (VA) between government and enterprises and Responsible Care (RC) action taken by chemicals enterprises are good practices carried out for the environmental management of chemicals in developed countries. The Chinese "Cleaner Production Promotion Law" has already established the legal status of VsA, and put forward a number of incentive policies.

Recommendations

A. Encourage the implementation of VA, RC and Product Stewardship in China, in communication with Chemical Industry Association. Research and establish a series of relevant matching policies and measures of management to promote the gradual implementation of VA and RC of environmental management of chemicals in China, on the basis of current regulations of the Cleaner Production Promotion Law.

B. Improve performance under VAs by clarifying their legal status and control procedures, and engaging in performance audits.

(2) Improve Information Publicity and Public Participation Mechanisms for the Environmental Management of Chemicals

Recommendations

A. Enhance publicity and communication of information concerning the environmental and health risks of chemicals by making information on pollution emissions and environmental monitoring of toxic chemicals publicly available.

B. Establish education programs on the environmental and health risks of toxic chemicals for the general public.

C. Establish public participation mechanisms that provide stakeholders with a platform to participate in government decision-making on chemicals management consistent with international trends.

Annex 1

CCICED Membership

(as of March 2008)

Mr. Zeng Peiyan	Vice Premier, State Council of China Chairperson of the Council
Mr. Zhou Shengxian	Minister, Ministry of Environmental Protection of China Executive Vice Chairperson of the Council
Mr. Robert Greenhill	President, Canadian International Development Agency Executive Vice Chairperson of the Council
Mr. Xie Zhenhua	Vice Chairman, National Development and Reform Commission (NDRC) Vice Chairperson of the Council
Mr. Klaus Töpfer	Former Executive Director, UNEP Vice Chairperson of the Council
Mr. Børge Brende	Managing Director, World Economic Forum; Former Environment Minister, Norway Vice Chairperson of the Council
Mr. Zhu Guangyao	Secretary General of the Council
Mr. Feng Zhijun	Vice Chairman, Environment Protection and Resources Conservation Committee, National People's Congress
Ms. Jiang Zehui	Vice Chairwoman, Committee of Population, Resources and Environment, the National Committee of the Chinese People's Political Consultative Conference
Mr. He Yafei	Assistant Minister, Ministry of Foreign Affairs
Mr. Zhu Zhigang	Vice Minister, Ministry of Finance
Mr. Yi Xiaozhun	Vice Minister, Ministry of Commerce
Mr. Li Ganjie	Vice Minister, State Environmental Protection Administration
Mr. Ning Jizhe	Vice Minister, Research Office, State Council
Mr. Li Jiange	Vice Minister, Development Research Center, State Council
Mr. Li Xingshan	Academician Dean, Central Party School of the Communist Party of China
Mr. Zhou Dadi	Senior Research Fellow and Former President, Energy Research Institute, NDRC
Mr. Lu Yaoru	Professor, Chinese Academy of Geological Sciences, Ministry of Territory and Resources; Academician of Chinese Academy of

	Engineering（CAE）
Mr. Zou Deci	Professor and Senior Urban Planner, China Academy of Urban Planning and Design, Ministry of Construction; Academician of CAE
Mr. Zhou Wei	Professor and President, China Academy of Transport Sciences, Ministry of Communications
Mr. Wang Hao	Professor and Director, Department of Water Resources, China Institute of Water Resources and Hydropower Research, Ministry of Water Resources; Academician of CAE
Mr. Ren Tianzhi	Professor and Deputy Director, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Ministry of Agriculture
Mr. Wang Wenxing	Professor and Senior Advisor, Chinese Research Academy of Environmental Sciences; Academician of CAE
Mr. Niu Wenyuan	Professor and Chief Scientist, Institute of Policy and Management, Chinese Academy of Sciences
Mr. Shen Guofang	Professor, Former Vice President of Chinese Academy of Engineering; Academician of CAE
Mr. Ma Xiangcong	Senior Research Fellow, Institute of Law, Chinese Academy of Social Sciences
Mr. Ding Yihui	Professor and Senior Advisor, China Meteorological Administration; Academician of CAE
Mr. Hao Jiming	Professor and Dean, Department of Environmental Science & Engineering, Tsinghua University; Academician of CAE
Mr. Roger Beale	Senior Associate, the Allen Consulting Group; Former Portfolio Secretary, the Department of Environment and Heritage, Australia
Mr. Corrado Clini	Director General for International Cooperation, Ministry for Environment, Land and Sea, Italy
Mr. Gordon Conway	Chief Scientific Advisor, Department for International Development, UK
Ms. Linda Cook	Board Member of Executive Committee and Chief Executive Officer for Gas and Power, Shell Company
Mr. Daniel J. Dudek	Chief Economist, Environmental Defense, USA
Mr. John Forgách	Executive Chairman, the Board of the Equator Group in New York; Brazil
Mr. Arthur Hanson	Distinguished Fellow and Former President, International Institute for Sustainable Development, Canada
Mr. Masami Ishizaka	Advisor, Overseas Environmental Cooperation Center, Japan

Mr. James Leape	Director General, WWF
Ms. Julia Marton-Lefevre	Director General, IUCN
Mr. Lars-Erik Liljelund	Director General, the Swedish Environmental Protection Agency
Mr. Dirk Messner	Director, German Development Institute
Mr. Mark Moody-Stuart	Chairman, Anglo American plc; UK
Mr. Mohammed Valli Moosa	President, IUCN Former Minister of Environmental Affairs and Tourism of the Republic of South Africa
Mr. R.K. Pachauri	Director General , The Energy and Resources Institute (TERI), India Chair, UN Intergovernmental Panel on Climate Change (IPCC)
Mr. Achim Steiner	Executive Director, UNEP
Mr. Björn Roland Stigson	President, World Business Council for Sustainable Development
Ms. Laurence Tubiana	Director, Institute of Sustainable Development and International Relations, France
Mr. Hans van der Vlist	Secretary General, Ministry of Housing, Spatial Planning and the Environment, the Netherlands

CCICED Secretariat:

Mr. Xu Qinghua	Deputy Secretary General
Mr. Guo Jing	Secretariat Director
Mr. Chris Dagg	Director, Secretariat International Support Office

Annex 2

China Council for International Cooperation on Environment and Development

Terms of Reference

Summary

1. The China Council for International Cooperation on Environment and Development (CCICED) is a high level, non-profit international advisory body established upon the approval of the Chinese government in 1992. State Environmental Protection Administration of China is the host agency of the Council. After 15 years of effective work during its first, second and third phases, CCICED has successfully fulfilled its expected objectives, fostered cooperation between China and the international community in the field of environment and development, and created extensive and far-reaching impact both nationally and internationally.

2. In the past 15 years, the Council and its Working Groups and Task Forces have made a number of valuable recommendations to the Chinese government in light of China's practical situation. These recommendations attracted high attention from the Chinese government. They were seriously considered, and some were adopted. This is a significant contribution to China's environment and development.

3. China has experienced dramatic economic and social changes since 1992. Rapid economic growth brought about increasing pressure on the environment and resources. In the past 15 years, with the acceleration of the globalization process, China has rapidly reinforced its interaction with the world in the fields of the economy, trade, development and environment. China, together with the whole world, is facing issues such as global climate change, degradation of biodiversity as well as a number of other problems. The global implications of the environment and development in China are increasingly relevant.

4. The State leaders of the Chinese government are fully aware that China has entered a crucial stage of development and thus they are promoting scientific development towards a well-off society in 2020. The Chinese government is determined to build a resource-saving and environmentally friendly society and to promote sustainable development so as to achieve a harmonious society, through speeding up the historical transformations on environment and development.

5. At the conclusion of the Third Phase of CCICED, parties from various sides have recognized unanimously the value and important role of CCICED, and agreed to continue their support for another phase of CCICED. The Chinese State Leaders has

clearly stated that since its establishment, CCICED has provided strong support for scientific decision-making by China in the field of environment and development, and the Chinese government has approved the establishment of the Fourth Phase of CCICED (2007-2011). The Chinese government has committed to continue its support to the Council.

6. Given the exceptional change of the socio-economic development in China as well as the increasing interaction between China and the world on environment and development, and on the basis of the lessons learned during previous three phases, CCICED (Phase IV) should be established with necessary reforms and innovation with regard to adjustment of the Chinese and international membership, policy study work, organization and procedures. At the same time, the capacity of the Secretariat to improve coordination will be further enhanced. In order to improve the impact and extend the influence of its recommendations, the Council should promote multi-channel mechanisms for the dissemination of its policy recommendations.

7. Based on Phase I, II and III, Phase IV of CCICED will continue to serve as an effective high level international policy consultative institution, to provide the Chinese leadership and policy makers in different levels of government with proactive, strategic, pre-warning policy recommendations on key environment and development issues. The Council will make its recommendations more practical, feasible and suitable not only for China's situation, but also relevant to the global implications. Necessary policy demonstrations and project demonstrations should be carried out in key areas. In light of the changing situation in the field of environment and development, recommendations should also be made to the Chinese government on how to adjust the existing strategy and on what counter-measures to take.

8. This Terms of Reference is based on those of the previous three phases and revised to reflect new developments as well as the needs of the Chinese government.

I. Objectives and Tasks

9. While continuing to pursue the overall objectives identified by the previous three phases, CCICED Phase IV will support China's bid to build a harmonious and well-off society by 2020, and will relate its work to the Five Year Plans for socio-economic development for this period. CCICED will offer practical policy recommendations, technical support, demonstration experiences and early policy warnings; and promote the further implementation of the sustainable development strategy of the Chinese government. CCICED will support the Chinese government in building a resource-saving and environmentally friendly society, achieving sustained growth of the national economy and the betterment of environmental quality, and continuing to assume the obligations of a responsible power in a bid to create a cleaner, safer, and more sustainable future for both China and the world.

10. The specific objectives of CCICED Phase IV are to:

1) Provide strategic advice, policy recommendations and early policy warnings to the Chinese government, in terms of ensuring the sustainable growth of China's national economy, protecting and preserving China's environment, ensuring the long-term supply and safety of energy and natural resources and promoting harmonious development between people and nature.

2) Foster international cooperation between China and the international community on critical issues of environment and development, such as relevant planning, programs, scientific development, technology transfer, trainings, etc.

3) Provide advisory service to the Chinese government on important decision making in the fields of environment and development and assess the economic, social and environmental impacts of such decision-making.

4) Provide the Chinese government with international experience in the fields of environment and development in the context of globalization, information society and S&T innovations, and at the same time assist China in introducing its accomplishments and experience to other countries.

5) Help to enhance China's capacity to accede to or implement international programs and to negotiate in international conventions aiming to alleviate global environmental problems.

6) Play an advisory and assisting role in promoting public awareness and public participation in environmental protection and training programs for officials at central and local government departments in order to enhance their awareness of policy-making on sustainable development.

11. While basing itself on the accomplishments and policy recommendations of the previous three phases, CCICED (Phase IV) will make the policy recommendations of the Council more practical, carry out more in-depth and more extensive demonstrations, and propose new recommendations for strategy adjustment in light of the changing situation. Phase IV should concentrate on further improving the quality of its advisory services in terms of the Council's operation and policy study work. Meanwhile, the Council will provide its advice while taking into account the interaction between China's long-term development and global environmental issues. Priority areas for research at the starting period of Phase IV could include, but are by no means limited to, the following: long-term strategic options for energy and environment including the response to climate change; environment and public health; long-term national eco-safety strategy and ecological service and management system; technical innovation for an environmentally friendly society; sustainable trade policies, consumption and investment policy; sustainable marine environment; regional development including the policy to balance environment and development in the western development drive; environmental issues related to the new rural development strategy; long-term strategy for China to implement international environmental conventions; public participation; the implication on the global environment and development imposed by China's development; and the social implications of policy

decisions on issues such as gender equality and poverty alleviation.

II. Organization of the Council (Phase IV)

12. The duration of CCICED (Phase IV) will be five years from 2007 to 2011.

13. The Council will consist of about 40 high-level Chinese and international members. Chinese members will be ministers, vice-ministers, renowned experts and eminent scientists from related area or sectors. International members will be of comparable status. The Council Chair will be held by a leader of the State Council of China. The Vice-Chairpersons will be nominated and invited by the Chinese government, with agreement by the Council Meeting.

14. The operational components of the Council (Phase IV) include:

1) The Bureau and Bureau Meeting

2) The Executive Vice Chairpersons

3) The Secretary General, and Deputy Secretary Generals

4) The Secretariat and the Secretariat International Support Office

5) The Chinese and International Chief Advisors

15. Normally the term of Council membership is five years. However, a Council member who is absent from Council activities for two consecutive years forfeits his or her membership automatically. Under special circumstances, appropriate adjustments could be made to the Council membership according to the approval procedure defined in the Rules of Procedure of the Council.

16. The Council Members shall possess influence and engage in the Council's affairs in their personal capacity. The members shall be ready to contribute their time and wisdom to the Council's work, including:

1) Participating in the Annual General Meeting every year;

2) Joining the debate on policy issues during the Annual General Meeting;

3) Offering their guidance and thinking to policy studies organized by the Council;

4) Reviewing the policy study outputs when requested;

5) Chairing Task Forces or Special Policy Studies when requested; and

6) Promoting the Council to other international institutions and to the public.

17. In principle, the Council Annual General Meeting will be held once every year. A theme will be selected for each annual meeting of the Council to discuss. If necessary, the Council Chairperson could call special meetings of the Council after consultation with other vice chairpersons.

18. A Round Table Meeting between the periods of two Annual General Meetings will be held in Phase IV to promote the dissemination and exchange of the Council's policy research outcomes with a broader group of stakeholders. The Council shall invite central and local government policy makers, representatives of the private sector, as well as experts and scholars to participate.

19. The Council shall invite representatives of private sector companies with a commitment to the environment and development to participate in a private sector forum. The forum will provide an opportunity to share information on the Council's policy studies and to seek private sector in-

put on the Council's policy recommendations.

20. The Council shall hold other public event such as policy seminars or forums to further extend the Council's influence.

21. Special Observer status will be granted to international organizations, institutions or companies that demonstrate a strong interest in the environment and development in both China and the world, and that are willing to contribute to the Council's work. Special Observers will be invited to send representatives to participate in the Annul General Meeting and other events.

22. Governmental officials at Chinese central and local levels, experts, entrepreneurs, NGOs, and representatives of international institutions, who are associated with the work of the policy study or the theme of the year, may be invited as special guests or observers to attend the Annual General Meeting or other meetings.

23. The policy recommendations and other outputs of the Council should be submitted to the Chinese government and disseminated to a wider audience through various channels, so as to foster further research, encourage their adoption and implementation, and thereby extend the influence of the Council. Such channels should include, but not be limited to, the following:

1) The Chairperson of the Council submits them to the State Council and to relevant government departments;

2) The State Environmental Protection Administration submits them to other relevant government departments;

3) The Secretariat of the Council forwards the recommendations of the Task Forces to relevant departments;

4) Other channels, such as the media, news conferences, workshops, website, and publications should be utilized to disseminate the Council's activities and outputs to a wider audience.

III. Arrangements for Advisory Work

24. The policy study work of the Council, including Task Forces and Special Study Projects, shall serve as the basis for the Council's advisory function. The mandates of the policy studies will be defined according to the objectives and tasks of the Council. Decisions to establish policy studies, including Task Forces and Special Study Projects, should be based on careful assessment and coordination according to the Rules of Procedure of the Council.

25. In order to meet the needs of Phase IV, the Secretariat should further enhance its capacity to carry out relevant tasks, such as: identifying and selecting themes for the annual Council Meeting; coordinating activities of policy study work; organizing relevant assessment meetings; preparing for the establishment of new Task Forces and Special Policy Studies; assessing the accomplishments of policy study work; monitoring the effectiveness of the Council's recommendations, etc. The Secretariat will work with the support and assistance of the Council's Chief Advisors on scientific issues.

26. In order to ensure the effectiveness of research and demonstrations, the establishment of any policy study program should be based on careful assessment, and is con-

tingent on the availability of appropriate expertise and sufficient funding support. Topics will be selected that clearly benefit from a combination of international and Chinese expertise and experience.

27. Policy study projects, including Task Force and Special Policy Study, shall each be co-chaired by one Chinese and one international expert. The members of the study team shall include both Chinese and international experts.

28. A policy study project should have clear objectives, tasks, a work plan, and work schedule. It should submit annual reports to the Council at the Annual General Meeting.

IV. Support and Service System

29. The Secretariat of the Council will be established based on support from the State Environmental Protection Administration of China. Its responsibility is to provide operational support for the Council's activities.

30. The Chinese government will continue to ensure effective arrangements at the working level to encourage full and active participation and support from relevant government departments, research institutions, and non-governmental organizations.

31. The State Environmental Protection Administration will be responsible for inter-ministerial coordination and for supporting the activities of the Council.

32. The Council will set up support offices or designate liaison persons in the primary donor's country to assist and take part in the work of the Secretariat, and to provide support and assistance in the international cooperation activities of the Council when necessary.

33. The Secretariat should carry out relevant activities to disseminate the research results of the Council to the public, so as to extend the influence of the Council and to encourage active public participation.

V. Financial Arrangements

34. Financial assistance from Chinese and international sources will be pledged for the activities of CCICED (Phase IV).

35. The Council should continuously ensure that its activities are properly related to other international activities in the fields of environment and development, scientific research and investment, so that extensive contacts will be established, and more international support will be mobilized to meet the needs of the Council and its policy studies.

36. The Council should work actively to obtain contributions and support from private foundations, multilateral financial institutions and other donors. Additional contributions from public and private sources and wider participation will be sought in support of specific activities and necessary studies as required.

37. The Council welcomes interested international organizations – such as scientific, technical, academic, financial and business organizations – to assist in China's efforts to achieve economic development in harmony with the protection of the environment, and to make special efforts to support the work of the Council.

China Council for International Cooperation on Environment and Development

Rules of Procedure

The China Council for International Cooperation on Environment and Development (CCICED) is a high level, non-profit international advisory body, established by and providing advice to the Government of the People's Republic of China.

I. The Mandate of the Council

1. The Mandate of the Council is outlined in the Terms of Reference and was adopted at the 1st Meeting of the Council in Beijing in April 1992. By November 2006, the Council had successfully completed its mandate for Phase I, Phase II and Phase III. The Terms of Reference of Phase IV has defined the mandate of the Council: to continue and improve research achievements, policy recommendations and successful experience of the first three phases; to provide more executable policy recommendations, enhance and extend demonstration projects; and at the same time, to provide the Chinese government with new strategic and pre-warning policy recommendations in the new context.

2. The objectives of the Council are to explore ways of coordinating and integrating environmental protection, economic and social development, science and technology and related areas in order to provide the Chinese government with more executable policy recommendations, technology assistance and demonstration experience for China's Five Year Plans, 2020 long-term targets and beyond, and the implementation of sustainable development strategies.

3. The Council will encourage the cooperation and support of the international community for China's efforts to promote a resource saving, environmentally friendly society, while protect its own ecological system, conserving energy and natural resources, and realizing environmental, social and economic sustainable development, as well as contributing to global sustainable development.

II. Adoption of the Rules of Procedure

4. The Rules of Procedure have defined the regular operation of the Council. The Rules of Procedure have been amended after its adoption in Phase I, Phase II and Phase Ⅲ of the Council, and are amended and adopted at the 1st meeting of the Council Phase IV.

5. Amendments to the Rules of Procedure are made in accordance with Section 62 below.

III. The Appointment of Chairperson and Vice Chairpersons

6. The Chairperson and Vice Chairpersons are Council Members.

7. The Chairperson of the Council will be a leader of the State Council, appointed

by the Chinese government.

8. The Council has one Chinese and one International Executive Vice Chairperson, who will be invited and approved by the Chinese government.

9. In addition, the Chinese and international Vice-chairpersons will be invited by the Chinese government, in consultation with relevant main donor countries.

10. The terms of office for the Chairperson and Vice Chairpersons shall be five years. Under special circumstances, they may resign before their term ends. In that circumstance, the Chinese government will appoint a new Chairperson or invite and approve new Vice Chairpersons.

IV. Approval and Change of Council Membership

11. Members of the Council will be invited and approved by the Chinese government to serve on the Council. The Chinese government shall consult with the primary donor country when selecting any new international members.

12. The term of Council Membership shall be five years. A Member may be replaced before the end of this term if the Member resigns for personal reasons, or does not perform his or her duties, or no longer meets the requirements of the Council. These changes shall be adopted by the Bureau Meeting of the Council and reported to the Council's Annual General Meeting.

V. The Bureau and the Bureau Meeting

13. The Council has a Bureau, which will consist of the Chairperson, Executive Vice Chairpersons, Vice Chairpersons and Secretary General.

14. The Bureau Meeting will be established and co-chaired by the Executive Vice Chairpersons to serve as the executive body of the Council. The members of the Bureau Meeting include the Executive Vice Chairpersons, Vice Chairpersons and the Secretary General. The executive responsibilities of the Bureau Meeting are to:

1) Consider and adopt changes to the Council Membership

2) Make decisions on the Annual General Meeting themes and dates

3) Approve the tentative agenda for each Annual General Meeting

4) Approve the themes to be studied by Task Forces

5) Give guidance on major strategic issues facing the Council, including major new initiatives to be undertaken by the Council

6) Endorse the general annual Work Plan of the Council

7) Approve the annual Work Report presented by the Secretary General

15. A quorum of the Bureau Meeting shall be a majority of its members, including both Chinese and international members.

16. The Bureau may invite the Deputy Secretary Generals, the director of the Secretariat, the head of the Secretariat International Support Office, the Chief Advisors, or other guests to participate in the Bureau Meeting as observers as required.

17. The Bureau Meeting will hold annually in conjunction with the Annual General Meeting.

18. Between Bureau Meetings, the Ex-

ecutive Vice Chairpersons, in consultation with other Bureau Meeting members, will make decisions on matters that require the authority of the Bureau and cannot wait for the next Bureau meeting. These matters include Council membership, significant changes to the annual work-plan, changes to decisions on the AGM theme or dates, changes to Task Force themes, or other decisions of major strategic importance. The Secretary General will bring proposals for decisions of this nature to the Executive Vice Chairpersons.

VI. The Secretary-General of the Council

19. The Secretary-General of the Council will be appointed by the Chinese government.

20. The Secretary-General is in charge of day-to-day operation of the Council, supervises the work of the Council Secretariat and oversees the work of the Chief Advisors. The Secretary General will, with the support of the Secretariat and the Chief Advisors, provide leadership and guidance to the daily operation and management of the Council.

21. The Secretary General shall designate the Deputy Secretary-Generals to assist the Secretary General's work. The appointment to the Deputy Secretary Generals shall be endorsed by the two Executive Vice Chairpersons of the Council.

22. The Secretary General is a Council Member, whose main responsibilities are as follows:

1) Reporting to and supervising the implementation of decisions made by the Bureau Meeting and Executive Vice Chairpersons

2) Complying with the Council's tenet and objective and keeping contact with other international organizations and institutions on behalf of the Council

3) Submitting an annual Work Report to the Bureau Meeting and providing additional information and advice to the Executive Vice Chairperson and Bureau Meeting as requested

4) Signing documentation of cooperation on behalf of the Council with partners, if necessary

5) Sending out invitations to Council Members for the Annual General Meeting and putting forward proposals on the timing of AGM and changes in Council Membership

6) Approving Special Policy Studies

7) Approving the establishment of Task Forces on themes decided by the Bureau Meeting

8) Providing recommendations to the Bureau Meeting on the theme of the Annual General Meeting, based on advice from the Secretariat and Chief Advisors

9) Submitting an annual work plan to the Bureau Meeting for endorsement, approving the annual operational budgets of the Council and overseeing the implementation of the annual work plan

10) Supervising the work of the Secretariat, approving the employment of the staff of the Secretariat

11) Issuing letters of appointment to the Chief Advisors, and overseeing the work of the Chief Advisors

12) Designating Deputy Secretaries General to assist with his or her work with

the endorsement of the Executive Vice Chairpersons

23. The Secretary-General Meeting will be established and held twice a year to make decisions on regular operation of the Council. The official participants of the meeting include: the Secretary General, Deputy Secretary Generals, director of the Secretariat, head of the Secretariat International Support Office and Chief Advisors. The Secretary-General Meeting will perform the following functions:

1) Reviewing annual work plans, including budgets in preparation for submission by the Secretary General to the Bureau Meeting

2) Reviewing proposals for Special Policy Studies and making recommendations on their approval to the Secretary General

3) Providing advice to the Secretary General on the detailed proposals, implementation plans, and management of Task Forces and Special Policy Studies

4) Monitoring progress on the implementation of annual work plans and monitoring results achieved by the Council

5) Providing advice to the Secretary General on other decisions as required

VII. The Annual General Meeting (AGM)

24. Participation in the Council AGMs:

1) Members participate in the Council AGMs in their personal capacities. They shall not send representatives in case of their absence.

2) Special Observers shall be invited to participate in the AGM.

3) Special guests and observers may be invited to participate in the AGM.

25. Notices of AGMs:

1) The Council AGM is held once every calendar year. Notice of the AGM shall be sent out in writing to each Member at least 90 days prior to the date of the AGM.

2) Under special circumstances, the Chairperson or Executive Vice Chairpersons may decide to call a special Council meeting for all Members. Notice of such a special meeting shall be sent out in writing to each Member at least 30 days prior to the date of the meeting.

3) No meeting shall be invalidated as a result of any member's failure to receive notices as described in this section.

26. Procedures at AGM:

1) The AGM agenda shall provide sufficient time for discussion among Council Members on the theme of the AGM, the Council's policy studies, and policy recommendations.

2) The Executive Vice-Chairpersons, together with other Vice-Chairpersons, will preside over the AGM of the Council.

3) Decisions at the Council AGM shall be made by consensus.

4) A quorum for any AGM shall be a majority of the Members consisting of at least half of the total Council Members.

5) The recommendations to the Chinese government submitted by the Council shall be forwarded to relevant Chinese government departments within 90 days.

VIII. The Operation of the Secretariat

27. The Secretariat of the Council will

be established based on the support from the State Environmental Protection Administration (SEPA). Headed by its director appointed by SEPA, the Secretariat shall serve as the implementing organization for the regular operations of the Council.

28. Under the leadership of the Secretary General, the Secretariat is responsible for the coordination and management of the Council's operation and undertakes tasks for daily operations. The main tasks and functions of the Secretariat are as follows:

1) Providing support, coordinating, and following up on the activities of the Council and its policy studies

2) Preparing the annual Work Plan, budgets and progress monitoring reports for consideration by the Secretary General Meeting in close collaboration with the Chief Advisors and Secretariat International Support Office

3) Taking charge of the Council's daily work for the purpose of regular operations

4) Organizing and undertaking the Annual General Meeting and the Round Table Meeting, including managing logistics

5) Preparing and organizing other activities such as policy seminars or forums of the Council

6) Coordinating, managing and organizing policy studies programs

7) Contracting Chinese expert teams/units for policy study activities of the Council

8) Working in partnership with the Chief Advisors under the coordination of the Secretary General and providing necessary resources, administrative support to the Chief Advisors, and organizing the Secretariat-Chief Advisors Joint Working Meeting

9) Establishing and maintaining close ties with relevant departments of Chinese government and playing a role on coordination when necessary

10) Ensuring the free dissemination of the Council's recommendations/outputs

11) Organizing the publication of the annual work reports, policy research reports and other publications

12) Creating procedures for the management of the Council's operations and policy study program

13) Being responsible for the budget planning and management, fund-raising, reception of donations and the mobilization of domestic resources including match funds

14) Working out strategies and publicity plans on public relations and conducting the implementation

15) Tracking the results achieved by the Council. Building up wide-ranging partnership and organizing the cooperation programs with other domestic or international institutions

16) Improving the Council's website and promoting information exchanges

17) Undertaking other tasks assigned by the Secretary General

29. The Secretariat shall obtain support in the international aspects of the Council's activities from the Secretariat International Support Office (SISO), which shall be established in the primary donor's country. It shall operate according to the management plan agreed to by the Chinese government and the hosting country. Its main functions include:

1) Functioning as an executing agency

for the primary donor country's project on CCICED

2) Providing support to the Secretariat regarding funding support and management on international contributions, based on principles agreed by concerned parties

3) Receiving and managing international donations based on donors' willingness and regulations, playing the role as an international executing agency for relevant donors

4) Contracting the international experts who work for policy studies of the Council when necessary and managing the payments to international experts; also contracting the International Chief Advisor and in international members of the support team

5) Providing assistance in preparing AGMs, including the international travel arrangements for international Council Members

6) Assisting in preparing the annual Work Plan including the budget plan, as well as the other Council activities

7) Tracking the results achieved by the Council

8) Providing assistance to the Secretariat in preparing annual work reports and financial reports as required

9) Providing training programs and technical support to the Secretariat as appropriate

30. Detailed working procedures between the Secretariat and the SISO shall be established in agreed guidelines to cover specific activities such as the establishment of new task forces, special policy studies, roundtables, etc.

31. The Secretariat welcomes donors to second their experts/staff to work in its office either for short or long assignments.

32. The Secretariat shall organize a Donors Meeting at least once a year. The Secretariat will report on the progress of the Council's activities and seek suggestions from all donors.

33. The director of the Secretariat and the head of the SISO shall participate in the Council AGM as observers and attend the Secretary-General meeting as members.

IX. The Operation of the Chief Advisors

34. The Council will invite Chief Advisors to provide scientific recommendations and expertise on its policy study work.

35. One Chinese Chief Advisor and one International Chief Advisor will be invited following consultation between the Chinese side and the primary donor country, and will be appointed by the Secretary-General.

36. The Chief Advisors will be nominated to serve as Council Members.

37. Under the leadership of the Secretary General, the Chief Advisors are to provide advice and consultation to the Secretary General, as well as to Executive Vice-Chairpersons when requested, on scientific areas related to policy studies of the Council.

38. The tasks for Chief Advisors include the following:

1) Evaluating the project proposals of the Task Forces and Special Policy Studies and putting forward recommendations to the Secretary General

2) Providing advice on the scheme of policy studies of the Council

3) Assessing the work of policy study programs

4) Giving suggestions for Task Forces' management

5) Commissioning Issue Papers for the Council

6) Drafting and finalizing Council recommendation to the Chinese government

7) Undertaking other duties as assigned by the Secretary General

39. The Secretariat will organize a small experts group and assistants to provide support to the Chief Advisors to carry out their duties. The Secretariat will provide administrative support and oversight to the Chinese supporting team, and the SISO will provide administrative support and administrative oversight to any international members of the team.

X. Policy Study Activities

40. Based on China's needs in the areas of environment and development, the Council will establish its policy study programs including Task Forces and Special Policy Studies to conduct research activities.

41. Duration of policy studies is as follows:

1) The research period for one Task Force is normally 12-18 months. Some of the Task Forces may continue for a longer duration but shall not exceed 24 month.

2) The total duration for one Special Policy Study shall not exceed 6-8 months.

42. The basic conditions of establishing policy studies are as follow:

1) The topics of the research should be priority issues with significant influence on the policies of environment and development in China.

2) The topics should clearly benefit from the inclusion of international expertise, perspectives and experience.

3) The Council should secure sufficient funding support from both international and domestic sources.

4) Suitable candidates for both Chinese and international experts are identified.

43. When establishing Task Forces or Special Policy Studies, the Secretariat and the Chief Advisors will work under the guidance of the Secretary General to ensure that:

1) The study findings are both relevant to senior Chinese leaders and ministries and are independent and based on the best science and expertise available.

2) The study area, funding budget, and expected objectives are clear.

3) The qualifications of the Task Forces or Special Policy Studies co-chair candidates are the best possible.

4) The timetable for the studies is sufficiently detailed and realistic.

5) The composition of expert team is the best possible. International members should not be limited only to donor countries and Chinese research institutions and experts should be involved as much as possible to assist domestic capacity building in China.

6) The Task Forces or Special Policy Studies have a clear scope of activities, including the preparation of final reports and meeting financial requirements.

7) The reports received from Task Forces or Special Policy Studies for publication are consensus documents reflecting

the views of participating Chinese and international experts. The Secretariat, working together with the Chief Advisors, will ensure that in cases where non-consensus document are circulated for a specific purpose, such as further consultation, the draft status of the documents shall be clearly identified on the documents, and any non-consensus content in the report shall be clearly marked.

8) Task Force reports and Special Policy Studies will be published in the name of the Council or the name of the Council's Task Forces or Special Policy Study teams.

44. Proposal and approval of policy studies.

1) Policy study topics could be proposed and identified by the Chairpersons and Council Members, Bureau Meeting, Secretariat, Chief Advisors, relevant Chinese ministries and other institutions affiliated to the Council or could be based on requests from Chinese leaders.

2) The Bureau Meeting will approve the topics to be studied by Task Forces.

3) The identified policy studies should have project proposals. The proposals should clearly specify the scope, expected output, budget and duration.

4) Any proposal shall be submitted to the Secretariat as the first step. The proposal shall be reviewed and evaluated by the Chief Advisors for their relevance to current policy debates, scientific soundness, feasibility, and methodology. They will forward their recommendations to accept, amend, or reject the proposals to the Secretariat. The Secretariat will screen the proposals to ensure that they contain adequate information to assess their value, feasibility and cost effectiveness. The Secretariat will prepare recommendations for the Secretary General on whether to accept, amend, or reject proposals.

5) The topics to be addressed by Special Policy Studies, and the detailed proposals and implementation plans for Task Forces and Special Policy Studies will be approved by the Secretary General. The Secretary General will seek advice from the Secretary General's Meeting on these decisions.

45. Members of policy study teams:

1) Each Task Force will be co-chaired by one Chinese co-chair and one international co-chair. Each Task Force may include up to 10 Task Force members, including the two co-chairs.

2) Both Chinese and international Council Members may co-chair Task Forces when required.

3) Each Special Policy Study will be co- chaired by one Chinese co-chair and one international co-chair. Each Special Policy Study team will include up to six members, including the two co-chairs.

4) In principal, the number of Chinese and international members in each Task Force or Special Policy Study team should be equal.

5) The Secretariat, working together with the Chief Advisors, will nominate the co-chairs and members. The Secretary-General will approve the co-chairs and members based on recommendations from the Secretariat and Chief Advisors.

6) Any members wishing to resign from the Task Forces/Special Study Projects

shall notify the co-chairs at least 60 days in advance.

XI. Financial Management

46. The funding for the Council consists of contributions by international donors and the Chinese government.

47. Any donors who would like to make financial contributions to the Council shall sign an agreement directly with the Chinese side.

48. The Council will gradually set up a core funding mechanism to finance Council study work and related activities.

49. The Secretariat, together with the Secretariat International Support Office, will administer core funds that enter their respective accounts. Funds will be audited annually by a third independent auditing agency, according to their respective financial regulations and rules.

50. An integrated annual work plan including an annual operational budget plan shall be worked out by the Secretariat, with assistance from the Secretariat International Support Office, in close consultation with relevant donors.

51. The Secretary General will approve and sign contracts entered by the Secretariat that are in alignment with the integrated annual work plan and budget. The Secretary General may delegate this authority. The Secretariat International Support Office will enter contracts in alignment with the integrated annual work plan and budget while respecting all relevant laws, guidelines, and regulations, in close consultation with and notice to the Secretariat.

52. The funds from international donors will be administered under guidelines accepted by donors and the Council.

53. The funds from international donors will be audited as agreed upon by the donors and the Council.

54. The funds for the Council will be executed through budgeting and final accounting.

55. The Council and any other organization or individuals accepting financial support for the work of the Council must keep accurate and complete financial records according to standard financial regulations and practice.

XII. Conflict of Interest

56. When accepting any gift, present or donation or allocating funds, any member of the Council who is officially or formally connected to the contributor shall declare his/her connection.

57. No Council member shall materially benefit, either directly or indirectly, from a contract or agreement entered into by the Council unless an explicit exemption is made by the Bureau Meeting.

XIII. Execution of Document

58. Entrusted by the Bureau Meeting, every agreement, contract, or official document in writing that requires execution or approval in the name of the Council shall be signed by the Secretary-General of the Council, or by one Deputy Secretary-General designated for such purpose by the Secretary-General.

XIV. Statements and Reports

59. Any official statement and an-

nouncement (except for regular announcements and news briefs issued by the Secretariat) in the name of the Council shall only be made by the Chairperson, Executive Vice-Chairpersons or the Secretary-General.

60. The Council will make an annual report to the Chinese government on its conclusions, activities and recommendations. This report will be submitted by the Chinese Executive Vice-Chairperson.

61. The Council will make appropriate arrangement for its relations with the media.

XV. Amendments to the Rules of Procedure

62. Amendments to these rules of procedure may be made by the Council at any Council AGM. The draft amendment shall be sent to Council members prior to the AGM.

CCICED
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Preface

The China Council for International Cooperation on Environment and Development (CCICED) was established in 1992 with the approval of the Chinese Government, as a high-profile advisory body consisting of senior international and Chinese experts on environment and development. Its mandate is to conduct research into environment and development issues in China, and to provide policy recommendations to the Government of China that will support scientific decision making processes towards the development of a resource saving and environment-friendly society.

During 2007-2009, the CCICED operated against the background of the international financial crisis, the challenges of climate change, and efforts by China to realize energy savings and emission reductions and to achieve a green transformation. The Council focused its efforts on such relevant key issues as innovation and environment-friendly society, institutional innovation and harmonious development, and energy, environment and development. During the first three years of the Fourth Phase of CCICED (2007-2011), the Council organized a total of 12 task forces and 5 special policy research programs and put forward policy recommendations to the Chinese Government covering such fields as low carbon economy, rural energy, economic instruments, urban energy, innovation, and the sustainable use of coal. The Council's findings and policy recommendations are highly relevant to the environment and development of China and have attracted the attention of the national departments concerned. CCICED Phase IV also sought to combine policy research with local practice and carried out local a demonstration project on energy and environment policies. This further expands the role of CCICED in facilitating local governments' efforts to adjust their policies on environment and development.

To enable readers to review CCICED's policy research findings during the first three years of CCICED Phase IV, we hereby publish CCICED Findings on

Environment and Development Policy (2007-2009).

This book comprises three parts. Part Ⅰ collects CCICED's policy recommendations to the Chinese Government from 2007 to 2009. The Council's policy recommendations, which flow from each year's Annual General Meeting, represent the culmination of CCICED's policy research efforts related to sustainable development in China. They reflect both Chinese and international perspectives and are of high reference value. Part Ⅱ is composed of the Issues Papers presented to the CCICED's Annual General Meetings in 2007, 2008 and 2009. The Issues Papers review key environment and development issues confronting China, options for action, relevant international background, and future development trends. They capture current thinking on sustainable development and serve as the basis for discussions among Chinese and international experts and scholars during Annual General Meetings. Part Ⅲ presents the Report on the Progress on Environment and Development Policies in China of 2007-2008 and 2008-2009. The reports summarize major developments in the field of environment and development, key policies and other measures adopted, and major areas of progress in the field of environment and development in China over the past year. This information is presented in the context of the policy recommendations advanced by CCICED. The two reports provided comprehensive and practical background for in-depth discussion of environment and development issues in China by CCICED Chinese and International Members and relevant stakeholders.

It is hoped that this book will enable readers to gain insight into CCICED's efforts in the field of environment and development during 2007-2009 and will provide useful material that will contribute meaningfully to the promotion of conservation culture and the exploration of a new path to environmental protection with Chinese characteristics.

CCICED Secretariat

March, 2010

Contents

Part Ⅰ

CCICED Policy Recommendations Submitted to the Government of China

As a high-profile advisory body, the main task of CCICED is conducting the research in key environment and development issues in China and putting forward policy recommendations to the State leaders and policy makers.

The council's policy recommendations on environment and development represent the culmination of CCICED's policy research efforts related to sustainable development in China. They reflect both Chinese and international perspectives and are of high reference value.

CCICED Policy Recommendations Submitted to the Government of China

(2007)

Overview

In light of the innovative strategic ideas and policies on environment and development put forward at the recent 17th National Congress of the Communist Party of China (CPC); the "Three Transformations" set out in 2006; and efforts during the first two years of the 11th Five-Year Plan, CCICED believes China is now entering a period of strategic transformation for environment and development.

This transformation towards a resource conserving and environment-friendly society will be a long-term undertaking with a clear need to meet important milestones such as the environmental targets in the 11th Five-Year Plan. The Council believes it will be extremely difficult to achieve these targets with the current framework for environmental management, levels of investment, and pollution-intensive mode of economic growth. The higher-than-expected rate of economic growth, fuelled by a range of incentives at the local level, intensifies these pressures. Reconciling China's environment and development policies is likely to be even more difficult during the 12th and 13th Five-Year Plans, since the problems will become even more complex and will include a growing ecological deficit.

Also, while China is focusing its main efforts on primary environmental problems caused by industrial and municipal pollution, a range of secondary, often non-point source pollution problems, mostly from the use of various chemicals, is threatening its environmental security and public health. The Chinese government has begun to pay great attention to the problem. The members of CCICED also

have expressed deep concerns about how to address these problems. They involve a wide range of pollutants, including those produced by the burgeoning chemical industry sector.

It is against the backdrop of globalization that China's industrial and urban revolution is taking place; this includes the building of a knowledge-based society and a socialist market economy. China's environment and development process has become integrated with that of the world. While China is faced with new environmental challenges brought about by globalization, it is also creating an impact on global and regional environments. China's ecological footprint, a measure of human demand on the planet's biologically productive land and water, is still low by comparison to many other nations, if measured on a *per capita* basis. However, it is growing and should become a matter of concern in policy decisions that affect international trade, climate change and other international cooperation. The future of China's environmental quality hinges on tackling these issues and others through changes that involve fundamental reforms and mechanisms for involvement of the whole society in their outcome. This is the key message arising from successful transformative approaches to environment and development in other countries such as Germany and South Korea. Incremental change is not enough.

China's commitment to becoming an innovative society is an essential step in the right direction. Innovation is the opportunity side for environment and sustainable development. The key to its success lies in taking a comprehensive innovation approach to institutional change, policies and technologies.

Supported by various task forces and other research efforts,[1] the 2007 CCICED AGM has focused on policy innovations, particularly on the following two aspects: (1) innovation of strategic thinking, including the transformation of environment and development strategies, as well as the challenges brought by globalization; and (2) innovation of specific policies and mechanisms, par-

[1] The studies reported at the 2007 AGM included: *CCICED Task Force on Policy Mechanisms Towards Successful Achievement of the 11th Five-Year Plan Environmental Targets, CCICED Special Policy Study on Strategic Transformation of Environment and Development in China, CCICED Special Policy Study on Environmentally Sound and Strategic Management of Chemicals in China, and interim reports from the CCICED Task Force on Innovation for China's Environmental-friendly Society, and from a CCICED-WWF preliminary analysis of China's Ecological Footprint.*

ticularly on emissions reduction for the 11th Five-Year Plan and beyond, and for chemicals management.

This examination of "Innovation for an Environment-Friendly Society" is intended to set the stage for future work of CCICED, including task forces on Innovation for Sustainable Development, Environment and Health, and Energy and Environment. It marks a shift in CCICED's attention towards collaborative work to identify early warning of key problems, and towards creative solutions that will rely much more on technology and policy innovation worked out in China. The business sector, long recognized as both the origin and centre of innovation, will play a key role in developing and implementing solutions for an environment-friendly society. Business engagement is key since business makes the operational decisions that most affect environmental outcomes. However, enterprises cannot do so if they are unclear about their obligations, and these need to be clearly defined and legally enforceable.

Recommendations

The following major recommendations to the Government of China are based on the deliberations and agreement at the CCICED AGM 2007. In addition, more detailed recommendations from the individual CCICED task forces and special study reports will be forwarded for consideration.

1. Strengthen and add new policies and mechanisms to achieve emission reduction targets

Achieving the 11th Five-Year Plan emissions reduction targets is a major challenge for the Chinese government. Despite the significant efforts to date, the challenge is made more difficult by the pace and composition of economic growth. The emission reduction objective was calculated on the basis of the emission volume at the end of the 10th Five-Year Plan period. But the Chinese economy is growing much faster than the original estimate of 7.5%. This fast growth rate, and the even faster growth of high energy-consuming, high pollu-

tion-emitting industries, will result in a need for a much higher level of emissions reduction than predicted. Structural changes in the economy are essential, as well as policies that provide incentives for process change rather than end of pipe solutions, but this may not occur quickly enough for 2010 targets to be reached. Very demanding targets for pollution reduction will be needed for the foreseeable future, at least to 2020.

The program for achieving the target of reducing SO_2 emissions by 10% compared to the 2005 baseline is heavily dependent on installing FDG (Flue Gas Desulphurisation) equipment in coal-burning electricity stations. This strategy is impeded by the poor performance of FDG equipment and operation, and higher than expected levels of sulphur in coal. Cost effective approaches such as coal washing have not been given sufficient attention. These concerns need to be addressed urgently. Achieving the target of reducing energy intensity (energy consumption per unit of GDP) is a necessary but not sufficient condition for achieving the SO_2 target. Further efforts will be needed to reduce SO_2 emissions from the non-power sector.

COD (chemical oxygen demand in water) is an even more difficult problem. It is doubtful that the very ambitious program for constructing urban sewage treatment pipes can be completed as planned. More attention should be paid to sludge treatment and to discharges from the industrial sector and non-point sources. The pricing and financing policies applied in this sector need to be re-examined.

There are serious problems in terms of quality control and performance. Monitoring is inadequate, and is impeded by three sets of data EPBs (Environmental Protection Bureaus) work with that are not compatible. Local EPBs often lack the authority and means to fulfill their responsibilities, and some local governments undermine their efforts. In short, management and institutional weaknesses are holding back progress. Inadequate financial investment is also a major constraint in reducing pollutant emissions. Using international definitions such as those of OECD and Eurostat, environmental expenditures amount to about 0.6% of GDP, about half of the official estimates, and low for countries at this stage of development.

End-of-pipe pollution control approach is necessary but not sufficient to deal with the growing volume of pollution in China. What is needed is an effective total emissions control (TEC) approach that controls both the volume and concentration of pollution. More emphasis should be put on cost-effective approaches such as washing coal, structural adjustment in the energy and industrial sectors, and removing incentives such as favourable financial conditions that foster excessive investment in polluting industries like coke and steel. Greater use of market instruments is needed to provide continuous incentives to find cost-effective approaches to pollution prevention and control, including innovation. This can include cap and trade market-based systems. Energy conservation and new processes that eliminate pollution production can help. Other economic instruments and strict enforcement of regulations are needed so that it is no longer cheaper to pollute than to clean up.

It is vital that environmental management systems within government be made much more functional, with clearly understood responsibilities and accountability at each level. The performance assessment of local political leaders should place greater emphasis on their environmental performance. Failure to do so results in economic considerations overriding environmental policy objectives.

Therefore, we recommend:

1) Adopting a new "Five Shifts" approach and examining how it could be implemented not only in the 11th, but also the 12th and 13th Five-Year Plans: (1) Move to a focus on reducing total emissions and specific improvements in environmental quality; (2) Move from an over-reliance on reducing pollution from selected industries to reducing pollution from all industries; (3) Move from total control of single pollutants to the coordinated control of many pollutants; (4) Move from increasing the number of pollution reduction projects to increasing their quality; (5) Move from reliance on administrative mechanisms to greater use of market-based instruments.

2) Under the leadership of the State Council, establishing a technological analysis platform for economy-energy-pollutant emission reduction and a joint policy making system between the relevant government departments to carry out dynamic tracking, early warning and response in regard to pollutant emission re-

duction; and with a strategic focus on understanding the benefits and costs of changing the economic development mode.

3) Constructing a total emission reduction system composed of reduction of resource-energy inputs, much greater efficiency improvement in production processes, and end-treatment of pollutant emissions.

4) Reforming the performance assessment system for local government officials to take account of their responsibility for achieving environmental targets and related policy objectives; creating a simple evaluation system for government officials based on a locally appropriate energy and emission reduction index, as well as the degree of compliance by enterprises with current environmental laws and regulations in their jurisdiction.

5) Improving the technical support capacity of both the central and local governments, including the development of a more integrated environmental information system, a scientific indicator system of pollutant emission reduction, an accurate emission reduction surveillance system, and a rigid emission reduction examination and evaluation system.

6) Improving the operability of COD reduction programs focusing on the key polluting industries and non-point source pollution, especially from agricultural sources; increase funding and implement faster construction of urban sewage pipes networks and sewage treatment infrastructure. Optimize SO_2 reduction programs through integrated programs that broaden the focus from scrubbers and other stack controls including quality of coal, and the proportion being washed, more effective supervision of the quality of FDG equipment, and developing a program to reduce pollution from coal-fired boilers in the non-power sector.

7) Beginning now to study trends in pollutant emissions, and how they could be reduced most cost-effectively in the 12^{th} Five-Year Plan period, paying attention to all the points mentioned above, but emphasizing greater use of public-private sector approaches to necessary investments; establishing long-term emission reduction mechanisms using market-based instruments including environmental taxes; resource pricing; emissions trading; the establishment of appropriate environmental finance mechanisms; and continuing efforts to build a high-performing

administration and management system, particularly at the local level, with necessary upgrading of laws and regulations.

2. Integrate chemical management strategy into China's overall national environmental and health management systems

Currently, China is producing and marketing approximately 47,000 kinds of chemical products, with about 100 new chemicals in line for registration annually. In the course of production, storage, selling, transportation, utilization and waste disposal, chemicals can have vital impacts on human health and environmental security owing to misuses, abuses, emergencies, and maltreatment of wastes. Many hazardous chemicals that are widely controlled internationally are still produced and used without restriction in China. In addition, accidents involving hazardous chemicals happen frequently. The international community is vigorously promoting SAICM – Strategic Approach to International Chemicals Management, with a proposed target of 2020 for production and use of chemicals in ways that minimize environmental and human health harm.

The rapid development of China's chemical industry sector makes formulation of a robust chemical management system an urgent matter. China's existing chemical administration is mainly limited to the professional safety administration of the flammable, explosive, and acute toxicity chemicals. The methods of chemical environmental administration are limited to end treatment of toxic chemical pollutants and the registration of toxic chemicals upon importation and exportation. The currently used classification system for hazardous chemicals in China does not fully reflect various potential environmental and health hazards and risks of chemicals. China is yet to exert systematic and institutional environmental administration on the chemicals that have potential and long-term harms on human health and environment.

Therefore, we recommend:

1) Establishing China's Environmentally Sound and Strategic Management of Chemicals System, with environment protection departments as the major responsible institution, coordinated with other relevant departments; and strengthen-

ing capacity building to carry out effective testing, evaluation, monitoring and management of chemicals from an environmental perspective.

2) Formulating China's chemical environmental administration strategy, with "prevention as the key measure, combining prevention and rectification of problems, strengthening surveillance, and regulation" as the guidelines. A long-term action plan for risk assessment should be developed. Chemicals with high risks to health and environment should be given earliest attention for possible replacement, and their manufacture and management should follow clean production and green chemistry concepts. The strategy should be WTO compliant.

3) Formulating a special law or administrative regulations on chemical environment administration. This should establish a basic institutional system on chemical environmental administration, including classification and labeling, notification of new chemical substances (currently established only by a ministerial rule), risk assessment and management of new and existing substances, national criteria for prioritization of chemicals of very high concern, appropriate environmental monitoring systems, a right-to-know system for release of toxic chemicals, and environmental accident prevention and emergency response systems coordinated with existing mechanisms.

4) Establishing a system of release recording on toxic pollutants and a publication system for toxic chemical pollutants so that the Chinese public is informed and can participate in the government decision making on chemicals management.

5) Promoting and supporting voluntary measures on the part of chemical enterprises, including Responsible Care and product stewardship initiatives that have been successful in other countries or internationally, and clarify the legal status of voluntary agreements between government and industry and actions taken under China's "Cleaner Production Promotion Law".

3. Seize the opportunity provided by China's strategic transformation of its environment and development mode

CCICED notes there has been substantial progress since 2003 towards creating a coherent approach to environment and development policies. It is encouraging for the future, despite the magnitude of challenges today. China is setting in place necessary conditions to optimize the potential of future innovations for sustainable development. The current transformation of environment and development strategy in China is a necessary step for China's social advancement. According to international experience, China should strive for strategic transformation of its environment and development path for the coming 15-20 years, leading to significant improvement of its ecological environment as well as its economic development. The 17th National Congress of the CPC marked a turning point for China's new strategic system to guide sustainable social-economic development—using Scientific Development Theory as an overarching framework for building a harmonious socialist society.

Signals for a strategic transformation of Chinese government policy relevant to environment include: a new industrialization pathway with five criteria, as well as a peaceful development path internationally; and elevating environment protection to the level of a "Conservation Culture", where the objective is building a resource conserving and environment-friendly society. The guiding idea has shifted from "rapid and sound development" to "sound and rapid development". China is demonstrating its immediate commitment through the difficult pollutant emission reduction objectives in the 11th Five-Year Plan.

Other countries such as Germany and Japan have found four key factors in their period of transformative change for environmental improvement. One is public participation and involvement of the whole society in decisions on environment and development. Second is that in most cases it is problems of environment and health that have galvanized action, whether it be Minamata Disease caused by mercury pollution in Japan, or by the effects of smog in Los Angeles. Third is the need for a progression of changes, some immediate and others longer

term, towards fundamental technological and institutional changes over periods generally of 5 to 10 years. Fourth is the need to take into account international aspects of the transformation as well, including impacts of the transformation on other nations. The results include substantial new economic opportunities and positive influences on environmental standard setting and practices influencing all sectors in society.

CCICED believes China is now in the most significant period for strategic transformation when it will be possible to accelerate the turnaround in the relationship between environment and development. To take full advantage of this key period, the Chinese government must solve three outstanding problems. First, the strategic transformation is taking a top-down approach and lacks the full involvement and support from all stakeholders and levels of government. Second, detailed and effective policies, capacities and action plans are still missing to carry out the strategies and principles set up by the central government. And third, it is essential to continue searching for better value from existing levels of investment, and at the same time, increase the flow and level of funds in support of environmental protection.

Therefore, we recommend:

1) Building public awareness and participation so that the whole society plays a role in the strategic transformation, including household and workplace consumption and environmental health, monitoring of local development, and direct participation in environmental improvements. Encouraging the participation of environmental NGOs as a way to draw upon perspectives from across the range of societal views. Also, providing special training and education to the policy makers, administrators and managers, especially of local governments at various levels, and enterprises. This capacity building is necessary to sharpen their consciousness of the importance and urgency of the coordinated environmental-social-economic development, and to enhance abilities to deal with practical implementation.

2) Accelerating improvement of China’s existing environmental protection institutional system to take maximum advantage of environmental legal frameworks, management techniques and technology. This should include upgrading the

institutional status of SEPA and local environmental protection departments; re-writing of key laws such as the 1989 Environmental Protection Law; appropriately stringent standards and the means to enforce their observance; allocating more human, capital, and technical and equipment resources to the environmental protection departments so they are well equipped to be the mainstay for promoting the strategic environment-development transformation. Clearly, the greatest need is to build a high-performing system that will drastically reduce the extent of illegal environmental behaviours, reform the penalty system to ensure financially effective penalties are in place; create enabling situations where enterprises, cities, towns, and projects of all types have the means to address environmentally sustainable development; and improve the environmental judicial system to secure both public and private environmental welfare and exercise environmental justice.

3) Making full use of market-based policies to promote the environment-development strategic transformation, including environment taxation, resource-energy taxation, green credits, environment insurance, ecological compensation, and emission trading, etc. This market-based approach, with carefully constructed incentives, is essential to fully realize the benefits of innovation, including development and commercialization of environmental and sustainable development technologies.

4) Reviewing current levels of environmental investment in the environmental sector to determine the amounts actually being spent in support of high priority activities, and where necessary redirect or increase the funds required for these priorities. In addition, place greater attention on how to encourage private investment for the substantial expenditures required to carry out ecological conservation innovations in the industrial sector and to establish innovative resource-conserving and environmentally friendly production and consumption models, including those that support a Circular Economy.

4. Address the challenges brought on by economic and environmental globalization in a more timely and effective way

China is facing new environmental pressures through its participation in eco-

nomic globalization. As the “world’s factory”, China is host for the relocation of many high energy consuming and high pollution emitting industries. While China enjoys a “trade surplus” in economic terms, it is also building a domestic “ecological deficit”, generated by the export-oriented economy that consumes a large quantity of energy and resources and produces a large volume of pollutants and greenhouse gases. In addition, China is also facing severe local impacts from illegal trade of hazardous waste.

China also needs to pay greater attention to addressing environmental effects that its market supply chains may have on other nations. At the same time, it should give full recognition to the positive contribution that a global competitive marketplace could have on its domestic environmental advancement. These are rather new effects that will grow in significance over coming years as Chinese multinational businesses become more active, and as China’s resource needs and economic activities continue to increase. China may find itself increasingly vulnerable to various forms of environmental protectionism and other retaliatory action, perhaps involving third parties.

CCICED is encouraged by the new “coordinate and cooperate to protect our only earth” international environmental cooperation principle, which was put forward by the Party’s 17th Congress. China’s effort in protecting global environmental conditions, such as ODS (Ozone Depleting Substances) reduction, carbon sequestration through afforestation, and its 2007 Climate Change Program are notable. China’s own strategic environment and development transformation is linked to success of the international community’s efforts to control global and regional environmental concerns, such as climate change.

China must be able to address global environmental concerns from its own perspectives and self-interests. But increasingly its influence on the world’s economy and ecology places China in a position of great responsibility to the community of nations. Indeed, the world’s economic and environmental security is increasingly being perceived to be in China’s hands. Over the coming five years, this perception is likely to be reinforced as China’s rapid economic growth continues. China needs to determine where it should place its major efforts to ad-

dress global environment and development issues.

Therefore, we recommend:

1) Gradually changing the current growth mode of trade in order to adjust the relationship between trade, resources and environment. Make full use of China's trade surplus to import products and technology with high embodied energy and resource content, and reduce export of some goods (especially commodities) with high embodied energy and resources. Find and expand substitutes for goods that require high energy consumption in their production, or sometimes import them. Speed up transformation of the current foreign trade growth mode, moving from the traditional growth mode relying mainly on price competition, quantity expansion and seeking very high growth rates, to a mode relying on quality improvement, increase of value-added, and optimization of structure. Expand the export of services and strengthen their international competitiveness.

2) Optimizing regional structure for manufacturing goods for export, including strict environmental upgrading of all industrial processing in eastern areas, while making full use of the local abundant human resources in the middle and west of China, and introducing environmentally friendly processing for trade to these areas. Levy an environmental pollution tax on products and industrial sectors with high energy consumption and high pollution, and assign costs for environmental damage to the responsible enterprises. Introduce appropriate advanced foreign technology and equipment, and promote energy saving and emission reduction activities to improve domestic environmental quality.

3) Strengthening environmental aspects of trade for recyclable and waste goods; and conduct regional planning within China for environmental management of trade for recyclable and waste materials. Carry out life cycle analysis for imported recyclables and wastes being reprocessed as raw materials, and enforce strict environmental entry standards into China of such materials. Restrict those processing enterprises in China that import recyclables and wastes from exporting the resulting raw materials, in order to ensure raw materials are used for domestic needs or producing higher value export products—not merely for getting foreign

exchange, while leaving behind pollution byproducts. Work with other nations to ensure the honoring of international agreements and international monitoring in order to curb illegal trade in toxic wastes.

4) Developing appropriate regulations for carrying out comprehensive environmental impact assessments on key market supply chains for raw products entering China, including agricultural products such as soybeans, edible oils, fish and cotton, wood products, biofuels, and minerals. Take steps to prevent negative influences on the environment in the countries of origin. Take additional steps to eliminate illegal timber trading and other such problems, including activities banned under the Convention on International Trade in Endangered Species of Flora and Fauna (CITES).

5) Strengthening environmental management of Chinese companies that invest or operate overseas, and improve the Corporate Social Responsibility awareness of these enterprises. Encourage Chinese enterprises to obtain international advanced environmental managerial experiences and environment-friendly technologies through their investment overseas or establishment of joint ventures in other countries. Such investment in environmental-friendly efforts will strengthen the long term competitiveness of Chinese companies.

6) Enhancing China’s participation in bilateral or multilateral environmental cooperation. Promote the implementation of international environmental conventions within China by setting up complete domestic implementation mechanisms, management systems and framework of policies and regulations. And participate more actively in the construction of the global environmental regime, while adhering to the principle of common but differentiated responsibilities; maintaining the right for development of all developing countries including China; building an international image of China as an environment-responsible nation through its actions. Shoulder international obligations within China’s capabilities, explore technological cooperation opportunities through South-North cooperation, and strengthen environmental cooperation activities between China and other developing countries in Asia, Latin America and Africa.

7) Combining the endeavors of energy conservation and pollutant emission

reduction in China with CO_2 emission reduction in order to develop an energy and industrial system with a relatively low CO_2 emission. In other words, begin moving towards a pathway in China consistent with global efforts to achieve a low-carbon economy in the future.

5. Construct a "Conservation Culture" through innovation

It is time for China to build greater domestic capabilities for "Made in China" advanced solutions to environmental and sustainable development technologies, along with the associated institutional strengthening and systems to ensure good ideas turn into commercially viable, widely used products. China's Medium-term S&T Plan calls for a major emphasis on environment in future R&D. Yet there are many challenges and barriers that have to be addressed in the National Innovation System (NIS) before it can achieve full potential. Furthermore, sustainable development in China and many other countries has tended to be implemented without much connection to the NIS.

There are significant problems with relying on imported environmental technologies to allow China to leapfrog in reduction on emissions in the same way as it has in other sectors, such as telecommunications. The problems include limited willingness to share advanced technologies (auto emissions), technologies not suited to Chinese conditions, and the high costs of accessing some advanced technologies and intellectual property rights (IPR), such as advanced electrical power generation systems. As well, some transformative technologies like hydrogen-powered fuel cells require additional development effort and time.

On the other hand, China has clear advantages that are not being sufficiently tapped for environmental innovation. Lower labour costs coupled with a potentially large domestic market could make Chinese environment and sustainable development products and services very attractive to the global marketplace. An example is solar photovoltaic panels.

The right enabling conditions for eco-innovation are not yet fully in place within China. These conditions include unleashing creativity within China's vast research system, including academies, universities and the private sector, but with

the recognition that short-term failure of some efforts should be tolerated. The financial investment systems for environmental innovation are still weakly developed and it is important that more venture capital be attracted at various developmental points so that environmental technology markets are strengthened. Regulatory frameworks favoring innovation are needed, especially market-based approaches that provide the necessary incentives for industry to move towards environment-friendly processing without pollutants and "green chemistry".

Many of the new products arising from biotechnology, nanotechnology and energy technology or other innovations will require assessment of their true potential for achieving environmental improvement and sustainable development progress. And of course, potential negative impacts on the environment also need to be considered. Biofuels are an example. These types of assessment are different from project-oriented evaluations, and proper regulations and guidelines are needed.

The decision to "make or buy" advanced environmental technologies is never simple, and must be decided on the basis of specific situations. For some advanced technologies, the best approach may be to take full advantage of foreign direct investment to draw upon the international experience of multinational companies, but be directed by stringent regulations or guidelines as a condition of investment. International joint scientific and development initiatives are already in place, especially for energy efficiency and some pollution reduction efforts. These will need to be expanded and more will be needed, especially in light of the urgency for solutions to sustainable use of coal, greenhouse gas reduction and other important environmental problems.

Therefore, we recommend:

1) Mobilizing both national and local level interest and willingness to implement environmental and sustainable development innovation strategies. The approach needed goes beyond environmental compliance, which is perceived to be cost driven and inconsistent with economic growth. This need is even more urgent than investment in R&D for new technologies, since many technologies are already available but not effectively used by enterprises, or promoted as solutions by local government. A combination of enforcement, incentives, improved planning,

awareness raising, and capacity development is required to address this type of system failure. Development of regional "innovation clusters" appropriate for the environmental and economic conditions is needed to build local-level understanding and access to suitable innovation products and approaches; for example, to address development in fragile ecosystems such as the Qinghai-Tibet Plateau, and the upper watersheds of major river basins, and major coal-producing regions.

2) Strengthening and popularizing the field of environmental technology R&D and removing obstacles to commercialization. Numerous technological breakthroughs already exist in China and others are likely to happen in the future. However, they must move more quickly from trial stages to commercialization, and be seen as attractive opportunities for investment at all stages. Current incentives do not promote long-term innovation for environmental technologies. This problem can be addressed through a combination of government commitment and involvement in the earlier stages of scientific research and development, and the private sector and investors in the later stages. The problem should be tackled as a central issue via the NIS.

3) Taking action to overcome market failure that hinders environmental technology introduction. Private enterprises should become the main players for the development and implementation of technologies for an environment-friendly society. However this is not happening to the extent that it should. The limited markets for such technologies, reliance on command and control regulation, inadequate resource and other pricing policies, and the limited sanctions for non-compliance all need to be addressed as components of market failure. Better green procurement policies operating at both national and local levels of government are needed. Preferential loans for initiatives making use of environmental technologies and/or denial of loans for initiatives that shun their use need to be implemented on a much broader basis than existing trial efforts.

4) Raising the public quality of environmental science and technology. China's economic and environmental future depends on making the world's most populous nation scientifically literate and able to create the social environment for many types of technology innovation. The commitment to an "innova-

tion society” depends on improvements to the educational system, and on demonstration of real environmental value arising from eco-innovation. In turn, these depend upon continued improvement in the production and reliability of environment and sustainable development information at all levels, including local communities.

5) Improving public environmental, scientific, and technical capacities. The future of China’s sustainable development depends on the dissemination of basic technical knowledge to the largest population in the world. The construction of a “Conservation Culture” will also rely on an improved education system and the increased value of environmental resources.

CCICED Policy Recommendations Submitted to the Government of China

(2008)

Overview

The Second Annual General Meeting of Phase IV of the China Council for International Cooperation on Environment and Development (CCICED 2008 AGM) was held in Beijing from 12-14 November 2008 with the theme of "Harmonious Development through Innovation". This meeting occurred at a time of great turmoil in the world's financial markets with the threat of severe global recession but also with a call for "re-regulation". This year was also a time of celebration of tremendous achievement in China – 30 years after the Reform and Opening Up and after the very successful Beijing Olympics.

These events, along with China's remarkable efforts during the snowstorm and earthquake disasters and in response to the melamine contamination and other public health incidents, have focused our discussions on how environment and development can play a stronger role in China's future harmonious relationships.

The 17th Party Congress of the CPC specified that scientific development, Harmonious Society, and promoting an *Ecological Civilization* should guide China's social values and progress. Now, a year after this historic meeting, there is growing evidence that transformative action is taking place towards building a resource conserving and environment-friendly society in China.

It is particularly significant that progress is being made on the 11th Five-Year Plan program for energy conservation and pollution reduction, that China leads the world in achieving many of the Millennium Development Goals, and that many of China's science and technology innovation goals are for sustainable development.

Moreover, necessary institutional strengthening, including the formation of the Ministry of Environmental Protection (MEP), is taking place. CCICED applauds this evidence of domestic progress and also China's expanding role on international environment and development.

Despite these praiseworthy efforts and achievements, China's domestic program for environment and development still faces many challenges, and much corrective action is necessary before its full contribution to a Harmonious Society can be realized. The action taken at the 3rd Plenary Session (October 2008) of the 17th CPC Party Congress to reduce the imbalances between urban and rural development is an important opportunity where increased environmental efforts will lead to a more harmonious society. The CCICED members are aware that public health problems induced directly or indirectly by pollution remain a serious factor for social advancement in China. This has been a priority area for CCICED research on harmonious development.

CCICED believes that an appropriate mix of incremental and transformative changes is needed to build a new relationship of environment and development in China and globally. That China is well positioned for carrying out these changes is fortunate. Environmental progress should intensify over time, first through incremental improvements and later by leaps and bounds, as the investments now being made in sustainable development innovation produce better technical solutions. CCICED has examined how environment and sustainable development innovations could be fast tracked, since it is unlikely that incremental change alone will satisfy China's ambitious environmental targets and longer term needs.

Nowhere is this need for innovation greater than in addressing environment and energy relationships and the global need to address reductions in greenhouse gases. CCICED has started several task forces and other activities on these topics. While the main results will not be reported until the 2009 AGM, a few preliminary recommendations are provided in this document.

The global environmental situation continues to decline, with direct effects on China through trade, climate change and in other ways. The Beijing Olympics has created a level of awareness around the world of China's environmental problems

and its capacity to address them. How China chooses to go about its efforts to promote an *Ecological Civilization* at a global level is therefore a significant matter, with implications for trade, market supply chains, and action on pressing concerns such as climate change. But China's domestic and international environment and development efforts could be threatened if the credit and financial crisis turns into a worse situation of recession.

The worsening global economic situation threatens social, economic and environmental progress of all nations, including China. This topic received special attention from both Chinese and international members. The CCICED AGM occurred just as China announced its substantial economic recovery package. Therefore there was a substantive basis for considering how China can turn the economic crisis into an opportunity for strengthening economic growth.

In the period of global crisis ahead there will be many opportunities where China and a few other major developing countries have advantages not found in more established industrial economies. This is particularly the case for sunrise industries and for green products, which will become of increasing significance in the second decade of this new century. In fact there may be a historic shift in leadership on environment and sustainable development from Europe and North America towards Asia. Trade and investment will be drivers for this to happen. Real solutions for global sustainable development are now as likely to arise from action in China as in other parts of the world.

Council members appreciated the Chinese position that the global economic slowdown therefore must not be allowed to stand in the way of environmental progress and that the economic stimulus package developed by China has incorporated environmental aspects. During this time of rebuilding the world's financial system and new economic growth paths, China could benefit by positioning its investments towards activities that will allow it to shape the nature of future world growth, for example as a supplier of renewable energy products and services. These are examples of what CCICED's Chairman, Vice Premier Li Keqiang, noted are actions that "promote development of the economy while taking good care of the earth that we share".

At the 2008 AGM CCICED reviewed final recommendations from Task Forces on Innovation and an Environmentally Friendly Society, and on Environment and Health. In addition, the Council received interim reports with some recommendations from three energy and environment Task Forces that will submit final recommendations in 2009, “Pathway toward a Low Carbon Economy”, “Economic Instruments for Energy Efficiency and Environment”, and “Energy Efficiency and Urban Development”. In addition, the CCICED Issues Paper prepared for the 2008 AGM identified a number of urgent challenges facing China, in part the result of the international economic and environmental situation. Our three key recommendation topics draw upon these reports as well as on the views of Council members.

The Council’s reports and discussions again underscore the need for effective implementation and enforcement of strong environmental legislation, greater use of credible economic instruments, and a more scientific approach to the development and dissemination of reliable environment and development information as means to build confidence and public trust in China’s environmental decision making. Of these points, the first and last deserve particular attention. Enforcement of regulations at a level that will change behavior is absolutely essential in order to foster innovative technologies and to improve environmental health conditions. But it is also vital to stress the need for public data that can be trusted by citizens and can become benchmarks for positive change via good standards.

Recommendations

The following major recommendations to the Government of China are based on the deliberations and agreement at the CCICED AGM 2008. In addition, more recommendations concluded in the researching from task forces of CCICED will be forwarded for reference.

1. Transformation challenges into opportunities for further implementation of a scientific development approach

2008 will surely be viewed as an exceptional year for China because of the devastating natural disasters, international financial turbulence, food safety incidents, successful Olympic and Paralympics Games and the 30th anniversary of the introduction of Reform and Opening Up. The year, on one hand, gave rise to a number of new problems and challenges for China in the field of the environment and development, while on the other hand, the great success and joy of the year left a precious legacy for China, as well. As the year of 2008 draws to its end, it is now important for the Chinese government to face up to the problems and challenges, identify opportunities and potentials, review experiences and lessons, take positive actions, and look into the future.

Therefore, we recommend:

1) Seek Opportunities in the Wake of the Financial Crisis and Advance "Sound and Rapid" Environment and Development Initiatives.

To find a remedy for the financial market and achieve stable economic growth are undoubtedly the top priorities for the world right now. However, we must remain alert to prevent the environment from becoming the next victim of the financial crisis, as may occur in some parts of the world. Once it becomes a trend to neglect environmental factors, the world's sustainable development will take a significant step backward. Thus, China must work with unwavering determination to reduce emissions, improve energy efficiency, and fight climate change. The Chinese government has recognized the risk from the current crisis and has integrated environmental protection in the domestic stimulus package. It must now transform these challenges to opportunities for sound and rapid sustainable development.

The stimulus package should follow four principles with respect to environment and development. First, do no harm to the environment in the implementation of the package. Second, take a systems perspective that will identify positive relationships for the environment and the economy. Third, highlight labor-intensive activities operating at an appropriate scale to help poor people while protecting

local environmental conditions, especially in the countryside. Fourth, seek co-benefits, especially for improving health and ecological restoration, as a consequence of energy improvements, disaster relief and reconstruction, and pollution reduction.

It is recommended that the Chinese government should fully be aware of risks and opportunities and take the following actions:

(1) Strengthen supervision and environmental management in the execution of the domestic stimulus plan, so as to prevent regions from boosting economic growth at the expense of environment in their response to the financial crisis.

(2) Consider not only environmental protection as one of the investment priorities of the stimulus package, but also carry out examination of supply chain environmental consequences and strengthen green procurement policies. These steps will boost the development of environmental protection industries and convey the strong determination of the government that environmental protection can be maintained even in the wake of the financial crisis.

(3) Take advantage of the opportunities arising from the financial crisis in order to advance transformation of the development mode for the domestic economy. This can be done by boosting the development of clean energy and technical innovation, low carbon economy and by strengthening capacities in the area of environmental protection and climate change in the remaining years of the 11th Five-Year Plan, and particularly during the 12th Five-Year development period.

(4) Advance energy price reform and further internalize environmental externalities with the plunge of oil and commodities prices. It is advisable for China to adopt a long term “escalator” approach to gradually raise energy prices. It means small, but periodic and predictable rising prices or the introduction of additional environment or energy taxes, with information transparency to fully prepare the general public and reduce possible resistance.

(5) For the longer-term, develop a Low Carbon Economy. The Chinese government should attach great importance to the development of a Low Carbon Economy (LCE) and get prepared for action, particularly in terms of technology options and feasibility analysis. The development of a low carbon

economy will benefit China both internally, in terms of addressing resources and environmental problems, and externally by contributing to the fight against climate change and raising international competitiveness. China should consider specifying low carbon economy related targets in the 12th Five-Year Plan for economic and social development and incorporate a low carbon economy in current strategies and actions.

2) Create a Better Mix of Government Regulation and Market-Based Mechanisms Between Factors Favoring Innovation and Those Favoring Stability.

The world financial crisis and the infant formula incident have shown that excessive reliance on market forces without effective regulation will create huge risks. In fact, market failures such as environmental externalities are often hard to control. The government thus should strengthen its supervision while adopting market-based instruments. China is at the initial stage of a socialist market economy where both market function and government regulation await improvement. Therefore the government should step up its supervision while giving full play to market-based instruments suitable for environmental protection.

Some of the most important market based approaches will require significant levels of capacity building for adequate management and supervision, including improved emissions monitoring, consolidating and standardizing emissions data, designating a legal registry for emissions reductions, and enforcing non-compliance with much stiffer penalties.

It is important for the Chinese government to maintain the balance between innovation and stability. Stability is a prerequisite for a harmonious society while innovation often entails reform to avoid unreasonable benefit distribution. Imbalance between the two will give rise to conflicts. But, if innovation helps encourage public engagement, promotes fairer benefit distribution and betterment of social welfare, it will help promote the development of a harmonious society. For instance, environmental innovation could help to optimize the relations between the environment and economy, resolve problems in the field of the environment and health, encourage wider public involvement, and give full play to the role of women in building a harmonious society.

3) Increase Speed Infrastructure Construction and Quality for Optimized Development and Harmonious Society.

In the face of such natural disasters as the snow storm and earthquake in 2008, the foundation for optimized development and harmonious society has proven fairly weak. Such weakness can be found in the relevant mechanisms, urban development patterns, the layout and quality of infrastructure, social security and emergency response. The weaknesses demonstrate that it is urgent for China to shift its growth pattern from quantitative expansion to quality development, and to achieve harmony between people and nature. The infant formula incident served notice that corporate social responsibility should be further stressed. A massive and systematic program is needed to achieve a more balanced development among various social and economic aspects. The foundations for harmonious society should be strengthened, including the moral and cultural basis for scientific development. If environmental factors are built into this more advanced approach to development, the chances for sustainability will be enhanced.

4) Strengthen Rural Environmental Management and Help Improve Overall Environmental Protection in China.

The rural areas of China not only lag behind the cities in terms of economic and social development but also bear the brunt of environmental pollution and ecological damage. The countryside is thus a weak point in environmental protection and the building of a harmonious society. The central government of China is committed to the integrated development of urban and rural areas. In addition to the strategic goal of building a new socialist countryside, a comprehensive rural reform scheme was passed during the 3rd Plenary Session of the 17th Party Congress. Against this backdrop, China should create a bigger role for environmental protection as part of the overall strategic goal of building a new socialist countryside. The environmental priorities of rural areas should include greater attention to rural environmental management systems and capacity building, environmental infrastructure, drinking water safety, soil contamination, indoor air quality management, exploration of an integrated urban-rural environmental management mechanism, and eco-compensation. The eco-compensation policies should be ex-

panded to include climate change mitigation and adaptation needs and damages cost by air pollution. Efforts on these priorities will improve overall environmental protection throughout China.

5) Develop Innovative Environmental Management Systems and Mechanisms Based on the Successful Experiences of Green Olympic Games.

The successful Green Olympic Games has left China with valuable environmental legacies, including hardware such as demonstration projects and infrastructure that help to improve the environment and serve the public, as well as software such as the concept of ecological civilization, improved environmental management, environmental information disclosure and wider public participation. All these may help to bring about deep changes in economic and social development patterns.

In its effort to host a Green Olympic Games, the Chinese government adopted successful measures to promote pollution prevention and control planning, environment-friendly buildings and infrastructure, environmental information disclosure, public participation, commercialization of the innovative technologies employed in the Green Olympics, control of trans-boundary emissions through the establishment of a regional environmental management system, vehicle exhaust pollution control, and phase out heavily polluting enterprises. China should review these successful experiences and develop standardized and long-term mechanisms of environmental management to improve the environmental quality of Beijing and other parts of the country on a continuing basis.

The 2010 Shanghai Expo offers a new opportunity for the implementation of the "Green Olympics" experience and the government of China should integrate more green measures in the planning and implementation of a "Better City; Better Life" Expo.

Also, China urgently needs to control transboundary emissions via regional environmental management systems operating on total emissions control, emissions trading, and with appropriate institutions such as coordinating groups comprised of the relevant provincial governors. The experience of the Olympics in reducing the inflow of pollutants from provinces surrounding Beijing sets a remark-

able precedent of cooperation that deserves to be emulated.

6) Review the Experiences of the Past Three Decades and Continuously Improve the Environmental Management System.

Over the past 30 years, China has tried to keep pace with the international community when dealing with the field of environment and development. In light of its realities, and drawing upon international experiences and expertise, China has developed its own approach with Chinese characteristics to address environmental problems and has made significant progress in creating its environmental management system and, in some locations, in improving environmental quality.

Three decades on, China is now in an important period for strategic transformation of its environment and development relationship. It is now necessary to systematically review the strategic ideas, theories, policies, and managerial practices in the field of environmental protection over the past 30 years. Such a review will not only help to consolidate successes achieved so far and further improve the environmental management system of China, but also will contribute to the international community by sharing the Chinese experience.

The establishment of the Ministry of Environmental Protection in 2008 was a major step forward for the Chinese environmental management system and reflects the commitment of the Chinese government to historical transformation in the environmental field. However, we note that environmental management system reform, perhaps leading to a super environment ministry, likely will be a gradual process. The next step should be further integration of environmental responsibilities of different ministries, which will optimize the central government organization and help raise capacity and efficiency. For the new environmental ministry, current attention should be focused on capacity building and financial resources. Responsibility, power, capacity, and efficiency should be integrated into this super ministry, which can put people first and better serve the general public.

7) Make New Contributions to Global Sustainable Development and the Building of a Harmonious World.

China and the world are mutually dependent. Given the large population and economic output as well as the important role of China in the global environment,

the international community has higher expectations for China on issues like climate change and the financial crisis. China has made tremendous progress in development and now proposes concepts such as ecological civilization and harmonious society. These efforts should make the world more interested in China's ideas and experiences.

Therefore, now is the right time for China to make a more substantive contribution towards global sustainable development and a harmonious world. Stabilizing the financial system, sustaining rapid economic growth, and resolving environmental problems in China are in themselves great contributions to the world. Meanwhile, based upon the principle of common but differentiated responsibility, China should make new contributions to the global fight against climate change and sustainable development; China should also expand its existing environmental international cooperation into cooperation for sustainable development with strengthened cooperation between China and other developing countries.

2. Introduce a national action plan or program for environmental innovation, 2010-2020

China's complicated and unprecedented challenges as it works towards becoming an environment-friendly society open the door to unprecedented innovation opportunities. Yet environmental innovation in China remains at a low level, lags behind innovations in other fields, and falls well short of the needs. There are several reasons for this situation:

1) Pollution clean-up rather than pollution prevention still dominates, and the institutions and mechanisms under which environmental protection and economic growth reinforce each other are yet to be established.

2) Incentives and enforcement actions are still too weak and the command and control approaches still predominate. There is not a mechanism or policy system in place that encourages enterprises to invest spontaneously in environmental innovation.

3) A disconnect exists between research on environmental science and technology and the commercialization of research achievements due to the absence of

technological application research institutes and supporting coordinating mechanisms.

4) Poorly developed technology and a limited system for collecting and publicizing environmental information accounts for low participation by the general public in environmental innovation and decision making.

China identified innovation as a core national strategy and mapped out the "National Innovation Strategy" and the "Mid-to-long-term Plan for Development of Science and Technology in China 2006-2020". While this strategy and plan can produce some of the necessary indigenous research and technological applications for key environmental problems, there is a need for a specific environmental innovation approach that can ensure the sustained and integrated effort necessary to fully capture benefits and opportunities.

Therefore, we recommend:

Introduce a *National Action Plan for Environmental Innovation* 2010-2020 for China. The action plan should define the strategic goals, targets, and measures of environmental innovation of China and address the technological, institutional, social and organizational aspects of innovation. The Action Plan/Program should be supported by key projects and increased investment and consideration should be given as follows:

1) Strengthen Indigenous Innovation Capacity by Setting Up a Special Program for Clean Technology Innovation, National Research Centers for Environmental Innovation, Sectoral Industrial Environment Research Institutes, and a System of Cross-Disciplinary Sustainability Innovation Laboratories.

A *Special Program for Clean Technology Innovation* needs to be introduced and this Program could cover technologies relating to vehicle pollution treatment, clean coal, solar power, wind power, nuclear power, carbon sequestration, energy efficient building, ecological restoration, and clean production. This Special Program would introduce Clean Technology as a major research platform in the same way as other fields such as nanotechnology have been fostered. It should be developed at a level equivalent to China's space program with expectations that it will become an important part of China's future economic growth and exports as well

as a key component of better environmental protection.

The Government of China should collaborate with relevant parties and jointly establish a number of high-level *National Research Centers for Environmental Innovation* in universities and research institutes. These Centers will bridge the gap between basic research institutes and market needs and help introduce, absorb and utilize foreign technology. They should link research-intensive industries and China's most renowned research bodies to establish China as a major player for environmental innovation.

Common environmental problems within specific industrial sectors necessitate the establishment of research institutes for specific energy intensive and heavily polluting industries on a cooperative basis among the government, the industries, and the industry associations.

Considering the ecological and environmental features of different regions in China, the State should collaborate with local governments, business and civil society to establish cross-disciplinary *Sustainability Innovation Laboratories* designed to demonstrate how to live at a high standard with minimum waste in both rural and urban settings. Their focus should be on practical demonstration of what can be done within the context of local social and economic circumstances and environmental conditions.

2) Adopt an Integrated Approach to Address Mechanisms, Institutions and Capacity Development Required for Full Application of Environmental Innovation.

The following requirements need must be met: First, in the field of environmental innovation, the environmental protection authorities should lead the coordination among relevant parties and give full play to the bridging role of industry associations connecting government and industry. Stronger regulatory rules and standards, incentives, and supportive policies should be introduced to help build innovation capacities of the enterprises, especially small and medium sized enterprises.

Second, to foster a market for environmental products, several measures could be taken: Tighten environmental enforcement in order to create a potential demand market; and, where appropriate and for a limited time, subsidize environmental

products used by enterprises and consumers so as to foster dissemination and application of environmental technology. More effective *Green Public Procurement Regulations* which require government agencies to procure a certain percentage of environmentally friendly products will be particularly helpful in creating a sizable market for environmental products. Action should be taken to raise resource and energy prices to expand the demand for environmental products that increase use efficiency.

Third, to considerably increase financial support for environmental innovation activities, *Environmental Innovation Funds* should be established with a focus on a Special Program for Clean Technology and other components important for enhancing indigenous environmental and sustainable development technology innovation. The State should devise a financial supporting plan for environmental innovation and adopt financial measures including venture capital investment, preferential listing policies, green credit, and preferential loans, to support environmental innovation activities.

Fourth, China needs to strengthen IPR protection and international environmental cooperation and to establish an *International Study Network on Environmental Technology* to facilitate learning from abroad and through joint efforts.

Fifth, drawing upon the experiences of OECD countries, China should establish an evaluation system for environmental innovation covering the whole process from R&D to commercialization as well as such aspects as environmental, safety, health and life cycle impacts.

3) Set Up an Improved National Information System for Environmental Quality, Environmental Pollution, and Environmental Science and Technology Knowledge with an Expanded Scope for Information Disclosure in order to Encourage Wider Public Involvement in Environmental Innovation Activities.

While China has made progress in environmental monitoring and public information disclosure, much work remains to be done before a full national environmental information system is in place and functioning. This is a vital component for decision making of government, business, communities and the general public. The system must operate in a very transparent fashion, with regular report-

ing on key environmental problems and environmental performance. Knowledge access should be as direct as possible and at low cost so that people and institutions throughout China can access the information. Information needs to be packaged in ways that permit comparisons and easy understanding.

Improved information access will promote innovation in several ways: knowledge about environmental options will improve sustainable consumption, better public acceptance of new environmental technologies and environmental measures, place pressure on firms and local governments to improve environmental performance, and provide information helpful to environmental innovators, including SMEs.

3. Expedite the establishment of a national management system for environment and health

China is faced with enormous challenges in the field of the environment and human health. First, a large number of its people are exposed to seriously polluted air, water, and soil, which pose huge health risks. Second, because of the absence of systematic research, monitoring and statistics, there is not yet a clear picture of the full magnitude and range of public health risks posed by pollution. Hence it is extremely difficult to identify targeted measures to address the problem. Third, whether or not the economic growth pattern of China changes fundamentally within the near future, environmental pollution will remain a serious problem for a relatively long period of time and this may give rise to more substantial health risks. Fourth, as the living standard increases, the general public will have higher expectations for a good and safe environment. Fifth, China has recently issued the National Action Plan for the Environment and Health 2007-2015, but concrete work under the action plan is yet to be carried out.

International experience illustrates that the mishandling of environmental and health issues could generate complicated social and political problems that result in harm to public health, impaired government credibility, and heavy social and economic costs. China is currently in a critical period of building a harmonious society and consequently the issue of the environment and health should be given highest

attention.

Therefore, we suggest:

On the basis of the National Action Plan for the Environment and Health 2007-2015, that the Government of China should accelerate the development of a national management system for the environment and health as well as an environmental management system based on "putting people first". In order to achieve this goal, efforts should be made in the following six areas:

1) Stick to Prevention as the Main Approach and Take Effective Measures to Reduce Environment and Health Risks.

A risk prevention system can be established by improving the environmental standards system, introducing a list of priority pollutants, and enforcing stricter control of environmental access by harmful substances. The monitoring network for the environment and health should be strengthened, especially in the field of health impact monitoring relevant to human exposure. The government also should gradually set up an early warning system for environment and health that will help to predict potential environment and health risks and will eradicate or reduce health damage by pollution.

2) The Government Must Bear the Main Responsibility of Environment and Health Issues. The Government Therefore Should Strengthen its Leadership in the Management System while Encouraging Extensive Public Participation.

Coordination mechanism between the relevant ministries should be strengthened. This could be realized through establishment of a national environment and health administrative coordination mechanism that is under the leadership of the State Council with participation by different ministries. Assessing government performance to ensure laws and regulations are properly implemented is also necessary. Based on their respective responsibilities, the environment and health authorities should allocate sufficient staff and resources to establish specialized administrative system for managing environment and health issues.

3) Establish and Strengthen Legislation for Environment and Health Based on the Polluter Pays Principle.

Legislation should address prevention, enforcement and environmental rights

of the Chinese public. A dispute settlement mechanism should be created to help concerned parties reach reconciliation over environment and health disputes through mediation, administrative settlement, arbitration, and litigation. The government also should gradually introduce a compensation system for human health damage by pollution so as to protect the environmental rights of the general public.

Improved coordination is needed between central and local authorities so that environmental health issues can be reported and assessed in a timely manner, with more effective action taken.

4) Increase Financial Investment in Capacity Building for Environment and Health Management, Research, and Compensation.

The central and local governments should increase their financial support for capacity building and basic research in the field of the environment and health. An *Environment and Health Fund* could be established for to help compensate victims of historical environmental problems, for when the responsible party has no civil compensation capability, and for when it is hard to identify who should be responsible. The Fund could help victims during their recovery and support education and communications activities. Multi-sourced funding should be sought.

5) Improve Disclosure and Access to Environment and Health Information and Encourage Public Participation.

The government should make public environment and health information available through accessible and comprehensible tools, such as government websites and the mass media. Prevention requires information on risks to be effective. The Government of China should launch a public access data base of pollutants and health risks. The government also should improve the public complaint mechanism and public announcement system, and create smooth channels for the public to participate in environment and health management. Supervision by the general public, social organizations, and the mass media should be strengthened and the reporting of environment and health violations should be encouraged. Various kinds of hearings and consultation meetings should be held to hear the voices of the public and relevant stakeholders on environment and health issues.

6) Undertake Targeted Intervention Measures to Address Prominent Problems

in the Field of the Environment and Health.

Where pollution has already caused harm to human health or induced diseases, action to reduce harm and risk needs to occur quickly and health intervention or medical care should be provided routinely to the victims. For the pollutants proved potentially dangerous to human health, the government should issue a catalogue of such pollutants as well as a relevant risk evaluation system, environmental access standards, and identification criteria. Such pre-intervention measures and health impact monitoring will help eradicate or reduce health risks caused by pollution. For other environmental factors with unclear health impact, China should increase research and adopt preventative measures.

CCICED Policy Recommendations Submitted to the Government of China

(2009)

The Third Annual General Meeting of the Phase Ⅳ of the China Council for International Cooperation on Environment and Development (CCICED) took place on 11-13 November 2009 in Beijing with the theme of "Energy, Environment and Development".

The CCICED members warmly recognize the 60th anniversary of the People's Republic of China. This 60-year period represents a historical shift for new China, especially over the past 30 years of reform and opening—from poverty towards being well-off, from backwardness to prosperity, and from a closed society to integration into globalization. We note in particular and congratulate China on its major transformation towards human-centred and sustainable development strategies based on scientific development and harmonious approaches. We strongly encourage China to continue promoting its strategic transformation of environment and development, in order to achieve and sustain green prosperity as the basis of China's future development. While there still is a long way to go in exploring a new path for environmental protection with its own Chinese-characteristics, the results will strengthen China's admirable progress towards elimination of poverty, its commitment to build an environment-friendly society, and, indeed, towards defining in real terms the nature of ecological civilization. In the process China can contribute to solving global environmental concerns, including climate change.

CCICED appreciates the Chinese Government's efforts to address impacts arising from the global financial crisis. We applaud China for its continued progress in difficult times towards meeting 11th Five-Year Plan energy conservation and pollution reduction targets, and for highlighting green growth as a new approach. CCICED members recognize that now is the key time to design an environment and

development strategy for the 12th Five-Year Plan. It is a critical testing period for China's sustained energy-saving and emission reduction efforts, and an important time to incorporate green economy including low carbon economy into the national development plan. Otherwise, China will be at risk of losing achievements of the 11th Five-Year Plan and of losing new growth opportunities.

We see a future in which it is necessary to address multiple crises involving the economy, energy, environment and climate change, and possibly other matters. Historical and practical experience has shown that the impacts of global financial crisis may be temporary. But the climate, energy and environmental crisis will present a significant and growing threat to the sustainable development of humankind and the globe's biodiversity and ecosystems—requiring global cooperation and common effort. The Council appreciates the new measures and targets put forward by the Government of China to address climate change; recognizes the gradually enhanced leadership of China's government in global affairs; and will pay close attention to the outcome of climate change negotiations in Copenhagen.

During the 2009 AGM, CCICED examined the findings and recommendations of five Task Forces covering key energy and environment issues including: low carbon economy, sustainable use of coal, urban energy efficiency, rural energy and environment, and economic instruments for energy efficiency and the environment. Based on these studies and further inputs at the AGM, seven policy recommendations are presented to the State Council. More detailed information on many of the recommendations is available in the individual Task Force reports.

1. Develop a green economy and speed up green transformation of economic development

The current times provide a historic transformative opportunity to build a more satisfactory economy and environment relationship. Green growth and green economy are new global initiatives in the process of responding to the financial crisis and important components of the G20 consensus for economic recovery. Within China

green growth should lead to a prosperous future economy consistent with the needs of the resource-saving and environment-friendly society called for by the Government of China. This new pattern of growth has implications for China's new emphasis on stimulating domestic consumption and for China's emphasis on higher value-added exports in future trade relationships. Furthermore, green growth is likely to be a more effective means to address multiple crises of the future including those involving energy, environment and climate change, and an important step towards the aspiration of an ecological civilization.

Therefore, we recommend:

From the perspectives of scientific development, ecological civilization and strategic consideration for long-term global competitiveness, China should consider green economy as an important approach to promote transformation of its economic development mode, and should develop a national strategy for green economic development as soon as possible. While striving for a Low Carbon Economy that will address many energy and environment concerns, China should also take actions in the following six areas to promote a green economy:

1) Strengthen the promotion of Circular Economy to increase resource efficiency. Circular Economy practices support green economy development by creating new wealth and resources through improved recycling and efficiency improvement, via the "Reduce, Reuse and Recycle" principles. China has many successful pilot demonstrations and substantial commercial experiences. Yet most sectors and rural areas are far from being eco-efficient in either use of energy or environmental resources when judged by international benchmarks. China should fully implement its Circular Economy Promotion Law that became effective this year, establish and improve relevant policy and regulations, and promote circular economy in all sectors.

2) Increase R&D investment for advanced green technology, develop green industries and foster new green growth opportunities. China should substantially increase its investment in R&D and industries for energy-saving, renewable energy, clean energy, environmental industries, urban public transport, building energy, ecosystem protection and restoration, environmental infrastructure and waste recycling, and make

green growth a key part of China’s industrial and economic development strategies.

3) Strengthen industrial restructuring to promote eco-reform of traditional industries. A key element of energy-saving and emission reduction tasks of China’s 11th Five-Year Plan is to phase out backward production capacity with high resource and energy consumption and high pollution emissions. So far, some industries, e.g., iron and steel, have already achieved this objective ahead of time schedule. Investment from the national stimulus package for tertiary industry and infrastructure in central and western regions has been significantly increased. However, there is still a large proportion of backward production capacity and overcapacity in China’s industrial base, hence substantial risk and pressure for rebound of overproduction that could result in greater environmental deterioration. China should seize this historic time of economic stimulus as an opportunity to incorporate environmental considerations into its transformation of traditional industries and industrial restructuring. This could be done through stringent environmental admission standards and permits to operate, pollution emission standards and management instruments, and by speeding up green transformation of all major industrial sectors. In particular, in its adjustment and revitalization plans for key industries China should further increase requirements for environmental protection, resource and energy efficiency; strengthen the phase-out of environment-inefficient production capacity; and strengthen the green transformation of industrial structure.

4) Develop rural green economy through environmental improvement of mainstream farming methods; introducing ecological and organic farming, low-carbon farming; and by improved management of ecosystem services. The unbalanced development between urban and rural areas includes not only income and development level disparity, but also differences in environmental quality, climate change adaptation capacity, as well as quality of life. In the development of green economy strategy and practice, China should pursue integrated rural and urban green development and avoid deepening rural and urban differences. Green economy development in rural areas should integrate low carbon pursuit into traditional ecological farming and organic farming, strengthen the management of land utilization, ecosystem services and biodiversity conservation, promote rural eco-

nomic development and create jobs while reducing pollution discharge and greenhouse gas emissions.

5) Advocate sustainable consumption and low-carbon lifestyle, enhance the role of the public and NGOs in green economic development. Recognizing the significant role of citizens and their consumption patterns in promoting green economy, it is important to raise public awareness for individual consumers and households, commercial enterprises, and industries – through resource-saving, low carbon, and environmental protection messages and action. Messages should emphasize modest levels of individual and household consumption that take into account embedded energy, high efficiency and low carbon; and certification regarding sustainability, low carbon criteria, and environmentally-sound production for both goods and services. China should promote green procurement by government agencies at all levels, strengthen its legal basis, disclose relevant information, and encourage the role of NGOs in the communication and technical aspects of green consumption, and in green economy development. China should continue its 2008 "Green Olympics" experience. The 2010 Shanghai Expo, with its "Better City Better Life" theme and with more than 70 million visitors expected, offers an unprecedented opportunity to promote a low carbon lifestyle and build low carbon cities.

6) Strengthen international cooperation and promote green economic development. Green development represents an emerging international consensus and follow-up sustainable development action concerning multiple crises including effects of this past year's financial tsunami and the challenges of climate change. It requires globally-coordinated efforts, with close cooperation between different countries and more joint efforts. The development of green economy needs to be built upon fair, equitable, orderly and free global trade practices, taking steps to avoid anti-trade protectionism, and expanding the number and value of environment and climate-friendly technology transfer arrangements. With enhanced overall capacity and increased sustainable development practical experience, China should play an increasingly important role in promoting global green development and in dealing with environmental challenges.

2. Develop Low Carbon Economy with consideration of both international and national contexts

Low Carbon Economy (LCE) is now seen by international society to be a fundamental approach and important trend for addressing climate change. LCE also can become an important driver for China to align its economic development mode with energy and environment considerations. The essence of low carbon economy is to adjust energy structure in production and consumption, decrease the use of fossil fuel, develop renewable energy, increase energy efficiency, lower carbon emissions, and decouple economic growth from emissions of greenhouse gases (GHG) and other pollutants. Ultimately LCE must be designed to secure the realization of various key development objectives such as long-term sustainable economic growth, new employment opportunities, technological innovation and many other objectives. LCE needs to take into account impacts on, and provide benefits to vulnerable groups within society. Advocating and developing a Low Carbon Economy will be useful for China’s overall efforts to control and reduce GHG emissions, to foster industrial and energy structural adjustment, and to pursue a new path for industrialization with low energy consumption, low GHG emissions and low pollution.

Therefore, we recommend:

Based on both the international and national contexts, China should develop a national Low Carbon Economic Development Plan as soon as possible including strategic objectives, specific tasks and measures. Low carbon pilot demonstrations should be initiated within key industrial sectors and within selected urban and rural locations. Low Carbon Economy lifestyles and opportunities should be promoted widely to China’s citizens.

1) Identify the strategic objectives of Low Carbon Economy. LCE in China should start with promotion of energy saving and energy efficiency, optimization of energy structure, development of low carbon energy and increase of carbon productivity. According to the overall objective of significant reductions of carbon intensity by 2020 over the 2005 baseline, China should establish a clear quantified target for low carbon economic development and strive for at least an annual

4%-5% reduction of carbon emission per GDP. The national target will need to be disaggregated on the basis of regional and sectoral characteristics.

2) Develop and implement operational policy mechanisms. In order to achieve the objectives of low carbon economic development, China should focus on the reform and improvement of the following policies and approaches, based on market mechanisms, technical innovation, and institution-building: (1) implement continued reform of energy pricing; (2) increase investment oriented towards a low carbon economy; (3) consider introduction of a carbon tax when the time is right; (4) study and establish a voluntary carbon emission trading system to promote low carbon finance, technology transfer, and low carbon economy development through market mechanisms; (5) promote low carbon technology innovation and application within China's industrial base and pay special attention to the training of professionals; (6) incorporate low carbon development into urban and rural planning, and into planning for all major transportation systems including road, rail, air and sea shipping; (7) initiate LCE pilot efforts; and (8) improve the energy statistical system by introducing carbon emission statistics.

3) Optimize energy structure and develop low carbon energy sources. China should pay close attention to development of strategic objectives for intensive, clean and high-efficient use of coal. Depending on costs of carbon capture and storage, as well as emission reduction, the proportion of coal in total energy consumption can be gradually lowered from the current 70% to 55%, 50% and less than 33% in 2020, 2030, and 2050 respectively. China also should vigorously develop low carbon energy sources, especially wind and nuclear power, and promote the commercialization of solar photovoltaic power generation, in order to achieve a full-scale, industrialized and commercialized low carbon energy mix by 2020. China should actively promote the building of nuclear power plants, which play an important role in controlling greenhouse gases emission and fighting global warming. Since safety is the ultimate condition of nuclear development, China should substantially enhance the capacity building of nuclear power plant safety supervision, thus ensuring safe, consistent, and healthy development of nuclear power plants.

4) Establish an industrial system featuring low carbon emissions. In order to achieve this outcome, the following priorities should be considered: speed up industrial restructuring and upgrading; increase comprehensive utilization of resources and promote lower energy consumption and emissions; promote application of advanced mature technologies and develop advanced low carbon technology to increase energy efficiency; build up a support system for low carbon technology innovation, and improve the legal framework and other enabling mechanisms.

5) Analyze the possible impacts on China's trade and economy of a climate change "border adjustment tax" and consider how implementation of low carbon economy initiatives might ease this threat.

3. Implement a national strategy for sustainable use of coal

With an energy supply and consumption structure dominated by coal, plus rapid increase of energy demand, it is not surprising that China's environment has suffered severe air pollution and ecological damage, and presented great challenges to GHG emissions reduction. Currently, China has already promulgated national plans to speed up energy structural adjustment and to increase the proportion of renewable energy in total energy production and consumption. However, in the next 20 to 30 years, coal will still be a dominant energy source taking a leading role in the energy mix for China. The safety, efficiency and cleanness of coal exploitation and utilization are major issues for China to address in an urgent and comprehensive fashion. It is possible to speak of sustainable utilization of coal if these issues are solved satisfactorily.

Therefore, we recommend:

While ensuring national energy security and environmental protection, China should develop and implement a strategy for safe, highly-efficient and clean national coal exploitation and utilization in order to provide a long-term, stable energy foundation for green economic development.

1) Further emphasize the strategic role of coal in the national mid- to long-term energy strategy, and speed up the development of a new national coal

strategy focused on sustainable use of coal. The development and revision of a new national coal strategy should plan for the safe, highly-efficient and clean utilization of coal based on the full life cycle of coal mining, transportation, final use, emissions and waste processing considerations; enhance the control and reduction of GHG emissions; control of the total coal consumption according to environmental and other criteria, and strengthen the supervision by central government.

2) Improve governance of the Chinese coal value chain. The Chinese government should strengthen responsibilities and mandate of relevant agencies, improve coordination mechanisms to improve sustainability of the Chinese coal industry by: (1) coordinating the actions and policies of the various government agencies dealing with China's coal value chain; (2) integrating the planning, investment and operation of the production, transportation and utilization phases of the coal industry within the overarching framework of a national energy policy that incorporates energy supply security, economic, environmental and social objectives. A critical aspect of this governance function is the emphasis on an integrated energy system policy that facilitates and provides incentives for the optimal development of mine sites, power plants, transmission lines and "smart" electrical grids and energy delivery systems, railways, coal ports, and facilities for CO_2 capture and storage.

3) Promote green mining. A combination of technical, legal and economic policy instruments should be used to promote green mining, to minimize ecological and biodiversity damage, and to restore affected environmental conditions. There are 6 main areas to be covered: (1) concurrent mining and reclamation, particularly in the areas rich in both coal resources and food production; (2) minimization of mined-land subsidence and improvement of management; (3) water resource conservation and aquifer protection; (4) environmentally sound mining waste utilization and treatment; (5) improved risk management and ecosystem protection; and (6) safe mine closure and site restoration. China should broadly implement a payment system for coal mining rights, and fully collect the one-time charge for this right; speed up the reform of coal mine resource tax policy; changing from a specific tax to a compound tax, or move to a totally ad valorem tax levy, and increase the levy limit; es-

tablish an ecological compensation system for coal mining, and implement a damage restoration deposit system for environmental management.

The “one ballot veto” rule should be strictly applied in cases where proposed coal projects would not comply with environmental laws and regulations—meaning that projects are not able to circumvent the permitting process. The implementation of strategic environmental assessment needs to be strengthened in all coal mining areas but especially in ecologically vulnerable coal producing regions such as Shanxi, Shaanxi, Inner Mongolia and Ningxia.

4) Develop a sound strategy for coal-fired power generation, with intensive, highly-efficient and clean use of coal. China should control growth rates of coal use to stay within environmentally sound and safe limits, and gradually reduce the proportion of coal in total energy consumption. Efforts should be accelerated for the development and adoption of advanced coal-fired power generation technology (e.g., ultra-superc-ritical and IGCC) to reduce coal consumption in power generation and to increase conversion efficiency to the highest international standards; promote technology and management for combined power, heat and cooling systems to increase the comprehensive utilization of coal resources in urban areas; optimize generator capacity structure to minimize efficiency loss during operation; promote price linkage of coal and electricity to regulate future power and coal supply/demand at the national level.

5) Improve and enforce standards associated with processing and use of coal. Additional attention to environmental management is required along the entire coal value chain. Key areas for improvement of standards include: coal mine closure and land-subsidence management and land and water contamination, proper recovery and use of fly ash and gangue, and other valuable byproducts; coal washing in relation to thermal coal specifications; extension of existing emissions standards in power plants to include mercury, and volatile organic compounds (VOCs). As well there is a need to establish local carrying capacity assessments that may lead to restrictions on coal mining or use based on water conditions, and to set out regional caps on air pollutants.

6) In heavily polluting situations, and based on the requirement of total emission control, establish pilot efforts for regional controls on total coal consumption, and strengthen pollution supervision for coal-fired power plants. China should develop coal consumption assessment standards based on regional environmental capacity, and implement total allowable coal consumption adjustment based on the requirement of total emission control in areas with significant air pollution, such as the Yangtze River Delta, Pearl River Delta and Beijing-Tianjin-Hebei region; implement simultaneous control of multiple pollutants, based on establishing systematic and scientific air quality standards and emission standards; develop a national clean air action plan, focusing on main issues in the next 20-30 years such as urban air quality, combined air pollution, regional air pollution and GHG emissions, etc.; strengthen enforcement of desulphurization in coal-fired power plants, and promote application of denitrification technology and improve emission standards; further reform and improve the pollution fee system and environmental subsidies for the price of electrical power; implement a user pay system based on emission indicators, and initiate an emissions trading pilot scheme for the power sector.

7) Encourage technical innovation and promote technologies related to the sustainable use of coal. Actively promote technologies related to green mining and clean coal technologies. Develop CO_2 capture, utilization and storage (CCUS) technology suitable to China's situation and needs. Strengthen international cooperation for joint development of technologies and for transfer of technologies; and develop demonstration technology suitable to China's situation of widespread coal availability and use.

4. Take more innovative approaches to address the key energy and environment issues in urban development

Urbanization in China is occurring at a far more rapid pace as well as in total numbers of people, by comparison to any other country in history. The rising total demand for energy use by urban dwellers will shift the balance, currently dominated by industrial use. From future sustainable development perspectives, it is impossible for China to follow the urbanization process of those developed countries which feature high energy consumption and high pollution. The huge popula-

tion migration of people from rural to urban areas plus limited resources, energy and environmental capacity will become bottlenecks to future urban and rural development in China unless per capita demand is kept to relatively modest levels. Therefore, in the next 10 to 20 years, the energy, environmental and climate change challenges related to urbanization will be major concerns in China's social and economic development. The current urbanization process in China has demonstrated that very rapid energy consumption increase and consequent environmental quality damage can reduce the quality of urban life. New innovative ideas and policies are needed to convert the present energy-intensive, pollution-intensive and carbon-intensive development path to sustainable development.

Therefore, we recommend:

China should thoroughly assess its urbanization policies of the past 30 years, and identify an overall strategy for a new road of urbanization based on lower energy growth and carbon emissions, and on overall higher environmental and social quality of life. The new urbanization road should focus on improvements to the key areas of rapid energy consumption increase such as urban buildings and construction, transport and livelihood energy demands, urban consumer behavior and lifestyle, urban climate change awareness, and strengthened policies to facilitate sustainable urban development throughout China.

1) Revise the current urban energy statistics system and establish a dedicated urban energy consumption statistics system with emphasis on energy consumption, especially the potential of energy saving from daily life activities as the key focus of urban energy saving. Urban energy consumption should be evaluated mostly based on actual rather than theoretical building energy consumption and daily commuting energy consumption.

2) Reduce the scale and rate of urban construction and improve building qualities. In the future, per capita floor space (home, public building and commercial building combined) should not exceed 40 m^2. Given the current rate of development, this target will be met in about 5-10 years, instead of the original 25-30 years plan. It is recommended that the governments at various levels should tighten up the approval of new projects and establish strict control of total allowable construction volumes. In addition,

it is also recommended that a property tax system should be implemented soon to manage irrational demand within the housing market. It is also important to establish sound demolition and management decrees for existing buildings.

3) Explore a new road for urbanization by designating low carbon cities. Cities need a more compact mode for urban development. This should be incorporated into urban planning throughout the country. China should properly increase density of population within its cities, develop city groups, city belt or city functional groups on the basis on mega-cities or central cities, and optimize distribution of specialized functions; identify urbanization strategy focusing on large cities; speed up development and implementation of national city/township system plans and land use plans; conduct pilot projects on low carbon and low pollution cities with lower energy consumption.

4) Develop energy efficiency policy for urban construction, promote energy-saving technology and standards, and construct "low energy and carbon buildings". China should gradually establish building energy efficiency standards for different regions and different types of buildings and, on this basis evaluate the energy consumption of buildings, decide on subsidies, support for individual technologies, and renovation for existing high energy consumption buildings; encourage developers and consumers to develop and purchase "low energy" and "low carbon buildings" through fiscal policy incentives; initiate low energy and carbon building pilot efforts; strengthen urban energy consumption supervision and audits; adopt certification for energy-saving products; improve efficiency of urban heat supply; and encourage utilization of new energy sources.

5) Deepen reform of district heating networks in northern China and significantly reduce heating energy consumption. Dispatch adjustment, increased insulation and combined heating and power (CHP) plants are some of the best solutions for efficient urban building heating in northern China. They offer the potential of 30 to 50 percent energy savings. To encourage CHP development, the current district heating system must be reformed and district heating companies should have management of the secondary network for delivery to consumers, while the primary network is under control of the CHP plant. Pricing would be established by elimination of the connection fees in

favour of charges by the secondary network management, which would have to demonstrate good services.

6) Make mass transportation and non-motorized transportation (NMT) a national strategic priority. A number of steps are recommended: intensify development of urban public transport, and increase share of public transport and control of unlimited growth of private cars; speed up rail transport and inter-city high-speed railway (cities with more than 2 million population should be encouraged to develop urban rail transport); promote vehicle fuel efficiency through mandatory fuel efficiency standards, and develop low carbon vehicles such as hybrid vehicle, electric vehicles; plan, construct and improve bicycle and walking pathways; develop enabling legislation and improve funding mechanisms, including a dedicated public transportation fund, to guarantee public transportation as a matter of the highest priority.

5. Strengthen policies for energy and environment in rural development including greater attention to climate change adaptation

China’s large, scattered rural population—and varying natural conditions and level of economic development—make energy issues even more complicated in the countryside than in urban areas. Since the reform and opening-up, China’s rural economy has been developing rapidly, and that development has brought significant challenges in energy use and climate change. First, total rural energy use has rapidly increased from 560 million tons of coal equivalent (MTCE) in 1995 to 730 MTCE in 2007 with an annual increase of 2.3%. In 2007, commercially produced energy only accounted for 23.2%; total rural household energy consumption was 350 MTCE. Straw and firewood accounted for the majority of non-commercially produced energy at 60% and 35%. In 2007, rural per capital energy consumption was 1.7 times that of urban levels but household energy consumption was only 40% of the urban levels. Second, environmental problems are getting more serious than before: from 1980 to 2004, total SO_2 emissions and CO_2 emissions from coal consumption increased about 4 times, and biomass and wood became a major source of indoor pollution. Finally, rural communities and resource

users are very vulnerable to climate change impacts. In the meantime, from land use and forest perspectives, rural areas also hold the largest potential of carbon sequestration.

Therefore, we recommend:

The China Government should integrate rural energy and environmental issues into the strategic task of Building the New Countryside, strengthen management and adopt comprehensive strategies, develop clean and renewable energy sources in the rural areas and establish a comprehensive rural renewable energy service system and develop low-carbon and highly efficient agriculture; and pay attention to the policy measures on climate change adaptation for rural areas.

1) Increase the role of rural energy development in the national energy strategy and national climate strategy. China should speed up the upgrading of rural electrical grids and increase efficiency of rural energy use; strengthen the development of energy-saving technology and new energy technology/products suitable for various rural regions; determine how to establish national rural energy financing mechanisms to promote sustainable energy construction in rural areas; improve rural renewable energy development plans and relevant regulations; develop rural biomass energy subject to local conditions; incorporate rural biomass facility, especially large or medium-scale methane facility, into national rural infrastructure plans; and meanwhile, strengthen rural environmental improvement to reduce health risks such as those associated with burning of coal for cooking and heating in homes.

2) Adopt integrated measures to stimulate the development of clean and renewable energy sources. Growing rural use of commercial energy sources such as coal, petroleum products, and electricity results in significant pollution and GHG emissions. Developing clean and renewable energy sources such as biogas (marsh gas) and biomass for electricity generation could help relieve gaps between energy supply and demand, curb pollution, increase farmers' income, and control GHG emissions.

First, a rural renewable energy strategy and related laws and regulations are necessary both to improve the rural environment and to tackle climate change.

Second, the government should promote renewable energy technologies to bring them into widespread rural use. The government could do so by expanding its own investment in modern biomass facilities, and by providing subsidies and tax incentives to encourage private capital to invest in R&D for rural renewable energy technology. Only with government guid-ance can China fulfill the goal of fully commercializing its extensive renewable energy resources. A Rural Energy Construction Fund could promote sustainable energy development, while "transfer payments" could subsidize electricity use among farmers.

Third, China should spur the rural use of biogas by integrating the construction of biogas facilities into efforts to rebuild rural infrastructure, and to set up market mechanisms in support of biogas development.

Fourth, China should expand the use of renewable energy sources to provide heat and electricity for rural buildings. Rural buildings already account for a large proportion of energy use in China, and the amount of energy they consume is rising fast. Thus, it is important to strengthen the monitoring and evaluation of energy conservation technologies, subsidies, and the promotion of energy saving materials under the rural building energy saving policies. Greater reliance on renewable technologies to heat rural buildings can help to conserve energy. To promote that goal, it is now appropriate to scale up activities such as the use of solar and shallow geothermal technologies in rural buildings as part of the modernization of the Chinese countryside.

3) Optimize land use to increase carbon sequestration potential and support the development of high quality low carbon, low pollution agriculture; introduce a new rural carbon sequestration compensation mechanism, with provision for fiscal transfers and possibly for international financial transfer mechanisms. China should maintain and increase forest, farmland and grassland carbon sequestration, and promote these GHG-reducing practices to a wider audience. The practices include afforestation, improved protection of natural ecosystems, low-till or no-till farming, improved grassland management, alternative varieties of animals and fodder, and more efficient use of fertilizer. The government should establish consulting services at all levels to ensure that farmers have access to energy-saving technologies and in-

formation on low carbon farming. The government should provide subsidies, insurance, and credits to advance these goals, especially in areas with fragile ecosystems and large numbers of farmers. A program that enables farmers to obtain credits for reducing GHG emissions through changes in production practices, and that markets and trades those credits, could achieve the dual goals of removing CO_2 from the atmosphere and providing new income sources to farmers and land managers. A low-emission, high-efficiency, recycling agricultural industry will help China reduce both pollutants and rural GHG emissions. Many good practices are available in China now. China should rely on a comprehensive, long-term strategy based on local circumstances to develop low pollution, low carbon high quality agriculture and to protect natural ecosystems, with subsidies to encourage investment in new technology and management approaches. National voluntary carbon trading mechanisms, and payments to impoverished farmers for reducing pollutants and GHG emissions are a cost-effective way to promote low pollution and low carbon practices while also contributing to the goal of alleviating poverty.

4) Improve the capacity of farmers and rural regions to adapt to climate change. Enhancing farmers' ability to adapt to climate change is essential in order to sustain the rural economy, improve rural living standards, protect ecological services and biodiversity, and ensure food security. Towards these ends: (1) China should evaluate the speed and scale of potential disasters, with systems for monitoring regional climate change, and early warning systems; (2) authorities at all levels need to consider adaptation to climate change when creating development strategies, and bolster community-based disaster prevention and training; (3) China will need to adjust the structure of the nation's agricultural production and consumption; (4) China should import agricultural products with high resource input values in order to ensure self-sufficient supply of other foods and to relieve pressure on domestic resources and the environment; (5) as part of its climate change strategy, China should pay greater attention to the protection of biodiversity, including preservation of genetic material in national and international gene banks.

5) Enhance the statistical analysis of rural energy use. To ensure that rural energy becomes an integral part of China’s energy system, authorities need to strengthen their statistical analysis of rural energy end-use by both households and producers. First, authorities need to unify the definition of rural production, to ensure that statistics reflect actual energy use of township enterprises. Second, national officials need to bolster the ability of county governments to organize and manage energy statistics. Agricultural Bureaus, Forestry Bureaus, and other industry bureaus should then calculate and report statistics on local energy consumption under the guidance and organization of local statistics bureaus. The National Statistics Bureau can collect, check, and issue the overall results, to ensure the authority and authenticity of the nation’s rural energy statistics.

6. Reform and improve economic instrument policies for increasing the capacity of energy efficiency and for environmental management

For China, reducing the total amount of energy consumption and improving energy structure is a fundamental solution to balance energy and environment, but this will be a long and challenging process. Therefore, China should consider increasing energy efficiency as a priority task. International experience has shown that increasing the price of energy is a very important way to improve energy productivity, and that energy taxes are an effective way to increase energy prices. Pricing policy provides long-term incentives for limiting energy demand, promoting technical innovation and increasing energy efficiency. Environmental taxes are a significant economic tool and long-term incentive to protect the environment. Therefore, launching environmental tax reform will not only help to meet daunting environmental challenges but also help to better cope with climate change, develop a Low Carbon Economy, and improve the quality of China’s economic growth. Also, the currently implemented Green Credit policy is a useful test for encouraging pollution control and energy efficiency through economic instruments. It reflects the concept of extending the economic incentives from end-of-pipe treatment to source prevention, and it already has achieved obvious progress. However, there

are still many inadequacies in current Green Credit policies which affect the full effectiveness of policies and need further improvement. Furthermore, China is experiencing a period of frequent environmental pollution incidents. Yet there is a lack of policy concerning insurance for environmental remediation, responsibility and compensation.

Therefore, we recommend:

China should consider setting a substantial increase in energy productivity as a national target; reform and improve policies of pricing, energy and environment-related taxation and Green Credit; and establish an insurance system for environmental damage and pollution liability.

1) Increase energy price as a long-term incentive to improve energy productivity. China should adopt a long-term, phased strategy to raise energy price continuously but in small steps, in line with the increase of the national energy productivity increase of the previous year, while disclosing relevant pricing information far enough ahead of time so that businesses and individuals can be properly prepared. The soft signaling effect of the announcement of these increases is crucial for triggering investments and changes of behavior, because this approach awards efficiency gains immediately. Energy pricing needs to be linked carefully with environmental tax reform in order to maximize its potential for energy and environment benefits, for example in the case of a carbon tax.

2) Implement environmental tax system reform with a focus on improving existing environmental taxes and establishing new ones. China should speed up the implementation of environmental tax system reform in order to remedy the inadequacy of the present environmental tax and fee system and to create a smooth introduction of new environmental taxes, restructure existing tax categories and improve relevant policies involving economic instruments. Wastewater, air pollutants, solid waste and CO_2 should be among the first items addressed by environmental taxes. The reform and development of an environmental tax system should follow a step-by-step approach, with immediate study on stand-alone new environment taxes, improvement of other environment-related tax categories, and consideration of relevant environmental tax policies. The approach should be to "do the easy

ones first, hard ones last”.

3) Improve and strengthen Green Credit policy and fully utilize the role of financial institutions in environmental protection and energy-saving. China should strengthen the use of Green Credit to regulate investment and industrial behaviors, speed up the promulgation of robust policy for Green Credit to limit high energy consumption and high pollution projects; carry out market reform for energy-saving and emission reduction fund management and use; establish a national guarantee mechanism for energy-saving and emission reduction credits, and provide interest subsidies for key projects; direct and standardize Chinese enterprises' overseas investment through Green Credit policies; develop Green Credit policies to support medium and small-scale enterprises in their efforts for environmentally sound business development and practices; and establish an open and transparent mechanism for Green Credit implementation supervision and information disclosure.

4) Establish and improve environmental pollution responsibility insurance regulations and policy system. China should identify in relevant laws and regulations the principle of liability for environmental damage responsibility along the lines of “the responsible party pays”, and determine the content of environmental pollution responsibility insurance; develop relevant standards and guidelines, including pollution damage compensation standards, environmental risk assessment criteria, contaminated site remediation standards and guidelines, etc.; regulate the stakeholders in the market of environmental pollution responsibility insurance; carry out pilot efforts to study the need for supporting laws and regulations for pollution responsibility insurance and compensation procedures; improve supervision mechanisms for this industry and establish technical support institutions.

7. Develop a green 12th Five-Year National Economy and Social Development Plan

From the perspective of transformative economic restructuring, environment and energy, scientific development and ecological civilization, the 12th Five-Year Plan period (2011 to 2015) is very important for China, especially in setting the stage

for achieving its 2020 national strategic objectives. China will still remain strong in its industrialization process during the 12th Five-Year Plan period. The weakness of traditional industrial modes will be more evident. Environmental problems in both urban and rural development will stand out. Further stimulus of domestic consumption needs to be set into a sustainable consumption mode of development. Internationally, the global economic restructuring as a result of financial crisis will have some obvious impacts on China. And the global trends towards green growth, addressing climate change, and other matters such as resource and energy prices may affect China's outlook on trade and environment. In summary, compared with 11th Five-Year Plan period, there will be significant changes of both national and international context.

Therefore, we recommend:

Preparations for the 12th Five-Year Plan should give attention to strengthening China's capacity for sustainable development including incorporation of green economy including Low Carbon Economy as a key element of the Plan; promotion of green growth and future prosperity based on transformative environmental protection, energy efficiency and innovation as strategic priorities; laying down a solid foundation for a quick development mode change involving a new path of industrialization and urbanization; climate change adaptation and ecosystem protection in rural areas; and adaptation to the new round of global economic restructuring featuring green economy.

1) Continue the mandatory targets for environmental protection and energy efficiency. Based on the 11th Five-Year Plan experience, China should continue to adopt mandatory targets for energy-saving and emission reduction as important tools to protect environment and increase energy efficiency; expand emission reduction to other pollutants, such as NO_x and heavy metals with major impact on environment and human health, and further raise the fuel economy standards of vehicles; develop carbon intensity indicators per unit of GDP as mandatory targets to control GHG emission. Models suggest that with some effort China can achieve at least a 20% carbon emission per unit GDP during the 12th Five-Year Plan.

2) Incorporate the green economy concept in the 12th Five-Year Plan as a

means to achieve sustainable development objectives. China should consider strengthening environmental management, increasing energy efficiency and addressing global climate change and adaptation as basic tasks for 12th Five-Year Plan development and implementation; expand the scale of Circular Economy; promote pilot efforts for Low Carbon Economy and other measures for addressing climate change, including industrial development, building construction, and information and communication systems characterized by low carbon emissions; improve green investment and development of environmental industries; facilitate structural changes and environmental upgrading of traditional industries; develop green economy in the rural areas; promote low-carbon lifestyle and sustainable consumption in urban and rural areas; and expand the scope and scale of public green procurement.

3) Strengthen and improve energy and environmental technical innovation and supporting system, increase national investment in R&D, enhance safety supervision of nuclear power plants. China should accelerate the pace of acceptance, diffusion and commercialization of innovation technologies related to energy efficiency and to Low Carbon Economy. This requires building a stronger supporting system for energy and environment innovation. A national new energy research institution should be established with the intention of making it open to universities, business and other research organizations in order to create common platforms of energy technology, energy conservation and environmental protection. This research institution should have the ability to conduct basic research, technology development, testing, monitoring and certification; and the ability to improve research and pilot activities related to major energy and environmental needs especially for Low Carbon Economy topics. China has entered into the fast development stage of nuclear power plants. China should attach utmost importance to the capacity building of nuclear power plant safety and environmental supervision, thus safeguarding prospects for future nuclear power plant development.

4) Place major energy, environment and green economy policies into overall fiscal and economic reform. China should improve the overall design and pilot implementation of key environmental taxes as a sound base of a fiscal system that can

benefit resource and energy conservation and environmental protection in the 12th Five-Year Plan period. China should initiate the research and pilot activities that will provide the funding channel for forest, grassland, and agricultural land improvements for rural carbon sequestration. China should speed up the implementation of property taxes to regulate the rapid increase of urban buildings and to encourage an urban sustainable consumption mode.

5) Improve information statistics on energy and environment performance. China should develop and standardize the monitoring system for energy conservation, emissions reduction, energy consumption for urban buildings and communication and GHG emissions; include better rural environment and energy information in national statistics system; improve and standardize national and local statistics, and improve supervision of statistics and information disclosure. Development of an improved basis for calculating carbon footprints is needed within various industrial sectors, communities, and for individuals and households. This is a task where government, business, communities and civil society organizations should all play a role.

6) Improve management mechanisms of 12th Five-Year Plan and implement EIA for plans at various levels. While drafting and promulgating the 12th Five-Year Plan of social and economic development plan, China should also draft, approve and promulgate sectoral plans and ensure the concurrent implementation of both the national plan and sectoral plans to produce the best outcome. After the promulgation of the "Planning EIA Decree", in order to ensure green development, China needs to conduct EIA on major development plans, sector development plan, regional and local development plans that potentially pose a major impact on the environment.

Part Ⅱ
CCICED Issues Paper

The Issues Papers are composed by Chief Advisors and their support team. The purpose of the Issues Paper is to identify key issues for consideration at the CCICED Annual General Meeting. The reports review key environment and development issues confronting China, options for action, relevant international background, and future development trends. They capture current thinking on sustainable development and serve as the basis for discussions among Chinese and international experts and scholars during Annual General Meetings.

Innovation for an Environment-Friendly Society

(2007)

Background

This Issues Paper is the sixth in a series started in 2002 to examine key problems in China's environment and development strategy. The purpose of each paper has been to identify major policy questions and issues associated with the theme of the CCICED's AGM. The Council, comprised of senior Chinese and international environmental leaders, provides advice to the Premier and State Council of China based on the work of its task forces and special studies. The November 2007 CCICED AGM is the first meeting of the fourth five-year phase of the Council, and therefore will serve as an agenda-setting session for work to be carried out over the coming half decade. The AGM will examine what it will mean for China to embrace "Innovation for an Environmentally Friendly Society".

Strategic Transformation and Innovation

1. 2007 – A year of environment and development in China and globally

The timing of this meeting is especially significant since it comes soon after the 17th National Congress of the Communist Party of China. This Congress firmly embraced scientific development, innovation and the need to address pressing environment and development concerns in China. President Hu Jintao noted the need for "promoting a conservation culture by basically forming an energy-and resource-efficient and environment-friendly structure of industries, pattern of growth and mode of consumption". During 2007, China introduced its first comprehensive action program to address climate change; established a Leading Group on

energy, environment and climate change, which is chaired by Premier Wen Jiabao; and took numerous actions to improve performance in meeting the 11th Five-Year Plan's 20% energy efficiency increase and 10% pollution reduction goals. The OECD released its first ever report on China's environmental performance, an important benchmarking and institutional analysis.

This year, environment has risen to the top level of priorities in many countries, including their businesses and communities, with concern for climate change being most prominent. But many other issues are in the spotlight as well, including the need for a better understanding of globalization effects, and of the environmental implications related to fast growing countries such as China and India. The International Energy Agency (IEA) in its 2007 energy outlook reference scenario calculates that these two countries would account for 45% of the global increase in energy demand in 2030. It is now 20 years since the famous report *Our Common Future* was produced by the World Commission on Environment and Development. Global progress on sustainable development is still limited, however, and "business as usual" attitudes still persist to an alarming extent.

2. China's strategic transformation of environment and development

China is entering a time of strategic transformation towards environment and development. This transformation is focused at present on energy efficiency and pollution control, but with much broader implications on how the world's most populous nation can rapidly align its economy, environmental protection and harmonious social development policies and actions towards sustainable development. China needs to do this on a much-compressed time frame by comparison to many other countries, since its longer target of attaining a "basically well-off society" by 2020 depends not only on continued rapid economic growth, but also on quality of life and a stable social system.

Ultimately this strategic transformation will affect how government governs, how all business enterprises operate within China and in their international operations, how the people of China participate in environmental decisions, and how

China participates in global and regional environment and sustainable development cooperation. It will demand new approaches of institutional change, improved planning and management, and technological changes far beyond what China has seen to date in its environmental protection and sustainable development efforts. And it will place unprecedented demands on other nations to adjust and improve their own ways of dealing with issues such as environment and trade, climate change, and many other related matters. One of CCICED Policy Studies is on Strategic Transformation of Environment and Development in China (see chapter IV), which was presented at the AGM.

3. Innovation for an environment-friendly society

President Hu Jintao has noted that innovation "is the core of our national development strategy and a crucial link in enhancing the overall national strength". Internationally there is great interest in determining how best to link innovation and sustainable development. It is difficult to believe that societies anywhere can expect to achieve substantive progress on today's environment and development problems without commitment to science and technology breakthroughs. Yet innovation must go much deeper into the way decisions are made and the strength of institutions to implement these decisions; and into the role and functioning of markets that can either encourage or discourage desirable changes depending on pricing and other signals.

It is encouraging that at the 17th CPC Congress such topics were considered. President Hu noted that "China needs to improve institutions for democracy, diversify its forms and expand its channels, and carry out democratic election, decision-making and administration and oversight in accordance with the law to guarantee the people's rights to be informed, to participate, to be heard and to oversee". These are among the most important conditions found in nations like Germany, The Republic of Korea, and Japan that foster innovation during their strategic environmental transformation in earlier times.

China is in a remarkable position as it moves to strengthen its science and technology capabilities. The available funding will place it among the very top na-

tions investing in S&T. A considerable amount of this funding will be earmarked for addressing priority energy, environment and development concerns during China's new 15-Year Science and Technology Plan. In the process, the existing National Innovation Strategy (NIS) will have to become much more focused on sustainable development priorities and on building independent, indigenous technology that will fuel future economic growth and well being in China. There are many barriers to be overcome, and the gap between goals and performance progress is still large. CCICED has initiated a new Task Force on Innovation for China's Environment-Friendly Society, which will present its final report at the 2008 AGM. Their Interim Report presented during the current AGM provides a critical examination of this topic in China.

The difficulties of implementing current environmental goals were reported during the meeting, and were based primarily on the work of the CCICED Task Force on Policy Mechanisms towards Successful Achievement of the 11th Five-Year Plan Environmental Targets. It is likely impossible to meet the targets without substantial commitment to innovative approaches, and these are not yet in place. Furthermore the challenge will become greater over time, especially during later Five-Year Plan since more types of pollutants will have to be addressed and absolute levels of some contaminants are continuing to increase.

Since the dawn of the new century, China has been in an industrialization phase of heavy industry and chemical production. The rash of serious incidents involving chemical spills and contaminations suggests that a stronger approach to chemical management is needed. Such an approach has ramifications for large and small domestic producers, multinational chemical firms operating in China, and for China's participation in overseas chemical markets. Fortunately, this is a subject where it is possible to draw upon innovation experience from a number of other countries such as Germany. A CCICED Special Policy Study on Environmentally Sound and Strategic Management of Chemicals in China would provide some useful recommendations.

4. Looking ahead – global problems and China's needs

China is entering into an era when its impact on the world will be considerable, and therefore its actions will be monitored closely and judgments will be made on its contribution to global environmental security and global citizenry. The extensive past work of CCICED on Trade and Environment, and recent efforts to understand how the effects of globalization affect China's environment and China's impact on other countries suggest that international cooperation will become increasingly significant. It is a topic well suited to CCICED, of course, but may now need to be examined in ways that recognize both China's very legitimate development needs and interests and how other nations should cooperate to provide the environmental space for this to happen.

Therefore, several exploratory initiatives were undertaken in preparation for this meeting. One is a new partnership of CCICED with WWF China to examine China's Ecological Footprint (the final report will be publicized on June 5, 2008, the International Environment Day) with an Interim Report presented during AGM 2007, revealing how China's very low per capita demands on the world's ecological systems are increasing. This is a relatively new way of examining the effect a country may have on the resources and environments of other nations and regions through market supply chains and other ways. This information casts a very different perspective than standard economic analysis of trade and identifies the nature of ecological deficits and surpluses around the world.

CCICED's long-standing interest in Energy and Environment has always been tied to innovation, and specifically to alternative sources and approaches to energy use. Some of these ideas, like wind power, are now in use and it is clear that energy innovation will be one of the most significant areas determining China and the world's success with sustainable development. Climate change adds to the urgency of finding new ways to improve energy efficiency, sustainable use of coal, and of alternatives that will reduce greenhouse gas emission and other harmful pollutants. These topics are being proposed as important elements within the overall context of Energy and Environment for CCICED work over the next two years.

In April 2007 CCICED held an exploratory meeting on “A Low Carbon Economy for China”. (For the key points arising from this meeting please visit the website: www. cciced.org)

Clearly, the coming years will not be a time of “business as usual” for China’s environment and development situation. Nor is it a time when any one nation can expect to achieve its own environmental objectives in isolation from global environment issues, or without consideration of the environment and development actions of other nations. As China’s President and Premier have both pointed out, the environmental burden on China is heavy and the situation is grave. It will require sustained effort, participation of all sectors and regions of the country, and new approaches that build on science, management and institutional approaches. What is called for is a broad base of investment in eco-innovation. This long-term commitment will become of increasing significance starting with the 11th Five-Year Plan, and certainly extending into the 12th and 13th Five-Year Plans.

The Government of China has made it quite clear that innovation rather than minor tinkering will drive the new relationship of environment and development. Perhaps the clearest vision is from statements by Premier Wen Jiabao concerning this relationship, in which three principles – Three Transitions – have been laid out: (1) environment and economic growth should be given equal status; (2) environmental problems should be considered concurrently, not after economic growth is achieved; (3) instead of the current focus on administrative initiatives, environmental action should be broadened to include legal, economic, institutional and other approaches.

China’s 11th Five-Year Plan Environmental Performance

The inability of China to meet fully the environmental objectives of the 10th Five-Year Plan, and the more stringent pollution reduction and energy efficiency goals during the first year of the 11th Five-Year Plan, reflect systemic problems that are described in the CCICED Task Force Report to the AGM. The key point is that only by addressing such matters as institutional strengthening and substantial up-

grading of the environmental management administrative structure, can real progress be expected. There is no single approach that can be implemented in isolation. This point has significant implications for success of environmental technology innovation.

While there is considerable investment in introduced technologies, and also evidence of success in their application, there are also observations that much of the investment has not been well spent in terms of improved environmental performance. The reasons vary but include lack of training, poor environmental monitoring and enforcement, and inappropriate choices.

The 11th Five-Year Plan will be a time of learning and transition in relation to discovering the best combinations of technological, institutional and management innovations for environmental improvement. It should set the stage for major longer-term investments that will see their full benefits expressed in the decade after, and in the case of some initiatives, much further in the future; for example, the ITER Project on fusion in which China is a partner. The time available between now and 2010 can be used to put in place a more functional governance system to support environmental innovation, including stronger participation by industry, and awareness raising of communities and people. Fortunately, the necessary investment capital may be much easier to find in China than in some other countries.

Some Global Issues Limiting Progress

Of the many issues limiting progress on building a better relationship between environment and development in other countries, a handful are particularly significant at this time of innovation and transition for China.

1) An export-driven high growth strategy, with its emphasis on continuous price reduction and mass production of consumer goods, has significant benefits both for the manufacturing country, in this case China, and the consuming countries, whether rich or poor. The reality, however, is that environmental conditions are being compromised in the manufacturing country, and in some of the countries supplying raw materials. This also happens in the richer, consuming countries

where cheaper imported goods contribute to ever-increasing demand and over-consumption. It is hard to see how this model can ever truly be sustainable.

2) Stimulating domestic consumption in China or other large developing countries from their current low per capita levels could lead to an impossible future global environmental situation. This could happen if consumption levels rise anywhere close to those of the richer countries today because ecological capacity will be exceeded, even with stringent eco-efficiency measures. Ecological footprints continue to rise with economic wealth; already the global resource and environmental situation may be beyond earth's longer-term carrying capacity. New pathways are needed that lead to high quality of life in China and elsewhere, but with relatively limited per capita consumption increases. As well, richer countries must become much more serious about their own transformative needs for environment and development and on sustainable consumption.

3) Declining resource and environmental intensity (e.g., use of energy or material per capita or per unit of GDP) is a misleading measure of environmental progress in situations where economic or resource exploitation growth rates are very high. Absolute pollution amounts, or of resource decline, may continue to rise even though utilization efficiency increases. This is particularly important in the debate about greenhouse gas reductions, but also for many other of the pollutants that China and other countries are producing, and for ecological and resource decline globally and regionally.

4) Social considerations of poverty reduction, equity in access to education and health care, sustainable cities and towns, sustainable rural development, and creation of new employment opportunities will continue to be drivers of sustainable development innovation in all countries. Yet this type of innovation is still often separated from environmental considerations. China, more than many other countries, is making a serious effort to make the linkages and take an integrated approach. China's success and experience will therefore be of value to many other nations.

5) Corporate social responsibility is taken seriously by many large multinational corporations in particular, yet it has not taken hold to the extent that it should

anywhere in the world, and certainly not in most parts of Asia, including China.

6) The framework for addressing global environmental protection, and for regulation of market-driven globalization matters, including technology sharing, intellectual property rights, and international trade and investment, is still weak and incomplete. As well, new issues are appearing each year, including many health and environment problems, and new mechanisms such as carbon trading. China's own strategic transformation on environment and development will depend a considerable extent on improvements for international action.

7) Innovation in the form of new or improved scientific and technology applications, investment, management and institutional change is needed both nationally and internationally, but often the changes occur much more slowly than desired and with a limited distribution of benefits.

China has now become an indispensable economic partner, stabilizing the world economy, fueling international economic booms, and raising the level of incomes for many developing countries. This success needs to be tempered with the difficult issues of declining environmental conditions. Global attention in recent months has been focused on a range of quality issues, including the efforts to improve the air quality in Beijing and the Olympic Games, to solve the problems of market supply chains and product quality, and how China will respond to climate change.[1] China needs to understand how it can balance its environment and economy relationship in the context of globalization effects.

Innovation for Environment and Sustainable Development

There are a number of specific characteristics about environment and sustainable development innovation worth bearing in mind, since these are as likely to be as applicable in China as elsewhere.[2]

1) The need for innovation increases as the commitment by governments and

[1] See Elizabeth Economy. 2007. *The Great Leap Backward?* Foreign Affairs. September/October; Joseph Kahn and Jim Yardley. 26 August, 2007. *As China Roars, Pollution Reaches Deadly Extremes. The New York Times*.

[2] These points are based in part on OECD, 2007. *Environmental Innovation and Global Markets.* ENV/EPOC/GSP (2007)2/REV1. Environment Directorate, OECD, Paris. 101pp.

the private sector shifts from an emphasis on cost-driven regulatory compliance to an emphasis on broader economic/financial, social and environmental benefits.

2) Many environmental innovations will arise from industrial innovation not primarily oriented to environmental improvement; for example, energy efficiency and product improvement. The potential for co-benefits is large.

3) Environmental innovation is often directed to maintaining public goods, which means that incentive for private investment and return on investment can be limited, especially in relation to alternatives. Market value is needed for technologies to thrive.

4) Bringing environmental innovations to full commercialization can be difficult, due to market imperfections and failure, or perverse incentives such as inadequate pricing.

5) Technology "lock-in" is a formidable problem for environment and sustainable development innovation, affecting institutional and financing responses even when R&D suggests better technologies are available or could be developed.

6) Co-evolution of technologies is often needed; for example, in the relationship of battery technology and hybrid automobile engine development.

7) Flexible instruments such as economic incentives and performance standards foster environmental technology innovation more than prescriptive measures (e.g., "best available technology" regulation), especially if the desired outcome is integrated changes in production or other processes rather than end-of-pipe pollution control.

8) Globalization, with its fragmented supply chains, may generate considerable international demand for accelerated development of environment and sustainable development technologies and their rapid deployment, including pressure for suppliers along the value chain to conform to consumer-driven environmental demands.

9) Some key environment and sustainable development technologies (e.g., for clean coal use, nuclear fusion, and sustainable transportation) are beyond the capacity of any one country, no matter how technologically advanced, and therefore international partnerships and joint venture activities are desirable.

10) Governmental intervention in choosing technology "winners" can be

highly controversial. One view is that governments should concentrate on defining clear environmental goals and a framework to address them, while being technology-neutral on how they are addressed.

China's Innovation Strategy and Key Links to Environment and Development

Scientifically based development, wealth shared fairly among all citizens, harmonious and sustainable development that provides for environmental protection, continued rapid economic growth, improved social services, and greater social equity are cornerstones of current Chinese policy. These elements are reflected in many of the approaches for innovation generally, and science and technology (S&T) strategies in particular.

The context for innovation has been set broadly, as explained by Vice-Premier Zeng Peiyan in a speech to the China Business Summit:[1]

> "…Innovation is the soul of a nation's advancement, as well as the everlasting driving force for national prosperity […] Problems often occur when people tend to pay attention to quantitative expansion and speed while ignoring quality […] We have to upgrade our development strategies, transforming our growth pattern and optimizing the industrial structure […] The objectives of reform are to bring economic and social development on the track of comprehensive, balanced and sustainable development."

He pointed out that this effort offers the potential for technology and innovation that could enhance productivity and increase competitiveness for China. The focus on institutional innovation should include reforming the administrative system, accelerating corporate reform, and establishing modern market systems.

Innovation must be linked with improved governance. As noted in a review of

[1] China Daily. 11 Sept., 2006. *Innovation is the Soul of Nation's Advancement: Vice-Premier.* www.china.org.cn/ english/BAT/ 180675.htm.

China’s S&T Strategy:[1]

> “The path to creating the overall well-off society will necessarily be characterized by technology innovations supporting greater efficiency and productivity, and institutional innovations supporting improvements in governance—greater market discipline and integrity, less government corruption, and greater administrative accountability.”

OECD countries are passing through a transition where stand-alone S&T strategies are now being viewed within a broader context of a National Innovation System (NIS) that can take into account many factors beyond specific S&T plans or strategy. In particular, a NIS must consider the role of the business and financial community not only for participation in research, but also in linking to the demand side and in providing clear pathways to commercialization. An NIS also must take into account the development of innovation clusters with appropriate capacity building and scientific and physical infrastructure development, enabling frameworks and regulatory systems, and help with fundamental matters such as the selection of priority areas of innovation in which to initiate substantial programs.

The NIS approach, however, has evolved relatively independent of sustainable development. Thus, while some environmental concerns may be addressed in specific cases, this is by no means a central element. Rather, NIS tends to focus on building competitive advantage of a country through new technologies. Sustainable development is its own form of innovation, with some specific characteristics. It is mainly in the last 5 years that NIS and sustainable development have become more closely aligned in OECD nations, stimulated particularly through concerns such as alternative energy and climate change, industrial eco-efficiency, sustainable infrastructure development and some aspects of natural resource and environmental management.

1. China’s national innovation system (NIS)

China is following somewhat the same pathway as other nations in creating its

[1] Cong Cao, R.P. Suttmeier and D.F. Simons. December 2006. *China’s 15-year Science and Technology Plan. Physics Today*.

approach to an NIS with a very impressive level of S&T investment, and considerable experience with what may best be described as an adaptive approach to its NIS. This system has a number of key characteristics that evolved over the past 25 years.[1] What sets China apart from others are the magnitude of commitment and the rapidity of transition. And China has placed development concerns front and centre in its innovation goals, with a strong commitment for environmental protection.

The public governance of S&T and innovation is relatively complex, as noted in the diagram on the following page (from OECD 2007. Synthesis Report). There are many challenges to be faced, as noted below (from OECD 2007. Synthesis Report).

A strong recognition exists of the need to make the NIS enterprise based. There are numerous mechanisms to involve the private sector and transform state-owned enterprises. Yet the reality is most Chinese businesses invest little in R&D, and it is a challenge to get adequate R&D investment as part of FDI initiatives.

From another perspective, China may be able to tailor its growing innovation capacity to competitive advantage as part of a "global innovation system". As noted by OECD[2]:

> "China can make a significant contribution to the world's knowledge pool and help to solve global problems. Among these are those relating to the strong demand for energy and natural resources and the environmental pressures associated with the rapid economic growth both of China and other emerging economies. China and OECD member countries have a shared interest in solving these problems."

There could be multiple advantages of China participating extensively in such a system. It is a means of sharing the burden and drawing upon a wider range of

[1] See, for example, Shulin Gu and Bengt-Åke Lundvall. 2006. *China's Innovation System and the Move Toward Harmonious Growth and Endogenous Innovation* in Shulin Gu and Mark Dodgson. 2006. *Innovation in China: Harmonious Transformation.* Special Issue of Innovation: Management, Policy and Practice. *eContent Management*, Queensland Australia. 218pp; OECD. 2007. *China. Synthesis Report. OECD Reviews of Innovation Policy*. OECD, Paris. 68pp.

[2] OECD. 2007 China Synthesis Report.

experience on complex technologies such as those involved in new energy technologies. China can draw upon its advantages as a low cost producer to commercialize innovation technologies and sell these abroad. And China will gain credibility internationally for its science and technology contributions.

A number of strategic tasks have been identified by OECD as possible means for enhancing the efficiency and effectiveness of China's NIS. These include: (1) Adjusting the role of government to enhance provision of public goods through science and innovation; (2) Improving the framework conditions for innovation, such as enforcement of intellectual property rights (IPR), fostering competition, improving corporate governance, fostering open and competitive markets, careful use of public procurement, and promoting technology standards appropriately; (3) Increasing research quality and efficiency by sustaining the growth of human resource for S&T; (4) Improving governance of science and innovation policy, including a focus on central and sub-national division of labour and responsibility, and improving inter-agency coordination; (5) Adjusting the set of policy instruments in order to develop the most appropriate types of R&D initiatives and programs; (6) Maintain adequate support or public R&D, especially for public good priorities such as environmental protection; (7) Strengthening the linkages between industry and science.

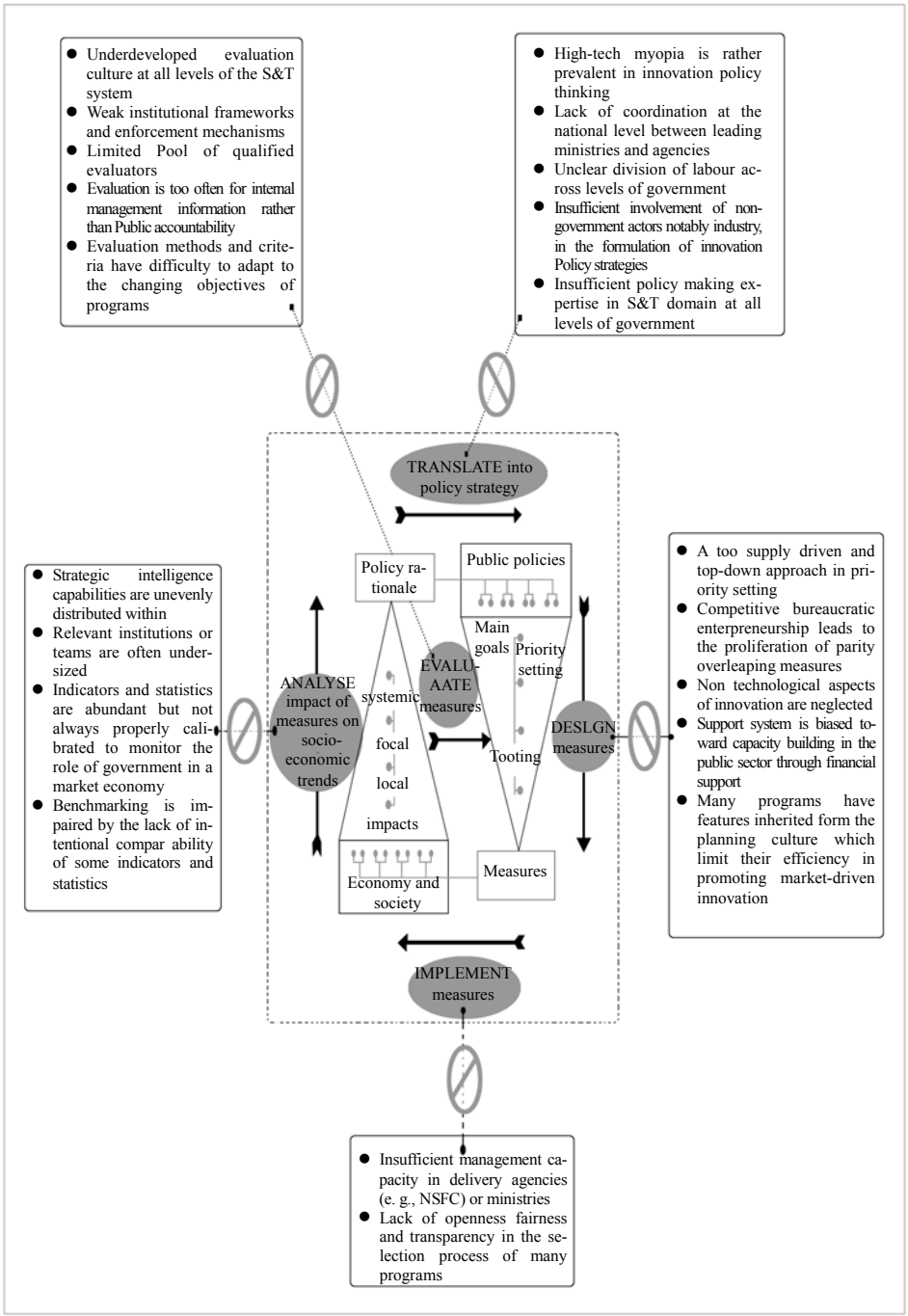
2. China's 15-year science and technology strategy

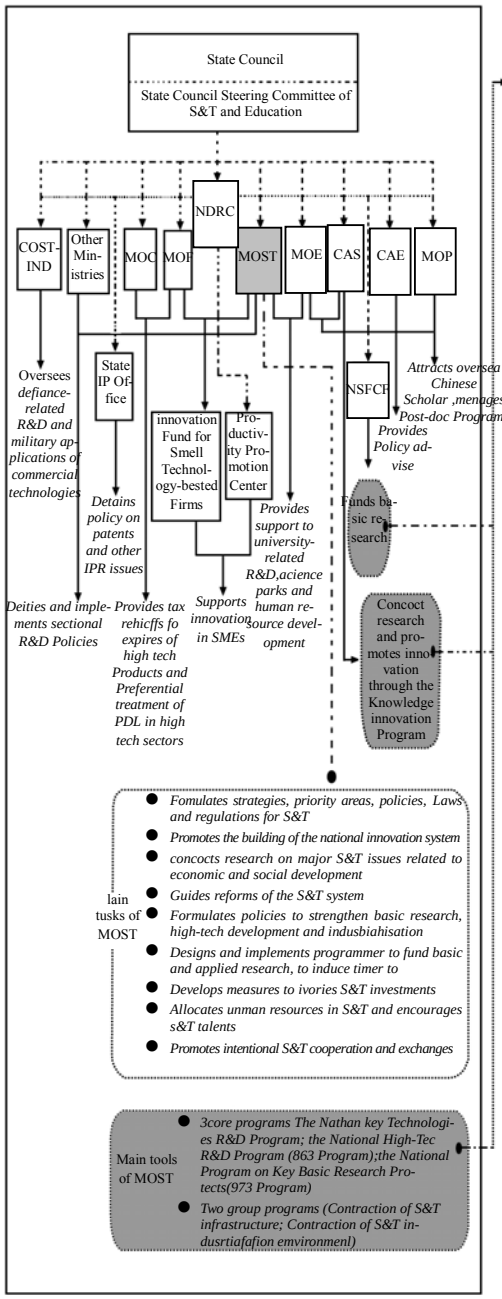
China is poised to become one of the world's leaders in S&T investment. The 2006 15-year S&T Plan[1] emphasizes "indigenous innovation" and technology leapfrogging so that some 60% of contributions for economic growth will come from technology advances, with dependence on imported technology no greater than 30%. China aims to be among the top five countries in terms of invention patents and overall S&T expenditure—a "global scientific centre". OECD believes that China is already the world's second highest investor in R&D, spending slightly more than Japan's USD 130 billion in 2006, but far lower than the U.S. investment of USD 330 billion. This represents an increase from 0.6% of GDP in 1995 to more than

1.2%.[2]

[1] For a useful review of the S&T Plan, Suttmeier and Simons, Physics Today. Dec. 2006.

[2] OECD. 2006. www.oecd.org/sti/outlook.


Underdeveloped evaluation culture at all levels of the S&T system
Weak institutional frameworks and enforcement mechanisms
Limited Pool of qualified evaluators
Evaluation is too often for internal management information rather than Public accountability
Evaluation methods and criteria have difficulty to adapt to the changing objectives of programs
High-tech myopia is rather prevalent in innovation policy thinking
Lack of coordination at the national level between leading ministries and agencies
Unclear division of labour across levels of government
Insufficient involvement of non-government actors notably industry, in the formulation of innovation Policy strategies
Insufficient policy making expertise in S&T domain at all levels of government
TRANSLATE into policy strategy
Policy rationale
Public policies
Main goals
Priority setting
Strategic intelligence capabilities are unevenly distributed within
Relevant institutions or teams are often undersized
Indicators and statistics are abundant but not always properly calibrated to monitor the role of government in a market economy
Benchmarking is impaired by the lack of intentional compar ability of some indicators and statistics
ANALYSE impact of measures on socio-economic trends
systemic
focal
local
impacts
EVALUAATE measures
Tooting
DESLGN measures
A too supply driven and top-down approach in priority setting
Competitive bureaucratic enterpreneurship leads to the proliferation of parity overleaping measures
Non technological aspects of innovation are neglected
Support system is biased toward capacity building in the public sector through financial support
Many programs have features inherited form the planning culture which limit their efficiency in promoting market-driven innovation
Economy and society
Measures
IMPLEMENT measures
Insufficient management capacity in delivery agencies (e. g., NSFC) or ministries
Lack of openness fairness and transparency in the selection process of many programs



Program	Year of start	implemented by	1981-1985	1988-1990	1991-1995	1998-2000	2001-2005
Key Technologies	1983		15	35	452	50	50
973	1997	MOST	•	•	•	12	21
883	1988		•	←	59	→	150
NNSFC	1986	NNSFC		5.7	15.8	44.7	100
Knowledge innovation	1998	CAS	•	•	•	54	200
TOTAL			15	•	•	•	521
Total as a share of total public S&T expenditures							17%

Table 3.2 Main MOST Programs

Core Programs		
Key Technologies	863	973
Promote the development of key technologies needed for industrial and social development	Promote R&D capabtiriles in high tech	Support basic research in selected areas

TWO Group Programs	
Construction of S&T infrastructures	Construction of S&T Industrion Environment
Support the development of infrasl-nuchunes and capable-ness	Support environmental Projects ,regional economic development, tech-based SMEs and S&T imte-mediarines

Key Technologies million RMB(2004)	883 Program	973 Program
Total funds raised	14985	9293	1031
Government funds	3003	4231	903
Government as % of total	20%	48%	88%

Funds allocated by central government to Selected TWO Group programs (million RMB)

	1988	2004
State Key Laboratory Construction Program	125	130
National Engineering Research Centre	40	85.5
Spark Program	39	105
Torch Program	51	50
Science and Technology Achievements Spreading Program	20	23
National New Products Program	135	140
Innovation Fund for Small Technology bested films	•	500
Agriculture Siamese and Technology Transfer Fund	•	250
Allison Plan for Promoting Trade by Science and Technology	•	20
Special Technology Development Project For Research Institutions	•	182

Origins of funds for the torch and Spark Programs(2004)

	Total	Torch	Spank
Funds raised (million RMB)	91888	71313	20573
%government	3%	2%	5%
%enterise	70%	72%	60%
%bank loans	23%	21%	30%
%oversees	0.3%	0.3%	0.8%
%others	4%	4%	4%

NDRC: National Development and Reform Commission
COSTIND: Commission of Science, Technology and industry for National Defiance
MOC: Ministry of Commerce
MOF: Ministry of Finance
MOST: Ministry of Science and Technology
CAS: Chinese Academy of Sciences
MOE: Ministry of Education
MOP: Ministry of Personnel
CAE: Chinese Academy of Engineering
NSFC: National Natural Science Foundation of China

Source: OECD based on data from MOST and other sciences.

The meaning of "indigenous innovation" is somewhat complex, and encompasses three approaches: original innovation, integrated innovation relying upon linking existing technologies for new uses (e.g., application of medical biotechnology for diagnostic testing of the environment), and "re-innovation" involving improvement of imported technology. All three approaches are of value in relation to environment and development innovation. It also should be noted that emphasis on institutional and management innovation is a crucial component for all three approaches—in order to improve implementation success of off-the-shelf technologies as well as innovative technologies.

A likely transition for China is towards greater ownership of intellectual property rights and possibly to industrial standard setting as part of its effort to become an innovation-based society. This has important implications for environment and SD technology development for both domestic use and international applications. The potential dilemma is the length of time to develop new intellectual property, and therefore the uncertainty and lengthy process to bring new technologies into the marketplace.

Another view is that gaining access to sophisticated, available environment and sustainable development technology from abroad is essential for the near term, especially during the 11th and 12th Five-Year Plans periods. While such an approach is appealing and in fact occurring, there are cost issues and issues relating to reluctance of some companies to share their most advanced features with Chinese operations. The role of China's government in setting appropriate regulations (e.g., auto emission standards) and IPR safeguards are important.

Chinese-international partnership for development and implementation of new technologies is a hybrid approach to innovation that is likely to be of increasing significance in coming years. It appears particularly important for alternative energy sources, and perhaps for water pollution control technology, hazardous waste management and prevention, etc. Many of these activities can be managed through foreign direct investment strategies, but some might also be done through government-to-government arrangements. Models for the latter exist (EU, USA, etc.).

Almost all of the 20 strategic research topics noted in the S&T Plan are rele-

vant in some way to environment and development, but several are critical including: agricultural S&T, culture for innovation and S&T popularization, ecology, environment protection and circular economy S&T, energy, resources and ocean S&T, human resources for S&T, modern manufacturing development S&T, population and health S&T, regional innovation system, strategic high technology and industrialization of high and new technology, transportation S&T, and urban development and urbanization S&T.

Environment and development innovation may be less in need of S&T megaprojects than some other aspects of the strategy, but it requires greater attention to accelerating the pace of development of promising initiatives, and to the need for funding related to those initiatives where the marketplace has not yet caught up with the societal need (e.g., low cost sanitation and water treatment, brownfield redevelopment, and advanced forms of biorefineries).

Regional and local S&T innovation and concurrent needs for implementation capacity development are significant, and involve the private sector and communities as well as governments at various levels. This aspect of innovation is critical for ecological initiatives and rural development, as well as industrialization in locations where innovative solutions may be needed to address pollution and other environmental impacts.

A National “Eco-innovation System” for China

The time may be right to propose the creation of a national eco-innovation system for China that could address in a comprehensive way the various opportunities and challenges to innovation for an environment-friendly society. This approach has not been widely tested, although it is being actively explored in Europe. Eco-innovation is defined as any form of innovation focusing on sustainable development through reducing impacts on the environment and achieving more efficient use of energy and natural resources. A key question would be how taking an eco-innovation system approach might influence outcomes of the 11th Five-Year Plan environmental efforts. By taking a systemic approach, could performance be

improved, and to what extent would the results be related to environmental technology and to what extent from institutional improvement such as local government strengthening?

The following 10 innovation issues are indicative of the need for policies and action in a systemic approach to achieving an environment-friendly society.

1) Create more widespread and effective use of existing environmental technologies that would lead to greater efficiency at a lower cost than developing new technologies, especially for industry and energy pollution control and new building technology.

There are many environmental technologies available at the present time, both within China and elsewhere. Such technologies could be introduced and adapted to specific Chinese development conditions, likely at lower cost and in a more timely way than developing new technologies. A good part of the challenge is not the technology *per se* being a barrier, but rather it is the lack of knowledge about its application, inappropriate incentives and regulation, and the need for an improved implementation management system.

It is sensible and necessary in the short run to focus on immediate opportunities even while seeking longer-term, more transformative options. Using existing technologies is a means for the industrial and construction sectors to demonstrate a commitment to corporate social responsibility in an immediate, goal-oriented and measurable way rather than via promises mainly of future, longer-term performance. It is a mechanism to maximize technology transfer by drawing upon multinational experience, especially as part of FDI packages and through cooperation programs, particularly with OECD countries. An additional benefit of maximizing use of existing environmental technologies is that it will further stimulate the rapid development of a robust environmental service sector within China.

The potential downside of embracing existing environmental technologies is that many will be from an earlier generation designed for pollution clean-up rather than prevention, and some will not be as cost-effective or efficient as newer approaches being designed today. In particular, the move towards elimination of serious pollutants through industrial ecology design and environmental planning pre-

sents more attractive longer-term options, including synergies for a circular economy, ability to control emissions such as greenhouse gases, which were not of such a concern in the design of existing pollution control technology, and perhaps discovering better approaches for China's situation.

2) Set environment and sustainable development objectives, standards, and incentives at levels that will promote innovative responses, while putting into place regulatory frameworks that will enable innovation solutions to be implemented effectively.

While China has already taken many initiatives for addressing this set of issues, the results are still far from optimal, suggesting the need for further national and local government interventions. The problems seem to be associated with the following matters:

(1) Inadequate drivers for action towards desired innovations (not only for new technology, but also for institutions, investment and management systems). The weak drivers are reasonably well understood. They include weak enforcement and punitive measures that simply become part of the cost of doing business; the continuing ambivalence of many local governments towards environmental management efforts where GDP growth may be threatened; and national laws and regulations that are too general or even work at cross-purposes, etc..

(2) Limited returns from existing S&T investment in terms of bringing new technology to commercialization and in terms of the relative low number of patents and other indicators of productivity of the S&T system.

(3) Failure of much of China's private sector to develop robust environmental management strategies and to undertake the original R&D that would support innovative solutions to pollution control, energy efficiency and other problems that should engage their interest.

(4) Failure to engage the financial sector fully into environmental innovation strategies. For example, it is only recently that bank lending has started to consider environmental matters.

This list of problems is very significant in terms of China's future success with innovation for environment and sustainable development. But it is a list that

may well grow over time as new technology innovations emerge.

Experience elsewhere suggests that public perception and markets are unlikely to embrace all forms of technology solutions. This may well be true in the future for China as well—in its domestic markets, but also via market supply chains for China's export-driven economy. Choice of biotechnologies for environmental matters, for example, may influence access of final products to foreign markets.

3) Develop environmental, safety, health and life cycle assessments of impacts arising from new technologies (e.g., biotechnology, nanotechnology) at all stages of their development from R&D to full commercialization.

Many assertions will exist concerning the benefits and risks of new technologies, starting with the earliest stage of scientific research. China has engaged domestically and in joint ventures with funding of initiatives and building of expertise covering a wide range of promising technologies. The new S&T strategy offers even more possibilities. How can there be reasonable assurance that the new investments actually will contribute to China's sustainable development needs in a more effective way? And what safeguards need to be put into place to ensure that the innovations do not create unacceptable health, environmental and safety problems on their own right? The design of existing environmental assessment procedures is not very robust for answering these questions, since the assessment system is geared much more to construction and other types of projects. Even policy environmental assessments are likely to be insufficient.

The OECD and some individual nations have started to consider appropriate assessment tools and procedures, for example, to cover innovations such as biotechnology applications for the bio-economy and nanotechnology and the environment. China will need to place more emphasis on these matters as its S&T strategy unfolds. The time to set in place an innovation environmental assessment system is now, before the new technologies overwhelm regulatory bodies, and before a serious incident occurs that is detrimental domestically and/or internationally.

The issue of whether assertions about the value of the potential S&T application are correct will always be difficult to assess, since the full potential often takes

two or more decades in order to be fully realized. The slow unfolding of the hydrogen economy is a highly relevant example. However, the area of technology assessment for environment and development has made considerable progress over the past five years, with development of useful tools and scientific dialogue processes that are valuable. China is already engaged in some of these processes, but likely should be doing more to ensure that initial choices are reasonable.

4) Enhance the contribution to environment and sustainable development innovation by multinational corporations, international joint ventures and partnerships for key technology applications.

The environmental role of the international business community investing in China has been extremely variable, ranging from negative to highly positive. It would be desirable for international businesses to be in compliance with all relevant Chinese environmental laws, but compliance is not enough to address innovation. Instead, multinational corporations should be prepared to consider the following: environment and sustainable development capacity building of staff in their own business, and sometimes with other businesses in the same sector; willingness to share cutting edge technology; support for environmental R&D within company operations and via grants or partnerships with Chinese universities and research bodies; and participation in certification and other innovative voluntary environmental programs. Some international companies operating in China are already engaged in many of these activities, but certainly many others are not. Furthermore, there are many supply chain issues, including subcontracting and outsourcing within China where there seems to be limited consideration of how goods are produced. These problems are exacerbated by the intense competition among provinces for investment and increased manufacturing opportunities.

The problems go deeper when investments in supporting infrastructure, such as commercial and factory buildings, transportation and utilities are considered. Some excellent trial efforts for LEED certified buildings have taken place, and many individual companies operating in industrial parks have established facilities that compare well with similar operations in their home countries. However, these initiatives appear to represent a small fraction of total investment. Some new in-

dustrial operations such as those for steel production tend to be designed at or above international norms. However, there is justifiable concern about the creation of many more facilities that will become brownfield sites or an on-going energy and pollution burden due to the limited initial investment in environmental controls.

What is required is a much greater environmental interest on the part of both Chinese and international investors in China, including those from other parts of Asia. The reality is that only two factors are likely to have a high degree of influence. One factor is strong governmental action of both a regulatory and enabling nature. The second is the market power in rejecting unsustainably produced items or demanding certification or other proof of sustainability. Over the coming 5 to 10 years it is quite likely that both domestic and international markets for Chinese goods will feel pressure from environmental concerns. There is an increasingly coherent approach being followed in environmental regulation, especially at the national governmental level.

5) Attract much more Chinese and international venture capital and private equity in support of environmental services and new environment and sustainable development initiatives, especially those at the start-up and scaling-up stages.

At the leading edge of investment is the role that could be played by venture capitalists in support of environmental and sustainable development innovation. Venture capitalists are typically needed in order to move innovations arising from small entrepreneurial companies from a preliminary stage of development to become a commercially viable operation. Use of venture capital in China is still at a stage where there are numerous problems, including an insufficient regulatory framework, and satisfactory relationships between entrepreneurs and the venture capital sources. There are many types of opportunities available, and until recent times environment has not been the focus of as much attention as other fields such as information technologies and biotechnology. However, the highlighting of energy efficiency and pollution control as key objectives in the 11th Five-Year Plan has elevated their significance to such investors.

Environmental services companies will likely prove to be attractive to private

equity sources in future years. The conditions to support more private equity investment for environmental protection include: a need for consistent drivers so that there is reasonable assurance of a growing market demand and profits that are at least as good as alternative investments; fair regulatory frameworks that ensure a level playing field for enforcement and therefore interest—on the part of municipalities, the construction sector and various industrial sectors—in purchasing both environmental equipment and services; and knowledge of the opportunities that are likely in the coming years. Government may also provide some direct stimulus through public procurement policies that favour environment-friendly products and services. Fortunately, there is a growing understanding of energy efficiency and environmental protection investment opportunities in both the venture capitalist and private equity communities within China.

6) Ensure adequate flow of innovation benefits concerning environment and sustainable development to less wealthy and rural areas of China, especially via the strengthening and support of small- and medium-sized enterprises (SMEs) throughout the country.

While most funds for environmental innovation R&D and follow-up commercialization are likely to flow into urban areas where universities, research centres, industry and commercial activities are concentrated, there are many applications that must be developed to meet needs associated with the countryside. Throughout China, the future strength of entrepreneurship will continue to be expressed largely through the remarkable number and variety of SMEs, including many located in smaller centres.

Megaprojects, including giant water and energy initiatives; some transportation projects such as the Qinghai-Tibet Railroad; regional development in China’s Northeast and in the Pearl Delta; and development of new cities encroaching into rural lands all have the potential to introduce not only a wide array of environment and sustainable development innovation technologies, but also vastly improved planning and management.

While China has undertaken many unique engineering initiatives in terms of scale and complexity, they alone cannot ensure sustainable development nationally or

in the various regions of China. It is particularly important that there also is sufficient scientific effort devoted to solving the many problems related to intensive use of landscapes, ecological construction and restoration, development of eco-communities and green buildings at all scales, including those in smaller cities and towns, and improvement of environmental quality in coal mining and heavy industry. This need is recognized in the new S&T strategy. The Asian Development Bank has noted[1] that SMEs are "more flexible in meeting the market demand for new technology and are therefore able to achieve rapid growth in the market." However, more needs to be done to provide an integrative approach that fosters and takes full advantage of small- and medium-sized enterprises potential to be local and sometimes national entrepreneurs.

The integrative effort should include not only capacity development within the national innovation system to build local environment and sustainable development S&T competence, but also fostering the necessary private sector and venture capital funding opportunities directed to meet needs of SMEs. In addition, within local and provincial level governance, more emphasis must be placed on building appropriate enabling arrangements for entrepreneurs to work successfully but without creating funding sinkholes.

It is at local and regional levels where considerable effort must be applied in order to create *adaptive strategies* for environmental problem-solving. This is a key concern for climate change, for addressing problems associated with natural disasters, and for issues such as desertification and maintaining ecological services. Adaptive strategies recognize that it is human behaviour that must be modified to successfully address environmental change. Such strategies depend upon a blend of technological application, good environmental planning, innovative economic incentives and a high level of public understanding and input.

7) Seek better solutions to high licensing fees, more timely and reasonable access to advanced technology and in general, build more proactive approaches to intellectual property rights matters for environment and sustainable development.

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[1] Asian Development Bank. 2002. *The 2020 Project. Policy Support in the People's Republic of China*. Chapter 8. *Technology Policy*. ADB, Manila.

The balance between indigenous technology development and the utilization of environmental technology developed elsewhere will be determined by many factors, but certainly issues surrounding intellectual property rights and cost of access rank high. The problem is more complex than monetary factors only, however. Those possessing advanced technology are wary of losing control over rights, or unauthorized copying, acts of industrial espionage, etc.. And there is also sometimes a concern about the absorptive capacity, which leads to staged access rather than leapfrogging.

In the coming years, as Chinese industrial and manufacturing development matures even further, and as the domestic environmental industry sector grows, there should be a much greater capacity and opportunity to assimilate advanced technologies. The value attached to these technologies quite likely will be even greater than today. And there will be new options, especially in alternative energy technology, green chemistry, biorefineries and other applications involving biotechnology and information technology. Energy efficiency, new coal technology and transportation are other areas where major advances are already occurring.

What will be needed are more effective international partnerships and joint ventures aimed at building the levels of trust and understanding, and experimentation with new approaches towards sharing technological experience and advances. In general it should be in the best interests of the rest of the world to accelerate the pace of China's transformation towards clean and efficient technology. Despite broad agreement about this statement, action has been relatively limited by comparison to the need. This is true for both government-to-government (e.g., EU S&T initiatives) or at the level of enterprises (e.g., the limited innovation efforts by overseas automobile manufacturers operating in China).

It is encouraging that new models are emerging; for example, the recently announced JUCCCE (Joint U.S.-China Cooperation on Clean Energy), a not-for-profit initiative designed "to accelerate 30 years of clean energy development into 10 years". It will bring together the U.S. and Chinese government, business, research, and investment interests to address China's current energy efficiency and pollution control priorities. Existing, but still evolving international

mechanisms such as the CDM (Clean Development Mechanism), and TRIPs (trade-related intellectual property rights) present future opportunities for China to make further gains towards more equitable arrangements on terms for technology access.

China also will benefit if it becomes a nation capable of exporting environment and sustainable development technology and expertise. This is already the case with solar panels, where China is a leader. New export markets for environmental products, taking advantage of China's comparative advantages such as lower production costs, could help to offset some of the fees paid to license advanced technologies. It also is a means of building economies of scale so that Chinese domestic markets can take advantage of more reasonably priced environmental goods.

8) Develop shared regional policies and practices with key countries and country groups within Asia and the Asia-Pacific region in order to create greater demand for environment and sustainable development innovation, and to create new markets for Chinese environmental goods and services.

With the rising level of need and interest in environment and sustainable development throughout the Asia-Pacific region, especially in South, Southeast and East Asia, there are good opportunities for China to build cooperative environment and sustainable development innovation ventures within the region. The advantages are obvious since often problems are shared or of a similar nature, costs of gaining access to appropriate levels of technologies may be less, and a clean environment will benefit all within the region. Also, there are bodies available that promote cooperation, such as ASEAN and APEC.

With huge populations and booming economies, markets for environmental goods and services in South and East Asia will become larger and larger. Yet there is insufficient cooperation to build a truly cutting edge approach that would take best advantage of the opportunities. It is striking that most of the international technology cooperation, venture capital access and capacity building necessary to supply these growing markets adequately are still via North America and Europe (along with considerable Japanese and growing Korean involvement). China and

India could change this equation very significantly through cooperation to become regional environmental innovation leaders.

9) Recognize the role of producing and disseminating reliable information on environment and sustainable development as a central component of national innovation strategy.

People and communities need to understand benefits, costs, and risks associated with innovation for environment and development and have direct access to benefits; otherwise there may be backlash. Fostering a culture of innovation within a country as large and diverse as China depends on education, public awareness, and a sense of opportunity. Environmental decline is now recognized as a matter of high concern by many of China's citizens, yet relatively few would be able to link problems and solutions to specific modern technologies or other innovations. Certainly the same was true in many western countries until a generation ago. Much of today's enhanced environmental perception has come about through a better understanding of pollution science, ecosystem analysis, etc., accompanied by an active media involvement to popularize scientific findings and to interpret environmental changes. The debates accompanying the search process to define the nature of problems and possible solutions have become an important part of democratic processes.

China's future choices on how and where to engage in scientific innovation for environment and sustainable development one way or another will be influenced by the voice of its people—whether operating through consumer choice, consultative processes, or other ways. It is essential that choices be informed by the best available Chinese and international knowledge, and that will require deliberative dialogue on technology, institutional performance, assessment of impacts and other concerns of the people.

10) Use China's comparative advantages to engage in the substantial markets for green products and services for both domestic and export markets.

China's low labour costs and skilled labour supply, ability to rapidly set up modern, efficient manufacturing plants, and technological design skills can be used to build international leadership in green markets of the future. Part of China's advan-

tage, of course, is the enormous potential size of domestic markets. Chinese businesses have been able to do this already with solar panels. Another opportunity clearly will be in the manufacture the next generation of lights to replace incandescent bulbs.

China has developed unique capabilities related to implementation of Circular Economy. Utilization of the world's waste paper is a one of the most significant examples of how China can meet its needs while contributing to the solution of a global problem. The idea of a Circular Economy is an important expression of an environment-friendly society. It is one of the most concrete ways to address environmental innovation.

Conclusion

China's strategic transformation on environment and development may well be unlike that of any other country. Coming some 30 years later than transitions in the OECD countries, China's transformation can be informed by many good and bad experiences of others. The challenge is for China's effort to be more successful than any other nation. Although there are many barriers domestically and internationally, there is also good reason to believe this success could be achieved so that China becomes a model for others.

Would it be in China's best interest to do so? And how substantial would be the economic, social, environmental and political benefits to the country? These are questions that will need to be debated. But it is clear enough that the entire world will benefit if China is successful.

Therefore, China's commitment to innovation for an environmental-friendly society is likely to become one of the great experiments of our time. It needs to be supported through accelerated efforts to more rapidly find ways to address such difficult and pressing problems as clean coal combustion and utilization, and mechanisms to properly assess new technologies so both domestic and international confidence is maintained. The experiment will start to demonstrate its benefits immediately, both to China and outside its borders. But the greatest payoffs will come in the longer term, hopefully to China's society of 2020, and to the world of

2030 when significant transitions in energy use, industrial ecology, Circular Economy and other innovations should be universal.

Environment and Development for a Harmonious Society

(2008)

Introduction

China seeks a transformative approach to environment and development that will provide lasting social, economic, and environmental benefits for its own society and, ultimately, for the world. It seeks an *Ecological Civilization* where conservation, in the broadest sense of the word, is a strong driving force influencing all elements of society. China wishes to accomplish these goals through fundamental shifts in the complex relationships between environment and economy, including in the use of an expanded range of market and regulatory instruments, specific implementation targets and timetables, and action consistent with scientific development and innovation. A successful transformative approach to environment and development will depend upon broad-based public support and participation and on international cooperation. The need is great for international leadership and action from a number of large countries, including China.

1. Harmonious society

At the October 2007 17th CPC Congress[1], people-centered scientific development was adopted as a constitutional amendment of the Communist Party, along with an amendment to pursue a "socialist harmonious society". These amendments focus attention on the role of values and reason in addressing developmental issues, including the protection of the environment. China's new approach has global relevance, with the potential for contributing to a "harmonious world"

[1] 17th National Congress of the Communist Party of China.

based on a path of "peaceful development". Premier Wen Jiabao has stated that:

"As China's development has shown and will continue to show, a prosperous, democratic, harmonious, civilized and modernized China will make even greater contributions to maintaining world peace and promoting human progress." [1]

These lofty ideals and welcome directions raise the issue of how Environment and Development action by China, other nations and the international community can contribute to a Harmonious Society within China and globally. This is the subject of the 2008 CCICED Issues Paper[2].

2. Global threats

The 2008 AGM comes at a time of unprecedented global financial market turmoil and the threat of severe global recession. Yet a large and growing ecological debt also threatens humanity. This coming year will test the commitment and capacity of all governments towards effective environmental action. It is vital that promising pathways towards sustainable development in China and globally not fall victim to tough economic times. It is via these pathways that future prosperity and stability will be secured. The paper examines key challenges and options.

3. Innovation

This year's AGM theme builds on discussions and recommendations concerning innovation from last year's AGM, a CCICED Round Table Meeting held in April 2008, and task forces providing interim or final reports at the 2008 AGM[3, 4]. CCICED believes that major commitments to innovation via science and technology and through institutional and behavioral change are essential to meet China's commitment to create an environment-friendly society. Therefore, we will continue to

[1] Speech at the 2007 Summer World Economic Forum Meeting in Dalian.

[2] This paper has been prepared by the Chief Advisors to the CCICED, Dr. Arthur Hanson and Professor Shen Guofang , with inputs from the Chief Advisors Group.

[3] CCICED Annual Policy Report 2007 Innovation for an Environment-Friendly Society; and Report of CCICED Roundtable Meeting 23-24 April 2008.

[4] Task Forces on Innovation for Sustainable Development, Environment & Health presenting Final Reports; plus three Energy and Environment Interim Task Force Reports.

focus on innovation as an organizing approach in our Issues Papers.

The link between a harmonious society and innovation is an interesting and potentially a quite difficult one. On the one hand, both concepts share characteristics such as promoting creativity, public information access, and participation in decisions. On the other hand, a fundamental issue is how to reconcile the inherent interest in creating stability within a society while still providing great room for the inherent instabilities associated with new ways of doing things—innovation. This may require a sophisticated recognition that rapid economic development and innovation will create the appearance of turbulence, but ultimately can lead to stability if conditions such as reasonably equal access to benefits and awareness raising accompanies change.

4. 2008

2008 has been a very eventful year for China: holding the very successful Beijing Olympics; coping with major disasters including unprecedented snowstorms and the Sichuan earthquake; staying the course of economic development despite high oil prices, rapid increases in food and other commodity prices, seeking stabilization and reform to the global financial sector; and addressing several crises of product contamination, including melamine in milk.

It is also an important anniversary—30 years after the Reform and Opening Up of China to modernization and globalization as a consequence of Deng Xiaoping’s transformative policy shift. This Opening Up has led to profound social change and poverty reduction, massive economic growth, initial action to correct severe pollution and other environmental problems, and international relations based around goals of trade, peace and regional stability.

It is also almost 30 years since China formulated its National Environmental Protection Law[1]. In March 2008 China formed the new Ministry of Environmental Protection (MEP), with Mr. Zhou Shengxian serving as the first minister having full cabinet status. China is now completing the third year of the 11th Five-Year

[1] This law came into effect on 26 December 1989, http://www.english.mep.gov.cn; http://www.chinaenvironmentallaw. com; http://www.greenlaw.org.cn/enblog.

Plan. There has been better progress this year towards achieving the Plan's environment and development objectives, but not enough[1]. Without further transformative changes in approach, it is likely that environmental improvements in China will continue along a linear pathway while factors creating environmental degradation occur in an exponential fashion. That is also the worry about climate change.

Internationally, there has been considerable introspection about the limited progress of sustainable development implementation during this year marking 20 years since the world began to respond to recommendations in the Brundtland Commission's report, *Our Common Future*[2].

Harmonious Society Explained

Harmonious Society is not a phrase widely used in western industrial countries, even though all the OECD countries, among others, strive to build a functional level of social cohesion and agreement on pathways that will lead to good quality of life and to happiness. Part of China's challenge in communicating with the rest of the world is to provide a persuasive view that its vision of Harmonious Society is one that is truly beneficial and in line with democratization and efforts for improving social equity.

1. Definition

Harmonious Society, as described in Chinese society from ancient times to today's approach, is holistic and balanced in approach. President Hu Jintao pro-

[1] MEP the National 11th Five-Year Plan for Environmental Protection (2005-2010) http://www.english.mep.gov.cn/Plans_Reports/ 11th_five_year_plan.

[2] These reviews and scenarios generally suggest future disharmony globally and the need for early action to avoid systematic environmental and societal breakdown. All call for transformative action at a societal level. These perspectives include the following reports and books: UNEP. November 2007. GEO 4 Global Environment Outlook. Environment for Development. UNEP, Nairobi. 539pp; OECD. March 2008. OECD Environmental Outlook to 2030. Summary and full report OECD, Paris.; Shell International. April 2008. Shell Energy Scenarios to 2050. 48pp; Gus Speth. 2008. The Bridge at the Edge of the World. Capitalism, the Environment and Crossing from Crisis to Sustainability. Yale University Press, New Haven. 295pp; Lord Nicholas Stern. April 2008. Key Elements of a Global Climate Change Deal. London School of Economics and Political Science. 56pp; Fred Krupp and Miriam Horn. March, 2008. Earth: The Sequel: The Race to Reinvent Energy and Stop Global Warming. W.W. Norton and Company. 279pp.

vides the following description:[1]

"The harmonious socialist society that we are trying to build features democracy, rule of law, fairness, justice, honesty, fraternity, dynamism, stability, orderliness, and harmony between man and nature. Democracy and rule of law means that socialist democracy is brought into full play, the basic policy of rule of law is implemented, and the positive elements of various sides are fully mobilized. Fairness and justice means that the interests of various social sectors are appropriately coordinated, civil conflicts and other social conflicts are correctly handled, and social fairness and justice is defended and realized. Honesty and fraternity means that everyone helps one another, honesty prevails in the society, and the people live next to each other in harmony with equality and fraternity. Dynamism means that every creative wish that is conducive to social development will be respected, creative activities will be supported, creative talents will be given free rein, and creative accomplishments will be acknowledged. Stability and orderliness means sound social organization mechanisms, social management, and social order: people live and work in peace and contentment; social stability and unity are maintained. Harmony between man and nature means economic development, wealthy life and balanced ecology".

2. Five harmonization elements

The following harmonization elements are emphasized in current government policy: (1) in the development of urban and rural areas (greater priority for rural development); (2) in regional development (assistance to poorer areas); (3) between economic and social development (health, education, employment opportunities); (4) between economic development and environment (resource use and environmental protection); (5) between domestic development and opening-up policy (domestic market growth and international trade). Since these elements are linked, it is necessary to address environment and development with respect to all five.

[1] Bo Guili. 2005. The Role of Chinese Government in Building a Harmonious Society. China National School of Administration. 7pp. Quote by President Hu on 2pp.

3. Measuring progress

Measurement of progress on achieving a harmonious society will be difficult. In China as elsewhere, there is recognition that various standard measures of progress such as GDP increase are inadequate[1]. Indeed, China's efforts to construct a Green GDP index reveal that a substantial portion of China's phenomenal economic growth is offset by environmental damage. China's policies are intended to take "People as a First Priority". The emphasis on people's well-being can be translated into a substantial number of concerns related to environment, including: poverty reduction, pollution reduction, ecosystem stability and services, health and environment, disaster management, and improved welfare and quality of life. The UN Human Development Index is a helpful measure for some of these concerns. Progress on achieving the Millennium Development Goals within China is a remarkable achievement[2]. Yet all of the measures cited are still insufficient to cover the range of aspirations set out by China. The implications for monitoring environment and development in the context of a harmonious society need further research.

4. Ecological civilization

The broadest Harmonious Society thinking has been statements concerning transformations within China and globally towards an Ecological Civilization[3]. An article in the China Daily just after the 17th CPC reflected on the need for changed perspectives:

> "This concept reflects an important change in the Party's understanding of development. Rather than emphasizing economic construction as the core of development as it did in the past, the Party authorities have come to realize that development, if sustainable, must entail a list of elements including the right relationship between man and nature.
>
> This concept is proposed at a time when 62% of the country's major rivers are seri-

[1] OECD's project on Global Progress on Measuring the Progress of Societies provides many examples of research on alternative measures.

[2] MDGs: China's Progress towards the Millennium Development Goals 2008. China and UNDP.

[3] Pan Yue. 2005. Ecological Civilization; and 17th Party Congress statements.

ously polluted, 90 percent of waterways flowing through urban areas are contaminated, more than 300 million residents are yet to have clean water to drink, and quite a number of localities fail to fulfill the required quotas for pollutant emission reduction and energy saving.

Facing such a reality, the construction of ecological civilization was absolutely not rhetoric for chest thumping by officials in their speeches. It needs to be transformed into tangible measures that will change the way our economy develops.

But it is never enough for the concept to be understood as environmental protection only and neither is it adequate for it to be comprehended as a supporting tool only for balanced economic development. With its definition containing a much broader meaning, the concept emphasizes the cultural dimension of development.

In this dimension, we need to put our relationship with nature into a new perspective: We need to consider nature as part of our life rather than something we can exploit without restraint.

Also in this dimension, social justice and fairness must be of great concern in development, we cannot expect to maintain ecological balance in a political sense unless we can make sure that disadvantaged social groups can fairly enjoy the benefits of development.

From the Outlook on Scientific Development to harmonious development and ecological civilization, we can see where the Party is trying to orientate the country's economic development and social progress[1]".

This notion of an Ecological Civilization is in line with China's domestic efforts to build a resource-efficient, environment-friendly society, a Circular Economy[2], a Low Carbon Economy, and to become a *Xiaokang* Society. These approaches reflect the reality of China's situation and needs. It is impossible for China to achieve its development along the wasteful lines followed over the last few hundred years by western societies. The planet will not bear the environmental

[1] China Daily 24 October 2007. Ecological Civilization.

[2] The Law on Promotion of a Circular Economy was passed on 29 August 2008 by the NPC Standing Committee and will take effect at the beginning of 2009.

burden and it is a pattern of development inconsistent with Chinese cultural ways[1]. For example the USA and China are believed to be the two nations with the largest ecological footprints, although the USA population is less than a quarter the size of China's[2].

5. Leading by doing

The path taken by 1.3 billion people cannot fail to have an impact on the world. This is a key point of China's potential importance in persuading other countries to follow a path toward an Ecological Civilization. Perhaps this concept proposed by China—and the actions that follow from it—could become the embodiment of *Our Common Future* for today's and tomorrow's generations worldwide.

Internationally, China has taken a relatively low profile over these past decades as it began its ascent towards its full position of influence in global society. It has participated in many multilateral arrangements for environment and development and has engaged in scientific, business and developmental relations with countries and people throughout the world. Now perhaps, it is impossible for China not to be in a leadership role. The country's actions are simply too important for it to be seen as a secondary participant or as an observer. China has demonstrated that it is an innovator on economic development and it will demonstrate that it is an innovator on environment and development.

International Experience

Some scientists argue that we have entered the *Anthropocene*, a period where human intervention has become a dominant factor affecting the Earth's ecology

[1] The CCICED-WWF report on China's Ecological Footprint shows the low per capita ecological footprint of China, but also the implications of a rise in consumption levels in a world already stressed beyond its long-term capacity to meet human and ecological resource and environmental needs.

[2] "The USA and China have the largest national footprints, each in total about 21% of global biocapacity, but U.S. citizens each require an average of 9.4 global ha (or nearly 4.5 Planet Earths if the global population had U.S. consumption patterns) while Chinese citizens use on average 2.1 global ha per person". Source: WWF. October, 2008. Living Planet Report. http://www.panda.org/index.cfm?uNewsID=148922.

and natural cycles. This underscores China's concern for widespread action to create an Ecological Civilization. At the October 2008 IUCN World Congress, members of this global voice for environment and development debated their vision for a new global transition for sustainability[1]. In the words of IUCN's Director General, Julia Marton-Lefevre "We need a new era of conservation that creates a social movement for change and relates to the nature of everyday living – one that embraces sustainable lifestyles and livelihoods as well as endangered species and spaces." The IUCN document provides at least a partial roadmap towards the vision of an Ecological Civilization. China's efforts could help realize this vision for one-fifth of the world's population and influence others' efforts.

The desire for a conservation philosophy has been with humanity for many thousands of years. Yet it has been exceptionally difficult to implement in modern affluent societies and in situations of significant poverty. It is apparent that the impacts of high consumption affect ecological conditions globally and that gross over-consumption can set off unintended financial consequences such as the current credit and economic crisis now affecting the entire world. Furthermore, although the global environmental agreements contribute to harmony among nations and across boundaries of culture, religion, etc., they are progressing far too slowly in their implementation at national levels. Despite this gloomy picture, there are lessons to be learned from various positive experiences in both rich nations and poor. Here, we have space to cover only a very limited number of examples.

1. Positive national experiences

Nations that lead in the UNDP Human Development Index, the Yale-Davos Environmental Sustainability Index, and other indices of well being, are of special interest also from the perspective of how they seek harmony in their development[2]. All those listed among the top 10 to 20 nations emphasize environmental quality within a broader quest for high quality of life.

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[1] IUCN. September 2008. Transition to Sustainability: Towards a Humane and Diverse World. Gland, Switzerland. 107pp.

[2] Other indices and research efforts include the Global Peace Index. http://www.vision of humanity.org ; GNH Gross National Happiness; Well-being of Nations Index; Happy Planet Index of the New Economics Foundation.

In Europe, the efforts to create harmonious societies appear to be particularly successful in some smaller countries, such as the Scandinavian countries and Switzerland. Given its position at a cultural and linguistic crossroads, Switzerland is particularly interesting. It has developed a democratic governance system that operates at the local "canton" level upwards. There is genuine "Unity in Diversity", including urban and rural views, at least four major cultural groups, and a strong, diversified economic base. A good environment, especially rural landscapes, is considered a key national and local asset that needs to be well protected for millennia.

Norway is a nation that appears to have developed a harmonious society through a combination of factors that includes: (1) respect for stable land ownership, including systems that discourage consolidation or excessive subdivision of family farms; (2) co-management and planning locally for sustainable natural resource use; (3) maintaining equity between rural and urban lifestyles and among different occupations; (4) proactive environmental planning and incentive-setting to address environmental concerns before they get out of hand; (5) concern for future generations through the creation of sovereign wealth funds; (6) investment in technology innovation for sustainable development. Norway, with other Nordic nations, has played important roles in seeking global harmonious development, as well, through their high profile on international environment and development matters and through the attention and funding they bring to international development cooperation.

Canada is quite a relevant example, given its geographic size and range of ecosystems, administrative complexity, and emphasis on multicultural harmony. Box 1 identifies several examples of institutions, management approaches, and mechanisms intended to build cooperation around environment and development. A substantial amount of Canada's efforts are directed towards federal-provincial harmonization and to addressing Canada-U.S. issues in a cooperative fashion. Canada has tried comprehensive approaches such as the *Projet de Société,* initiated in 1992 to develop a broad societal consensus around environment and development, but these have not thrived.

Japan, especially in its post-war efforts to build a resource-efficient society,

protect its forests, and construct environment-friendly cities and towns, has created models for a harmonious society. These strengths include unique government-industrial relationships that sometimes foster remarkable progress on environmental innovation, for example, Toyota's leadership in automobile innovation and Keidanren corporate social responsibility[1]. Yet in past decades Japan's progress was sometimes at the expense of a complex ecological footprint such as the damage created through tropical forest supply chains. Furthermore, despite the perception of being a relatively homogenous and harmonious society, the people of Japan hold strong and differentiated views. An example is the prolonged land use and environmental disputes that surrounded the construction of Narita Airport. Japan's harmonious relationship with nature stems, in part, from religious belief, especially Shintō where "nature is whole; it is clean and inherently good".

Several developing countries have developed relevant experience. One of the most dramatic examples in recent decades has been the efforts of Costa Rica to build an economy focused on ecological restoration of its forest lands and on the value of its biological diversity for ecotourism and other direct benefits[2]. The effort has been successful because of the country's social investments, especially for health and education. Also, Costa Rica has developed a participatory governance system and invested in science and technology for sustainable use of its ecosystems.

Box 1 Canadian Environment and Development Approaches for Harmonization

Canada faces some of the same types of challenges as China in terms of the range of development concerns in its various regions, income disparities and rural-urban divides, the need for ecological stewardship, an export-driven economy, concern for harmonious relations with neighboring countries, and various security issues, especially in marine and coastal areas and those related to climate change. Canada is a federation of provinces and territories that hold significant natural resource management and other responsibilities. There is a high level of public participation in governmental decision-making and a variety of channels exists to ensure this

[1] http://www.keidanren.or.jp/english/policy/csr.html.

[2] http://www.web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/LACEXT/COSTARICAEXTN/0, contentMDK: 20232979~pagePK:141137~piPK:141127~theSitePK:295413,00.html ; Honey, M. 1999. Ecotourism and Sustainable Development. Who owns Paradise? Island Press, Washington D.C..

happens. While often there appears to be disagreement, impasses, etc., there are many examples of how the mechanisms in place for environment and development do help to improve social harmony, justice and quality of life—all factors in why Canada has ranked among the top countries on indices such as the UNDP Development Index and the Yale-Davos ESI.

Example Institutions

CCME *—The Canadian Council of Ministers of the Environment has been in existence for more than 40 years. It is "the principal forum for members to develop national strategies, norms, and guidelines that each environment ministry across the country can use", operating by consensus. It has produced harmonized guidelines that enhance efficiency and certainty across the country, especially for business endeavors.*

NRTEE *—The National Round Table on the Environment and Economy was established 20 years ago to seek common ground among industry, government and civil society on specific environment and development concerns and transmits this advice to members of the federal cabinet. It builds its views with considerable input from the public.*

IJC *—The International Joint Commission is comprised of an equal number of U.S. and Canadian Commissioners who address environmental concerns in border regions. The IJC has been particularly effective on complex concerns related to the Great Lakes. It operates via government references and provides for stakeholder and government inputs.*

CEC *—The Commission on Environmental Cooperation operates within the framework of the NAFTA Free Trade Agreement between Canada, Mexico, and the U.S. It develops common strategies for the continent on management of biodiversity, produces a State of the Environment report for North America, and produces other reports such as release or toxic substances by various states and provinces. CEC has a formal citizen complaint process to investigate situations where a country may not be enforcing its environmental laws adequately for a specific issue.*

Example Management Approaches

Co-management Agreements *—A growing number of formal agreements between the federal government and resource users have been developed to share responsibility on specific natural resource management situations. Most of these have been worked out with the First Nations and the Inuit. The creation of Nunavut, a new territorial government in the eastern Arctic, is an example where co-management is enshrined and covers fish and wildlife among other topics. Another prominent agreement is for the management of the Gwaii Haanas National Park Reserve on the BC coast, with responsibility shared between the Haida First Nation and Canada.*

LRMP *—British Columbia faced acrimony bordering on violence and loss of some export*

markets over its forest management practices during the 1980s and early 1990s. An integrated Land and Resource Management Plan for each forest region was developed by the Provincial Government in a highly structured, participatory fashion to achieve agreement among stakeholders. This approach has been coupled with the development of a major system of protected areas in BC. Versions of LRMP now exist elsewhere.

FCM-Green Municipal Fund *—The Federation of Canadian Municipalities is an independent body representing all Canadian cities and towns—large and small. Through the Green Municipal Fund the Federal government entrusts FCM with substantial funding for environment and sustainable development projects, including water treatment, air pollution control, brownfield restoration, and other initiatives of interest to the municipalities. This approach ensures that interests and priorities of the municipalities can be addressed, while ensuring a transparent and competitive process.*

Environmental Justice

NWMO *—Long-term management of Canada's nuclear wastes has been a contentious concern subject to several major studies. These have led to the arms-length Nuclear Waste Management Organization. Nuclear power plants are putting substantial funding into a trust fund until there is agreement on location for a permanent waste storage site. This site will be selected only from one or more communities that express interest in having such a site and with inputs from many stakeholders. This is intended to avoid NIMBY ("Not In My Back Yard") debates.*

Intervenor Funding for Environmental Assessment and Monitoring *—A persistent concern has been providing sufficient funding so that key stakeholders can participate in environmental hearings on an equal footing with business and government. These funds are generally built into major environmental assessments, for example, in the Mackenzie Valley pipeline project, one of Canada's biggest projects proposed at present.*

An example of regional effort is in the Amazon Basin of South America. There is a need to protect the rights and economic needs of indigenous tribes, provide opportunities for poor farmers and others, and to adequately protect the biodiversity and ecological integrity of this vast region. The Republics of Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, and Venezuela must cooperate on the Amazon. They signed a 1978 Treaty for "harmonious development" of the Amazon, and in 1995 the ACTO, the Amazon Cooperation Treaty Organization was established to conduct work in support of biodiversity conservation and other needs. This body is an adjunct to the national efforts of countries such as Brazil.

2. Community-based initiatives

Harmony within societies at local levels depends upon relationships involving environmental impacts, social justice issues such as exposure to pollution or lack of basic needs such as clean drinking water, and economic factors such as employment opportunities associated with local resource development. Problems often are traced to situations of gender inequality, discrimination against minorities or poorer people who live and/or work in more dangerous and unhealthy situations. Both the World Conservation Organization (IUCN) through its *Conservation for Poverty Reduction Initiative*[1] and the UNDP though its *Equator Initiative Prize*[2], have documented hundreds of situations where environmental objectives are being met by communities fostering harmonious relations locally and with national governments.

Throughout the world there has been a move towards decentralization of environmental and natural resource management. Sometimes, such as the case of Indonesia, this has been to move stewardship responsibilities directly from national to local *kabupaten* (county) level. In some countries, negotiated arrangements have been made with specific groups for co-management or community-based management of environmental resources, including habitat, fisheries, and forests. In some cases land and resource ownership is ceded to local interests. Such mechanisms have the potential for improving stewardship of the environment, while also leading to greater harmony and innovative institutions for managing, for example, biodiversity and water resources.

3. Corporate policies

Some of the most interesting and significant environmental efforts for social harmony happen through the interplay of government, industry and civil society, either at the level of individual enterprises, or at a sectoral level through industry associations, or sometimes via cooperative efforts involving government,

[1] http://www.iucn.org/about/work/initiatives/sp_cprihome/index.cfm.

[2] http://www.equatorinitiative.org.

non-governmental, or community organizations. The government's role is to set standards and to create an enabling situation where industries can meet challenges in an efficient fashion. Industry efforts are driven by various motives, including: the desire to avoid excessive regulation, the right to operate in communities, corporate social responsibility (CSR)[1], access to financing and insurance, risk reduction, and the Responsible Care Program of the chemical industry (and now many other sectors); many gas, oil, and mining initiatives; and the move towards socially and environmentally responsible forestry throughout the world. There are many local, national, and international organizations that help to make these cooperative sectoral efforts credible and effective. They include CSR advocates and monitoring bodies, standard-setting and certification organizations such as the Forest Stewardship Council (FSC), and ethical banking for project financing[2,3]. Major environmental organizations such as the WWF, the World Resources Institute, and international bodies such as UNEP play important roles through their convening power, research, and ability to provide credible, independent views.

4. Gender and environment

In recent times greater attention is being given to gender and environment relationships, especially in rural areas where women and children may be severely affected by poor indoor air quality, or by issues such as pesticide use that may affect reproductive health, or from natural resource and other development projects that fail to provide sufficient benefits oriented towards women. The UN Millennium Development Goals highlight the need for gender sensitivity; this theme is important for all international development agencies. Access to social benefits, including good health care and equality in education opportunities, are essential if all citizens are to be informed and capable of contributing to environmental improvement. *Gender mainstreaming* is becoming an essential part of environmental man-

[1] For overview on China, see Geoffrey. 2008. Mapping the Harmonious Society and CSR Link1. Wharton Research Scholars Journal. U of Pennsylvania. http://www.repository.upenn.edu/cgi/viewcontent.cgi? article=1047&context= wharton_ research_scholars.

[2] WBCSD, Global Reporting Initiative, UN Global Compact, CSRChina.net, etc..

[3] Equator Principles http://www.equator-principles.com/index.shtml.

agement and sustainable development. This is a means of improving power sharing and therefore increasing the potential for greater harmony in social relationships.

The UN Fourth World Conference on Women was held in Beijing in 1995 and set the basis for many of today's considerations on the role of women in sustainable development. China's equality provisions in its constitution and laws and its adhesion to the International Convention for the Elimination of Discrimination Against Women (CEDAW) provide a good basis for further action on gender and environment. China is well-positioned to promote this element in seeking a harmonious society[1].

5. Three key issues facing the global community

1) Addressing Imbalances in Globalization Benefits and Costs.

At the March 2008 China Development Forum, Angel Gurria, OECD Secretary-General noted that while globalization has reduced poverty, especially within China, some 40% of global assets are now in the hands of only 1% of the world's adults[2]. Even within many of the world's richest nations, including 17 of 24 OECD nations, child poverty has increased during the past decade. His conclusion is that "Globalization is inevitable, but it is intrinsically neither good nor bad. It is our policy responses that make the difference".

Mr. Gurria focused on several important matters where the responses of both developed and developing countries needs to be well-coordinated if we are to have a more harmonious form of globalization: stabilizing and improving the factors of economic growth worldwide; tackling climate change with a viable cost-sharing formula between the richer and poorer nations; restoring the ethical dimension of economics so that poverty can be firmly addressed in the context of producing more harmonious societies; breaking the deadlock of the Doha Development

[1] CCICED has prepared a Gender Equality Strategy to guide its own work. CCICED Secretariat and Secretariat Int'l Support Office. July 2008. 15pp; The Tenth National Women's Congress was held in October 2008, pledging measures to narrow female-male income gaps and to improve women's ability to participate in science and technology innovation, and to enhance participation in decision-making bodies.

[2] Working in Partnership for a Harmonious Globalisation. Speech by Angel Gurria. March 2008. Beijing. http://www.oecd.org/ document/38/0,3343,en_2649_201185_40333606_1_1_1_1,00.html.

Agenda (DDA) of trade reform[1]; and addressing internal migration in the context of aging populations and other factors.

The imbalances of globalization created within a country such as China are seen as interlocked challenges that now urgently need to be addressed including: income inequality and regional disparities; the right balance between rural and urban development; high consumption of natural resources and great need for cleaner energy; and improved environmental quality[2]. Certainly other developing countries face similar challenges. Gurria notes that the list is in fact similar to the challenges faced by OECD nations. Therefore it is desirable to find solutions that reinforce the overall strength of global society. He indicates that the concept of "harmonious development" of China is very close to the "core mandate" of OECD itself.

2) Renewed Attention to Regulation.

Over the past 25 years the power of markets has been celebrated—not only for unleashing creativity leading to high economic growth, but also as an opportunity for improving competitiveness and for decreasing the need for command and control regulation. In particular, if macroeconomic conditions can be properly set and if macropolicies are in place to meet some of the concerns related to social and environmental externalities, then market-based instruments should be successful supplements to slimmed-down regulatory frameworks. Over time market-based approaches have produced dazzling results in the rapid growth of economies. They have led to concepts such as "smart regulation" that rely upon self-regulation and limited governmental checks and balances, and upon the opening of markets to new influences and purposes beyond their originally intended purpose, for example, commodity markets as a place for speculative trading beyond the purpose of spreading risk for producers.

The powerful message arising from the financial meltdown that has occurred this fall is that self-interest of even the richest and most powerful financial institutions can be misdirected. Recent years have demonstrated other important flaws in some fundamental decisions related to market-based approaches. Specifically, on

[1] http://www.wto.org/english/tratop_e/dda_e/dda_e.htm.

[2] Angel Gurria. 2008.

environmental externalities, market failure is common and not easy to overcome. Second, as the recent turmoil in world markets has demonstrated, when fundamental safeguards on the financial sector are ignored or removed, the systemic effects will be widespread to the point where these effects are a threat to both development and environment worldwide. The havoc wreaked by high oil prices, for example, compromised the ability of governments to move towards a systemic approach towards pricing carbon. Third, when regulatory breakdown occurs either at the producing or distribution end, consumers pay a price in terms of environmental health with backlash felt on trade. This has been demonstrated repeatedly over this past year as China faced problems with heavy metal contaminants in toys and melamine, first in pet foods and then in the milk scandal. These contamination problems are viewed as not only inadequacies within the Chinese regulatory systems[1], but also of those countries and companies that are inadequately regulating and monitoring quality of products before they reach consumers.

We can expect a renewed focus on regulation of all types. This focus will not reject market-based regulation, hopefully, but it will emphasize the need for much stronger and more effective regulatory frameworks in which markets should function better. The implication is that monitoring needs to be a more prominent component so that improper behaviour can be caught and dealt with at an earlier stage. Ultimately there must be sanctions that operate at a level sufficient to deter such behavior.

An important question is whether environment and sustainable development considerations can lead the way in developing a new balance for regulatory systems. It is attractive to consider this possibility for several reasons. First, a great deal of theoretical effort and some good practical experience exists on how a balance can be found between market-based and other regulatory approaches. Much of the work relates to pricing and incentives, where necessary standards and understanding of potential environmental benefits are already available.

The second reason is the urgency of addressing environmental matters in the

[1] Willy Lam. October 2008. Milk Powder Scandal Exposes China's Worsening Administrative Malaise. China Brief. Jamestown Foundation. Vol. 8, Issue 19.

context of the new economic realities facing the world. Past economic downturns have led to increased environmental disruptions such as the effects on forest land-use and small-scale mining in the aftermath of the Asian Meltdown of 1997. Climate change mitigation and adaptation should be incorporated into the priorities associated with national and international financial restructuring. These will be among the world's largest financing needs over the coming decades. Climate change will require continued building of new markets such as the sale of carbon credits.

A third reason is the comprehensive nature of sustainable development. From its start, sustainable development has focused on the interlocked nature of economic and environmental concerns and on how treating the environment responsibly will provide substantial social benefits, including greater equity. As regulatory regimes get reviewed, it is important that they be based on sustainable development principles and support integrative objectives, for example, those supporting environment and public health, and that they promote preventive action on pollution and excessive resource consumption.

China is in a relatively strong position for this renewed attention to regulation. It has made a point of developing a "socialist market economy" with opportunities to adjust raw market forces. China also is still in the design stage of its approach to "rule of law" and to the opening up of its financial sector. China has the buffer of substantial financial reserves and a population oriented towards savings rather than excessive consumption. Hopefully these attributes can be used not only to minimize some of the damage being created elsewhere by the current turmoil, but also to ensure that China's own financial commitment both to environment and to the innovation required for implementation of scientific development can be sustained. China likely will be of great help to other nations and the world community in the critical months and year ahead.

3) Effective Action on Global Agreements for Environment, Economy and Development.

Achieving agreement on steps to be taken and actual progress under several global accords—particularly those on climate change and on biodiversity, on the

Millennium Development Goals, and on full acceptance of the Doha Development Agenda—has been on the most important "to do" list for environment and development of the world community for several years. The limited success has been disappointing, especially since many countries have passed through a period of great prosperity when action was quite possible. Now, during this period of economic recovery and greater hardship for many, there is a serious need to increase momentum, and use these goals as building blocks for more sustainable approaches to development.

The key selling point certainly can start with the contribution each accord could make toward improved investment results. Should rich countries reduce their high level of agricultural subsidies, including new ones, and generally ill-conceived subsidies for biofuels from corn and grain[1]? How can trade barriers reducing and international development assistance be targeted even more directly towards meeting the MDG goals, including transfer of experience from the most successful country of all, China? And how can innovative financing for climate change action be increased in a way that contributes to renewed economic growth? Such questions are not really new to any of us, but they take on new meaning in a time of severe global downturn.

If we need to be reminded about how serious the overall environment and development situation is, or could become, it is only necessary to see how quickly the gathering storm of climate change effects has become apparent and how missing the 2015 targets of the MDGs will expose the world to further disharmony and human misery arising from poverty.

6. Addressing convergent crises

A significant international debate has emerged concerning the potential for the collapse of societies and even civilizations from environmental crises[2]. This debate

[1] This topic is explored in specific countries, including the USA and China in a series of reports produced by the Global Subsidies Initiative. The report on China, Biofuels—At What Cost? Government Support for Ethanol and Biodiesel in China. Is available at http://www.iisd.org.

[2] Jared M. Diamond. 2005. Collapse: How Societies Choose to Fail or Succeed; T. Homer-Dixon. 2006. The Upside of Down. Catastrophe, Creativity and the Renewal of Civilization. Random House of Canada; James Lovelock. 2006. The

covers the far end of the spectrum of disharmony associated with environmental change and impacts. There are other possibilities seriously discussed, for example, concern expressed by senior EU officials about climate change refugees flooding Europe, or Japan's plan to repatriate all its citizens living abroad in the event of a global pandemic[1,2]. Additionally and of a more immediate nature are the major short-term dislocations of millions of people that now routinely happen in the USA, China and elsewhere as a consequence of severe weather events such as hurricanes, typhoons and cyclones. Such efforts to protect populations at risk promote social harmony. China should be applauded for its efforts to improve weather monitoring, early warning systems, and planning to achieve rapid evacuation when weather or other natural threats occur. The two environmental monitoring satellites launched in September 2008 will help these efforts[3].

Societies no longer can deal with individual crises in isolation. There is a tendency for convergent crises to develop. Effects of an international financial crisis may affect food supply, at a time of serious drought within a country or region, which may lead to social unrest. Environmental degradation is sometimes the serious consequence of prolonged crisis cycles, for example civil strife and war in many developing nations, gradual loss in ecosystem productivity and services arising from repeated droughts, or systemic pollution such as acid rain.

Over the past decade China appears to have developed a considerable level of resilience in addressing convergent crises. It was able to avoid the worst consequences of the "Asian Financial Meltdown" in the late 1990s and at the same time turned the major crisis of severe flooding arising from El Niño into an opportunity for ecological restoration of damaged uplands. In 2008, China has once again been put to the severe test of several major natural disasters while at the same time having to deal with serious inflation and international energy, food, and financial market crises. It is clear that China has strengthened its capacity to respond

Revenge of Gaia: Why the Earth Is Fighting Back - and How We Can Still Save Humanity. Allen Lane.

[1] Ian Traynor. 10 March 2008. EU Told to Prepare for Flood of Climate Change Migrants. The Guardian.

[2] Asahi Shimbun. 11 April 2008. SDF to Retrieve Japanese if New Flu Hits Abroad.

[3] 8 Sept. 2008. Chinese Vice Premier Hails Launching of Disaster-monitoring Satellites. http://www.news.xinhuanet.com/english/2008-09/06/content_9810515.htm.

quickly and definitively, although problems remain (Box 2).

Box 2 Some Lessons from the 2008 Wenchuan Earthquake

The economic growth and development modes need to be improved. During the development process, science and objective rules should be respected and the development direction, sectoral and industrial distribution, urban construction and development layout, etc., need to be scientifically proven and planned. It is necessary to set up an effective social supervision system and mechanisms to guide the whole society and ensure that the economy develops along a good, sequential, and sustainable track:

The social mechanism to respond to natural disasters must be improved and regulated. This includes the establishment of warning the emergency response system against natural disasters, the improvement of information transparency to promote wider public participation, the establishment of effective disaster insurance systems, and formal control and supervision mechanisms on modern social charity.

Awareness and strengthen capacity building must be improved. It is especially necessary to popularize the education and knowledge on natural disasters to improve awareness and safety knowledge, thus to enable people to protect themselves and rescue others when disasters take place. At the same time, the technology and capacity to tackle natural disasters need to be strengthened, including research and development of rescue technology and equipments and training of rescue professionals.

Guiding the disaster-hit region reconstruction with the concept of scientific development is necessary. Post-disaster reconstruction should not simply restore the original status. This false goal will not lead to scientific, rational and harmonized new cities and villages built under the principles of sustainable development from the planning stage through to the management and administration of the completed infrastructure.

(Extracted from a longer report prepared for this Issues paper by Yu Hai of the PRCEE in MEP)

The way forward should include a clearer approach for turning crisis responses towards sustainable development. This will become more urgent as climate change effects become more prevalent throughout China. Climate change adaptation needs to be directed not only towards crisis avoidance, but also to creating sustainable development strategies in key sectors based on the presumption of serious "surprises" that are characteristic of complex interactions among crises. Many of the effects of severe natural disasters are really the effects of poor plan-

ning, corruption, management, and supervision decisions, which together make populations vulnerable.

China's Challenges

1. Economic growth model, volatile markets and recession

Others have pointed out China's difficulties associated with the current economic growth model. There is growing inequality as measured by the internationally-recognized Gini Coefficient, which has grown from 0.29 to 0.41[1]. Joseph Stiglitz calls for distributive impacts being a part of every policy decision, focusing on a good balance between the market and government regulatory system, an improved property rights legal framework, and a broader tax system that places less emphasis on value-added tax. He points out that, based on the experience of the US and elsewhere, weakening social protections goes counter to a Harmonious Society and may interfere with future productivity. Specifically, Prof. Stiglitz cites the low investment in education and schooling (e.g., in the period 2002-2005, China spent about 1.9% of GDP on education and about 5% on health; Brazil, by comparison spent 4.4% and 8.8%); and the lack of access to health insurance for many families. He calls for a new economic model where innovation can help provide a focus on saving resources, not saving labor. Such a model, in the opinion of Stiglitz, will lead to a more harmonious society while providing for the long-term, robust growth that will give China a competitive edge internationally.

China's Vice Minister of Finance believes financing sustainable economic development will provide the "material foundation for a harmonious society". The Government in its budgets will give top priority to key factors contributing to this objective including: "sufficient supplies of qualified workers and capital, technological innovation, and the capability of resources and environment to sus-

[1] Joseph Stiglitz. 2008. Towards a More Sustainable Growth Strategy for China. Presentation at CCER, Peking University.

tain rapid economic development”[1].

China appears to be uniquely positioned among all nations during the current world financial crisis and recession. While not immune to negative impacts, it also has buffers including its large and growing domestic market, budget surplus, and huge financial reserves. Premier Wen has suggested recently that “If a large country of 1.3 billion people can keep up stable and relatively fast economic growth, that is a big contribution to the world.” (Xinhua)

The environment and development challenge is to avoid responding to the economic downturn by sacrificing existing environmental gains or by cutting back on future sustainable development. There are three specific matters for consideration: (1) how to accelerate employment and revenue opportunities associated with environmental protection initiatives and innovation, especially in water and air pollution, solid waste, and energy and climate change problems; (2) how to increase the flow of funding to China’s rural countryside through environmental protection initiatives of direct benefit to local people and to support ecological services for the nation; (3) how to increase the contribution and efficiency of private sector efforts and therefore relieve some of the burden on government.

At this time of very tight credit abroad, which will affect start-up environmental technology companies around the world and therefore the rate at which environmental innovations will become commercially viable, Chinese financing and access to Chinese markets might prove valuable. Joint ventures could be encouraged, potentially under highly favorable conditions for China. It may also be a good time for China to invest in well-established environmental companies abroad in anticipation of future opportunities in fields such as water sanitation and renewable energy.

This is also a time when China might work with other nations to ensure that banks and other elements of the financial sector further develop environmental safeguards in their lending practices, insurance policies, and “green investing”. This is a new topic for China, but an exceedingly important one. It also relates to Corporate Social Responsibility implementation for companies operating within

[1] Xinhua News Agency. 29 June, 2008. Govt’s Budget Targets Education, Innovation, Environment. http://www.china.org.cn.

China and Chinese firms operating abroad.

2. Olympic games "green experience"

The 2008 Beijing Olympics and Paralympics have left a lasting impression domestically and internationally of China's efforts to come to grips with its environmental protection needs. Beijing's air quality rose to the highest levels seen in a decade, among other environmental achievements[1]. In the aftermath of the Games, Mr. Ban Ki Moon, the UN Secretary General, said that, "The Beijing Games is a…success of the practice of 'green Olympics, a High-tech Olympics and the People's Olympics'…The Games was also an important chance for the international community to promote world peace and harmony through enhancing dialogue and mutual trust"[2].

The challenge is to maximize the lasting benefits to come from these Games, including the experience gained in the advanced measures for environmental protection, including vehicle controls, advanced building design, and Circular Economy applications. People throughout China and throughout the world now have a better appreciation of the magnitude of China's environment and development situation and the efforts and the large expenditures involved in environmental cleanup. The challenge remains as to how Beijing can continue to experience the cleaner air exhibited in August 2008—and better, and how the environmental benefits seen in Beijing can spread to other locations throughout China, given the great financial effort required for one major city. How can other nations learn from these undertakings?

The Olympics were really a celebration of the 30 years of Opening Up and Reform that made China a candidate to host the Olympic Games and other forthcoming events such as the 2010 Shanghai Expo, which has a theme of "Better City, Better Life" and a focus on how to create an eco-friendly society and maintain sustainable development[3]. Through these events China has created a tremen-

[1] Greenpeace China has provided a thoughtful and detailed analysis of China's Olympic environmental effort: After the Olympics: Lessons from Beijing. 45pp.

[2] http://www.chinaview.org ,17 September 2008.

[3] http://www.en.expo2010china.com/expo/expoenglish.

dous "green marketing effort" that may have more influence with citizens than other, more technical approaches towards sustainable development.

3. Environmental supervision and enforcement

This past year has seen an unprecedented effort to strengthen environmental supervision and enforcement, especially via the new MEP[1]. Even so, the efforts are still not enough to turn the tide of environmental degradation and illegal activities. Some existing laws and regulations provide for stiffer penalties than in the past, but this does not necessarily deter polluters and others who damage the environment. Local governments often do not strictly enforce environmental protection measures. This problem continues to be a key challenge for the central government. There also is a major problem of the quality and continuity of environmental monitoring. These and other issues have been addressed in detail by past CCICED task forces and in OECD's China Environmental Performance Review[2,3].

4. Rural environment and development reform

Rural people still comprise 56% of China's 1.3 billion population, with income levels of only about 30% of city-dwellers. In 2007 the income gap was the largest ever. This inequality and other disparities, especially in access to education and health, are matters of great concern. At the October 2008 meeting of the CPC Central Committee major decisions were taken to address this persistent and deeply troubling disparity[4]. These decisions included commitments to: double disposable income of rural residents by 2020 based on 2008 levels; eliminate absolute poverty, now at 15 million according to official estimates; "establish a mechanism to integrate rural and urban areas in terms of economic growth and social development"; protect farmers rights; position agriculture as the founda-

[1] See the 2008 Policy Report by the CCICED Chief Advisors Group, which documents China's efforts to strengthen environmental policies over the past 12 months.

[2] CCICED. 2006. Environmental Governance Task Force Report; CCICED. 2007. Task Force Report on Achieving 11th Five-Year Plan Environmental Objectives.

[3] http://www.oecd.org/document/47/0,3343,en_2649_34307_37809647_1_1_1_1,00.html.

[4] 3rd Plenary Session of the 17th CPC Central Committee 9-12 October 2008.

tion of the national economy and put food security as the top priority via agricultural modernization and supervision of product quality; and develop public utilities in rural regions.

This approach is meant to promote greater equity and social harmony. The list does not explicitly address environment and development matters, but there are several. Already China is the world's largest consumer of fertilizers, which often are over-applied. With a renewed focus on food security, there is a need to work out improved means to address severe agricultural pollution of China's waterways and groundwater. Treatment of manure and utilization of agricultural residues for biofuels, biogas and chemicals are important topics where many more environmental advances can be expected through eco-innovation efforts. The call for increased public utilities in rural areas should open new employment and wealth creation in the countryside through investment in water supply and sewage, and through more efforts on rural sustainable energy such as wind farms and solar electrical generation sites. Product quality concerns will demand much more attention to pollutants entering into food chains and issues such as organic certification.

5. Stability

China values stability in its political system, in its economic growth pattern, and as an important prerequisite for its development. China has been able to absorb the impacts of many internal and external perturbations over this past decade and undoubtedly will have to deal with more in the future. The challenge is how to keep a steady course in a world with many destabilizing influences. Environmental degradation is one of the major such influences locally and, now with climate change, also regionally and globally. Another part of the stability challenge is the country's ability to turn serious crisis situations into opportunities to foster sustainable development; this already appears to be a significant element of China's efforts to build a harmonious society.

Environment and security provides a framework for examining relationships

between environmental degradation and social stability[1]. Another approach is to examine how environmental justice concepts are applied to reduce social friction and to redress harm done to particular groups or members of society.

In particular, achieving the necessary level of ecological services will require substantially more investment in eco-compensation programs and effective ecological construction efforts with a better guarantee of long-term results. This is especially important for insidious environmental change with the potential to affect large areas and major populations. The prime example in the past has been desertification, especially in the Loess Plateau. In the future, water supply and quality problems are likely to become major environmental justice issues.

The poor suffer the most serious consequences of natural disasters and the effects of long-term environmental degradation. In China this raises important questions about environmental justice and equity issues related to pollution, health and environment. A prime example is the indoor air pollution associated with substandard housing in rural households. Badly ventilated stoves, often burning coal, contribute to respiratory diseases and death among the poorest people and particularly affect women, who must spend long periods of time cooking and doing other indoor tasks.

The substantial number of protests each year concerning pollution incidents provides evidence of discontent over crisis on the part of some people directly affected by these problems. But many others suffer silently because they have little choice, for example, those living and working in many of China's coal mining communities. In some other parts of the world, the situation of pervasive, health-threatening air, water, and soil pollution would be unacceptable from a social or environmental justice perspective. As part of China's drive towards a harmonious society, this will also become the case within China, likely in the coming decade. Environmental justice has major reform implications for the justice system and rule of law.

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[1] See the Woodrow Wilson Center Environmental Change and Security Program publications on China. http://www. wilsoncenter.org/ index.cfm?topic_id=1413&fuseaction=topics.publications.

6. International cooperation

China has made it quite clear over the past several years that it wishes to contribute substantively to global environment and development, but not through overt leadership. On the other hand, there is a growing international view that China is a vital player on almost all environmental matters. China can demonstrate by its domestic actions how to achieve a more harmonious society globally including environmental actions. China also can directly assist other countries by sharing its environment experience and can be an important contributor by its enhanced participation through international cooperation and agreements. A major challenge for China is to seek what it considers "fair and just" international rules, whether for the environment, climate change, trade, the transfer of technology, or for other objectives.

1) World Trade and a Harmonious Society.

China owes much of its rise in economic prominence to its careful entry into the World Trade Organization and its skillful use of comparative advantages to build markets abroad. It also has benefited other countries through its demand for raw materials, which come from a growing number of sources, including developing nations in Latin America, Africa and Asia. Yet there are voices abroad that worry about China's growing impact on resource and environmental sustainability in other countries and on job losses through outsourcing of employment to China and other Asian countries. These are matters related to globalization trends more generally, but China is seen as the key country.

Market supply chains for food, energy, and other commodities and goods imported into or exported from China are central to the debate. Through careful research, the environmental costs and benefits are just beginning to be understood. The two key aspects are: how to maintain access to resources while contributing to international good relations and prosperity elsewhere; and how to avoid being caught in international squeezes such as food availability and price increases that will reduce domestic Chinese security and harmony.

The volatility of pricing in commodities, such as metals, oil, and gas, has

meant windfall profits for some companies and countries and great hardship for others. There are strong suspicions of market manipulation that exacerbate the situation. This is certainly not the path towards a globally harmonious society. This also compromises governmental capacity to make shifts as the introduction of carbon taxes and alterations in resource pricing that would promote the proper cost internalization of environmental externalities.

China is in a difficult position, since it depends so much on imported raw materials and also is deeply concerned with higher rates of inflation that can influence not only social stability but also its economic growth rate. The substantial government support provided to maintain gasoline and diesel fuel prices below world levels is an example of the serious situation.

The World Trade Organization has argued from the start of its existence that trade agreements are a route for enhancing global harmony and sustainable development. There is a danger, however, that the current impasse of World Trade negotiations, especially on the issue of agricultural market access, will lead to further bilateral and regional trading arrangements and to a movement away from globalized trade. There could be serious implications for China and, indeed, for many of its key trading partners.

Furthermore, there is still much to be done before the world's trading system, environment, and sustainable development are made compatible. Whether by the widespread adoption of international standards for the environmentally sound production of goods, and further development and acceptance of meaningful environmental certification, or through binding rules negotiated as part of trade agreements, the existing situation needs to change dramatically if it is to be compatible with the concept of an "Ecological Civilization". What should China's position be on the strengthening of environment in trade agreements? So far, China has been engaged, but does not hold a leadership role.

2) Fair and Just International Environmental Rules.

The international community should set up fair and just international environmental rules, abide by the principle of "common but differentiated responsibility", shoulder global environmental obligations together, step up international en-

vironmental treatment, and establish smooth and efficient implementation mechanisms for international environmental conventions and treaties, all of which eventually will lead to a more harmonious world.

These ideals tend to become stumbling blocks once they are translated into specific agreements and implementation strategies. They may lead to disappointment and frustration on the part of China and others in the quest for real progress on matters such as climate change, movement of hazardous wastes, and agreement on the inclusion of environmental matters in trade agreements[1].

How can this situation be improved for the mutual benefit not only of large developing countries such as China, Brazil and India, but also smaller and poorer nations and the OECD nations? Certainly one part of the solution is related to the role of the U.S. under a new President. The announced position on climate change of both parties is stronger than those of the current administration and with a greater support for multilateral solutions.

But the U.S. is not the only player with a major role in proposing and agreeing to environmental rules. If China is to satisfy its own needs for improved international environmental frameworks, it will have to build coalitions that cut across many interests. It also will need to build its image of both responsible international cooperation and of a nation genuinely committed to environmental improvement domestically and globally.

3) Millennium Development Goals (MDGs).

The Millennium Development Goals are an essential part of the global move towards sustainable development, but in many countries progress on meeting 2015 targets has been limited[2]. China has been an important exception. In the words of UNDP's China representative, Mr. Khalid Malik, "China is leading the way." It will achieve its MDGs by 2015. Yet key challenges remain. In Malik's view, they are environment, equity, and gender equality[3].

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[1] On 29 October 2008 China issued a White Paper on China's Policies and Actions for Addressing Climate Change http://www.china.org.cn/ government/news/2008-10/29/content_16681689.htm.

[2] Jeffrey D. Sachs. 2008. Common Wealth. Economics for a Crowded Planet. Penguin Press. New York. 386pp.

[3] Khalid Malik. 2007. A Contribution to the Achievement of a Harmonious Society. Statement at International Conference on CSR in China, 29 June 2007, Kunlun Hotel; and MDGs: China's Progress towards the Millennium Development Goals 2008. China and UNDP.

At his speech at the UN session on MDGs held in New York in September 2008, Premier Wen focused attention on the need for greater cooperation with other nations in order to meet the global MDG objectives[1]. He also noted China's direct efforts with poorer developing nations, including debt forgiveness, direct financial assistance, capacity building and technology sharing. Included is a new five-year commitment to 100 small-scale clean energy projects for developing countries, including small hydropower, solar power, and bio-gas initiatives.

China should be able to deploy more of its domestic environmental protection experience in support of developing countries in the years ahead. The commitment it has made for innovative technology development in water use, renewable energy, and pollution treatment will produce an array of new tools. Very likely the Chinese technologies will be cheaper and perhaps more effective for the needs of poor populations. Moreover, China is building a substantial body of experience on how to protect environmental services, including ecological reconstruction, and on financial systems for eco-compensation. This experience will be of value for many other countries that face similar problems concerning water basin, forest, agricultural, and coastal sustainability. China's disease control experience and growing efforts to address environmental and health issues link well to MDG needs abroad as well as in China.

Environmental Protection and Harmonious Society

The fundamental premise of this Issues Paper is that environmental protection is an intrinsic part of, and a contributor to, a Harmonious Society in China. In this section we will examine several breakthroughs needed for this premise to be fully realized[2].

[1] Wen Jiabao. 26 September 2008. Speech at High Level Meeting on MDGs. United Nations, New York http://www.news.xinhuanet.com/ english/2008-09/26/content_10116246.htm.

[2] The first part of this section is based on a longer report prepared for this Issues Paper by Zhou Guomei, from the Policy Research Center of MEP.

1. Roles and principles

The role of environmental protection in building a harmonious society/world is illustrated below, focusing on five elements (Figure 1).

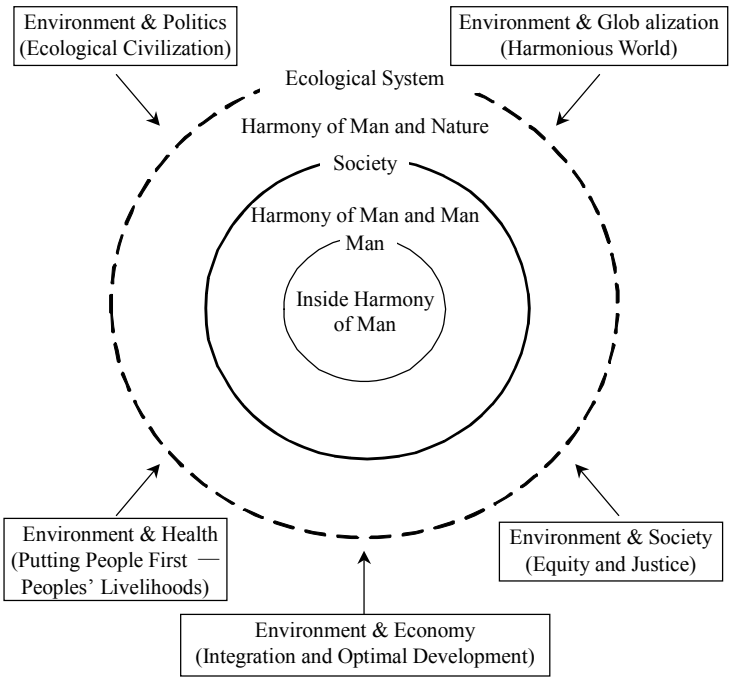

Figure 1 Roles of environmental protection in building a harmonious society

Several principles that are consistent with statements of current Chinese leaders are noted below:

(1) The Concept of Ecological Civilization is a basic tenet for a harmonious society.

(2) Putting People First is key to a sound environment and harmonious society relationship.

(3) The harmony of humans and nature requires the integration of environment and economy for optimizing development.

(4) Social equity and justice should be sought through environmental protection.

(5) China must promote international environmental equity and contribute to building a Harmonious World.

2. Approaches to sound environment and a harmonious society

In order to materialize a "socialist harmonious society", the scientific outlook of development should be adopted where the harmonious development between people and nature is an important idea. The immediate priorities should be to: (1) solve environmental problems that threaten people's health and sustainable development; (2) safeguard ecosystems; (3) reform environmental management systems. Much attention already has been given to these priorities, including within the 11th Five-Year Plan and in various Chinese and international reviews, including past CCICED reports and recommendations. Therefore, detailed accounts are not given here. Instead, we focus on the breakthroughs needed during the coming five years if China is to achieve its long-term vision of an environment-friendly society domestically and contribute to an *Ecological Civilization* globally.

We believe eight breakthroughs are essential.

1) A radical adjustment of the relationship between the environment and economy.

This fundamental shift has been called for in Premier Wen's Three Transformations and in the efforts of the 11th Five-Year Plan to meet pollution reduction and energy efficient targets. But the adjustments will have to be much more radical in the years ahead. These adjustments should include reaching efficiency levels in resource utilization that the world has not yet achieved and campaigns with Chinese consumers, municipalities, businesses and government bodies to ensure that "awareness of conservation will be firmly established in the whole of society".

The necessary adjustments will require relentless attention to achieving more stringent environmental protection targets, greater investment in the means to do so, and monitoring the benefits. It will require more attention to environmental protection and standards over the full life cycle of goods produced, distributed, and consumed in China. The result for China should be a high level of competitiveness in

the sunrise economy of sustainable development globally and nationally. It will mean a very discerning type of consumerism, especially in demand for high quality products and services. Finally it will be fostered by Circular Economy development.

2) Trade, investment, and financial sector reform must be consistent with sustainable development.

While China has benefited tremendously from its membership in the World Trade Organization (WTO) and from the immense inward flow of foreign capital, by no means has this been without major problems. These problems include environmental degradation associated with manufacturing for export, impacts associated with market supply chains domestically and internationally, and difficulty in accessing the best technology for environmental protection. By supplying cheap goods to world markets and buying raw materials, China has provided benefits to some developing countries, but most of the produced goods have gone to richer countries, exacerbating overconsumption in these markets.

China has only limited capability to address trade and investment issues on its own. But it is very clear that bodies such as the WTO, national regulatory bodies and central banks, and the financial markets that operate internationally have failed to create a system that respects the dictates of either environmental protection or sustainable development. This realization of failure is quite apparent and in particular the political talk and action accompanying current bailouts of the financial sector suggests a re-making of the system. It would be a shame if this did not include greater attention to sustainable development. This is also true with respect to the current efforts to breath life into WTO negotiations.

China will have considerable credibility in global negotiations over the coming years and could help to move the international agenda of trade and investment and of financial sector reform towards consideration for environment and sustainable development. These aspects would also require additional attention to domestically within Chinese banks, insurance companies, stock markets, and trade and investment regulatory bodies.

3) A long-term transition for China to become a Low Carbon Economy.

China's energy and environment relationship is currently heading into difficult territory with significant increases in imported oil and gas and high projections for the use of coal. Conventional energy efficiency solutions are needed in many sectors, including major industries, transportation, agriculture, and municipal infrastructure, but will not be enough. Energy conservation in daily living by people is also essential. However, a Low Carbon Economy solution will go much further: it will be comprehensive in the sense that it will account for capture and reduction of greenhouse gases; and it will provide for economic valuation of carbon, including carbon storage in nature. A Low Carbon Economy will be opportunity-driven, making it attractive to innovators and entrepreneurs in Chinese society. It will be based in part on the substantial financial opportunities associated with international and domestic carbon trading and special funds such as the Clean Development Mechanism (CDM).While the transition may be long-term, the directions need to be set soon, ideally during the planning for the 12th Five-Year Plan.

4) An environment and health action consistent with the alarming range and level of toxic impacts, potential for pandemic disease, and other environmental risks.

It is laudable that China now has an Action Plan on Environment and Health[1]. However, as will be reported by the CCICED Task Force on Environment and Health, this is only the start of what will need to be a very significant effort to reduce the mortality and ill health associated with chronic pollution, workplace and home health hazards, casualties related to disasters, and the threat of pandemics. Environmental health in China also includes the substantial number of deaths and injuries associated with transportation now that private autos are so prevalent, lifestyle matters, such as the rise in the number of smokers and other factors that will lead to increased cancer, heart disease, diabetes, and other health problems associated with affluence. Many of these problems are interactive and solutions are not straight-forward.

5) New ecosystem protection approaches that provide substantial and lasting

[1] Ministry of Health. 12 November 2007. Action Plan on Environment and Health (2007-2015). Available on http://www.english.mep.gov.cn.

economic, environmental, and social benefits to rural people.

The investment by China in forest and grassland restoration, protection of water supplies, and the ecological services associated with wetlands, nature reserves, degraded agricultural areas, watersheds and coastal deltas is already substantial. But it is not optimal, since national systems for eco-compensation are not refined fully, nor is the effectiveness of existing approaches very great. There is a need to act on the reality that most of these efforts should become permanent and provide a greater level of benefits to rural residents. Also, to recognize that pollution remediation is now an important part of ecological restoration, including industrial, agricultural, mining and energy, municipal clean-ups, and preventative action. Integrative solutions must combine economic, fiscal, ecological, technological, and institutional innovation.

6) Great acceleration of the pace of the development and commercialization of technological innovations for environment and sustainable development.

China should become the leading nation in the world in applying innovative environmental technologies. This may not happen until the next decade, but the groundwork is being laid through the tremendous science and technology research investment and through the emerging demand that will guarantee large domestic markets. China also offers huge advantages for low cost production and to bring production on line quickly. Wind energy is an excellent example of this advantage.

The range of environment and sustainability products and their associated services will define the 21st Century economy to a considerable extent, including advanced transportation modes, smart power grids, lighting, renewable energy sources, advanced water use such as capture of value of waste products such as heat from urban sewage, biorefineries, and other advanced approaches associated with biotechnology and information technology.

At present there is no well defined national innovation system for environmental protection, even though there are many initiatives and some important platforms.

7) The orientation and strengthening of the existing environmental management system to take full advantage of public participation and to respect public environ-

mental rights.

The increased information transparency[1] and steps taken to provide for public inputs to environmental decision-making and the handling of environmental complaints from the public have been successful. In the years ahead the public needs to have a more substantial role in decision-making and also to have the awareness and capacity to do so effectively. In some settings it should be possible for individuals and community-based organizations to become co-managers with the government in addressing resource and environmental concerns. For example, this should be the case in areas surrounding major nature reserves.

Public environmental rights can be expanded to include the right of environmental supervision, the right of being informed, the right of environmental compensation, and the right to participate in development of environmental policies and decisions affecting projects. All citizens, rich and poor, rural and urban, male and female, should enjoy equal access to these environmental rights.

Clearly, the existing environmental management system still suffers from the limited quality of information available to detect problems in a timely and definitive way and to verify progress. There is a need for a much stronger monitoring system—a system that should operate with due consideration of public input and information sharing.

8) Shifting international environmental cooperation towards integrated, sustainable development solutions.

International environmental cooperation should expand from pure environmental considerations to include sustainable development. We should combine environmental cooperation with development cooperation and resolve many, if not most, environmental problems through development. While we have witnessed progress for some global environment and development problems, the majority of problems continue to worsen. We have noted the growing prominence of regional environmental problems and trans-boundary environmental conflicts and that these

[1] For example, the MEP Guidelines for Release of Information, National Catalogue of Hazardous Wastes, Blacklist of Polluted Cities, State of the Environment Report and Semi-Annual Report on Indicators of Major Pollutant Discharges of All Provinces, Autonomous Regions and Municipalities.

problems have had more impact on political, economic, and social development. In addition, there are always new environmental problems emerging and becoming international in scope. These challenges make strengthened international cooperation a must. Sustainable development is a consensus of the international community. We should overcome cultural and ideological differences by taking coordinated action to establish the smooth and efficient implementation of mechanisms for international environmental conventions and treaties.

The benefits from successfully addressing these breakthroughs will directly contribute to a more harmonious society within China. These benefits include:

(1) New economic opportunities and livelihoods with less negative impacts.

(2) Better access by businesses and communities to cost-effective environmental solutions.

(3) Improved corporate social responsibility on the part of Chinese companies.

(4) Opportunities for people to be heard and to contribute to decisions affecting local and national development.

(5) Safer environmental conditions, including reduced risk of injury or loss arising from natural disasters and pollutants.

(6) Improved quality of life and health, with other benefits such as improved transportation.

(7) Improved trust from people towards decision-makers.

Conclusion

Environment and development is a key component in China’s efforts to build a harmonious society. The existing efforts at improving environmental management within China should pay good future dividends in terms of social and economic well-being for the people of China through improvement in the quality of life and satisfaction. Still much more progress is needed. In fact, the entire foundation for building a harmonious society in China requires considerable strengthening.

Experience elsewhere in the world has shown that environmental improvement is a shared concern within societies, around which conciliation and consensus

for action can occur. Environmental matters also can lead to measurable progress that can be communicated and provide a good entry point for public awareness-raising and responsible civic action.

China is taking a robust overall approach to environmental problem solving through scientific development, transformative rather than incremental change on environment and development, and attention to the application of a broader range of instruments to bring about desirable environmental improvements. However, the challenges are still massive, as noted in the eight breakthroughs described in the previous section. Implementation challenges continue to hinder progress on building a new relationship between environment and development, and therefore, on creating a harmonious society.

China faces the prospect of additional crises, given the risk of natural hazards such as earthquakes, floods and droughts; the effects of existing environmental degradation and unsustainable patterns of development; and global factors such as climate change. The tendency in the world today is for crises to converge into "Perfect Storms" involving environmental, food, energy, financial, or other crises. Globally, we are likely in such a situation at present. Fortunately, China in recent times has demonstrated both resilience and responsiveness to such circumstances. Importantly, it has recognized that crises, no matter how complex, come opportunities to innovate and seek new sustainable development pathways. As the severe tests of Wenchuan and other disasters this year have shown, there is still considerable room for improvement.

Environment and health is a pressing issue that is likely to become a source of greater social disharmony within China unless it is addressed more vigorously and quickly. It is an issue for citizens in all parts of the country and in both cities and the countryside. Transparency of information remains a concern, along with full definition of the extent of specific problems and equitable solutions. Increasingly, failure to deal effectively with environment and health makes China vulnerable in its external relationships—trade, environment and public health.

China's commitment to becoming an innovation society is, of course, tied to its efforts to build a harmonious society. It will be helpful to consider environment

and development as an important bridge in this process. China's efforts to build a new economy around a better balance of domestic and international consumer demand based on products and services requiring less energy and material will open many new opportunities for the country to increase its competitiveness. We believe this shift should be taken even further in certain sectors, such as renewable energy, where China can demonstrate world leadership and make full use of its comparative advantages. A shift towards being a country known for its commitment to a Low Carbon Economy and also firmly embracing advanced approaches to becoming a Circular Economy are practical ways this can be done.

China's great goal of promoting an *Ecological Civilization* needs to be introduced to the world in a highly skillful way and backed by significant action both domestically and internationally. Domestic action is well underway with the 11th Five-Year Plan's environmental goals. But, China's reputation as a nation committed to building international cooperation on the basis of peaceful development and improving the global environment still needs to be strengthened. China's commitment to achieving the Millennium Development Goals domestically and to use this experience with others internationally is a good example where progress is clear.

The global community is seeking clear signals of leadership from China on a number of matters including environmental concerns. The present global financial crisis has highlighted how China has positioned itself to reduce the impacts faced by others. Yet, it should also be apparent that no country is immune from the longer-term impacts. Thus, an important element of seeking a harmonious society will be innovative polices to keep the global and national goals for environment and development alive with demonstrated progress, no matter how difficult the economic environment becomes during the coming year. It is a crucial time for climate change matters, in particular, and on this topic, China can demonstrate considerable resolve, hopefully in concert with the new political regime in the USA, others in Europe, and elsewhere.

The worst situation would be to revert to the old economic model of "pollute first, clean up later".

China's Green Prosperity Future–Environment, Energy and Economy

(2009)

Executive Summary

Of the multiple crises facing the world at present, those posing the greatest threat to environment and development include the 2008 financial meltdown and its economic consequences, climate change, and poverty. Crises breed both challenges and opportunity, a point well realized within China. Thus China is seeking to mitigate the impacts of the global economic downturn with a stimulus package that will shift emphasis towards domestic consumption and accelerated infrastructure development, while continuing to build a modern economy in both urban and rural areas. It hopes to continue its march towards 2020 goals for improving both income levels and quality of life, including becoming a more environment-friendly society. This Issues Paper, prepared for the CCICED 2009 Annual General Meeting, explores how China might achieve a Green Prosperity Future through linking its future growth to better environment, energy and economy relationships. It will be essential to do this in order to address global climate change.

The unprecedented level of international cooperation to deal with economic recovery has shifted attention to the role of the G20 group of nations including China and other emerging large economies. In the dialogue at the UN, in G8 and G20 meetings, and in many other international gatherings during this past year, concern has been expressed that economic stimulus should not be at the expense of the environment, and, indeed, that economic recovery should be based on *Green Growth*. G20 leaders and many other nations have pledged significant action to address climate change, including efforts based on energy efficiency improvement, shifts towards greater reliance on renewable energy, and on pursuit of a low carbon

economy. These commitments to new approaches have to be long-term, certainly with a need to set goals to 2020, 2030 and 2050, with very substantial investment, innovation and capacity development.

China has given energy and environment high priority in its economic stimulus package, drawing on goals set for the 11th Five-Year Plan. The overall approach to environmental protection should continue to be improved during the next few years of recovery period. Structural changes within 10 key industrial sectors are being undertaken, including environmental protection action and more efficient use of resources and energy. In cities and rural areas environmental improvements, including better planning and design of infrastructure are happening and it is critical to accelerate progress. China also hopes to gain international competitiveness through its investment in new green technologies and products for which there will be both domestic and international markets. However, the growing income levels of people will significantly raise the per capita levels of energy use and greenhouse gas emissions. Therefore, how domestic sustainable consumption issues are addressed will become a key matter for concern. Chinese citizens at present are savers rather than spenders and frugal in their consumption. But that is not a guarantee of future sustainability, especially depending on shifts in lifestyles and decisions regarding urban design, transportation and other infrastructure. Greater emphasis on energy productivity and structural shifts in the economy towards more emphasis on tertiary, service based industry is important.

This year five CCICED Task Forces will report their findings and recommendations on various aspects of energy and environment. The topics include: Sustainable Use of Coal, Urban Energy and Environment, Rural Energy and Environment, Economic Instruments for Energy and Environment, and Low Carbon Economy. These studies cover the most critical issues that China needs to address for continuing its high rate of economic growth, but gradually decoupling this growth from increases in energy use and from environmental degradation.

With more than three years of the 11th Five-Year Plan completed it is possible to examine where progress has been made, and what remains to be done. For example, of the mandatory targets related to energy and environment, it should be

possible to meet the very important 10% reduction goal for SO_2 emissions a year ahead of schedule. However, to reach the goal of 20% energy reduction per unit GDP from 2005 levels will require further reduction levels of 5.89 % in 2009 and in 2010. Now that renewed levels of economic growth is definitely a strong prospect for China, the reliance on intensity indicators (tied to GDP) rather than total loading is dangerous in that absolute amounts of pollutants and energy use are still likely to be on the increase. Furthermore, many important pollutants such as NO_x, ground level ozone, mercury and other heavy metals, and POPs are not subject to targets, or even control strategies. Greenhouse gases and carbon reduction strategies were not incorporated into the 11th Five-Year Plan.

Looking ahead, China can continue along the pathway of transformative change concerning environment and development. The opportunities associated with Low Carbon Economy in particular should provide both competitive advantages and improved quality to future growth. There are many specific topics that may be highlighted for consideration in the 12th Five-Year Plan and beyond. In addition there are a number of specific drivers that should be taken into consideration in China's national planning and action for *Green Prosperity*. Those with direct links to environment, energy and economy include the following:

- Energy conservation and energy efficiency needs in a variety of sectors to bring energy intensity in line with, or better than, existing international norms.
- Reduction in energy intensity for urban buildings, infrastructure construction and operations, and urban transportation.
- Continued efforts to expand as rapidly as possible the use of renewable energy sources in China, focusing particularly on wind, solar, marsh gas (methane), and small-scale hydro.
- Specific actions related to international arrangements on energy, environment and climate change, including carbon pricing and possible trading, CDM, bilateral and multilateral agreements on technology transfer and partnerships, IPR, and investment arrangements.
- Adaptation needs concerning climate change.

- Mandatory targets for reduction in GHG emissions and carbon intensity of development.
- Continued improvement in environmental quality through more stringent reductions in pollutants covered under the 11th Five-Year Plan mandatory targets, plus a broader range of pollution control (e.g., mercury from coal burning, NO_x).
- A system for reduction in total pollution load for some sectors and regions.
- Improved protection for ecological services, and eco-compen-sation.
- Environment and health targets designed to reduce or eliminate mortality and cases related to specific causes, and improvement in environmental safety associated with key sectors such as coal mining and various types of industrial sectors.
- Full achievement of the MDGs within China, including those related to environmental sus-tainability.
- Strengthening frameworks to improve green growth opportunities, including scientific R&D, innovation technology investment, institutional strengthening and capacity building related to advanced efforts that will provide China with new economic growth opportunities and export potential related to meeting international demand especially those related to environment and energy.
- Improvement to the statistical information base for both energy and for environmental performance.

Key themes where China must build new or revised policies are:

- Strategy for sustainable use of coal.
- Immediate and longer-term steps towards Low Carbon Economy and Development, including implementation in both urban and rural settings, in various industrial sectors, and shifts towards green growth for both domestic and export products.
- An energy productivity strategy, including a progressive, predictable approach to energy pricing and the use of an improved mix of regulatory

and economic incentives.

- Carbon pricing, which may be based on carbon tax, cap and trade, or other arrangements.
- Targets for energy efficiency and energy-related environmental con- cerns, with some based on absolute amounts rather than intensity.

This Issues Paper has examined several global shifts of historical dimension taking place virtually simultaneously. On economic recovery and associated institutional changes there is a sense of optimism gradually emerging, in part due to the rapid action by political leaders to avert worst-case scenarios. The power sharing that is taking place in the restructuring of global institutions, and in the decision-making among the world's major economies is an outcome that would have hardly been believed possible only a year ago. China has strengthened its potential for international cooperation as a result.

The second great shift has been the depth of dialogue on the issue of climate change. Unfortunately getting a solid agreement about the best approach, with high levels of immediate action, is proving to be extremely difficult in the lead-up to Copenhagen. Whatever the immediate outcome, it is the start of a new way of thinking about our planet, and particularly about developing the Low Carbon Economies needed for the future.

The third shift is international cooperation concerning poverty reduction, and global capacity to address this serious problem. China's strides towards meeting its Millennium Development Goals present a remarkable success story, but one that is tempered by growing inequalities in wealth, and the realization that a fair part of China's population remains far too close to the poverty line. Yet China also can contribute much through expanded international cooperation throughout the developing world. The technologies that China is diffusing in its rural areas, its experience with renewable energy, and the advantages it brings in driving down the costs of production of many products are examples of unique contributions China can bring to many others in the world. Poverty is interlocked with climate change impacts and adaptation and with better environment and development relationships.

The fourth and hopefully very enduring shift is towards societies based on innovation that can more rapidly address the changing circumstances and demands on productive forces within national economies and globally. Green growth involves new forms of both production and consumption. It should influence all sectors of economic productivity, ranging from primary and secondary industries to the commercial, tourism, telecommunications and other aspects of modern tertiary activities. It is understandable that much of the focus on green growth currently centres around energy, environment, and climate change, but ultimately it is transformation of lifestyle, infrastructure design, and the way business is carried out that will determine better outcomes—a future of Green Prosperity.

Will China be the global leader in developing this new future? China's potential is great because it has the means to address key challenges and opportunities precisely at the point in time where it is building the infrastructure to house, transport, meet energy needs, water supply of its people at a better level; and because it is prepared to invest in social improvements, especially for health and education. China also has demonstrated its tremendous capacity to succeed in the global marketplace. With the great size of its domestic markets, its export marketing skills, and its ability to be adaptive, smart and fast, China has advantages that will be put to good use in coming years.

It is well to seriously consider the meaning of Ecological Civilization, a phrase used mainly in China. If nations can prosper at low levels of ecological damage—with a deeply felt respect for nature and the ecological services provided by the global commons and by the rich resources of the planet—then we might achieve an Ecological Civilization globally. China's leadership has called for this state of harmony between people and the planet, and we must presume that it will become a central part of China's on-going development philosophy. Other countries will have much to learn, and hopefully much to contribute, during this common journey towards a prosperous future.

Introduction

The multiple crises faced by China and the world call for new paths to prosperity. These pathways must align environment, economy and development in ways never before seen in the modern world. They must be resilient enough to address economic and financial upheaval; major environment, energy and climate change concerns; declining ecosystem conditions and ecological services; growing world demand for natural resources including water and food; unmet human development needs; and public health threats. These are among the *Common Challenges of the 21st Century.* [1]

The greatest challenge ever faced by the modern global economy occurred during this past year. It has been the most significant year for climate change negotiations. And, a very important shift in global relations is underway, with the emergence of the G20 this year as the major forum for shaping global economic decisions. In this year of New China's 60th Anniversary celebrations, and certainly in the coming decade, opportunities and expectations concerning China's participation in global economic, environmental and development matters are greater than ever before.

Our 2009 Issues Paper focuses on China's Green Prosperity Future because any future development pathway that fails to create a much improved relationship between environment and the economy ultimately will impoverish rather than enhance human well-being. This is true within China and elsewhere. Indeed, it is a fundamental point being stressed globally—at meetings of the G8, the G20 and in the United Nations General Assembly. Even in these harsh economic times, there has been a quite remarkable level of global resolve to continue efforts to address environmental protection. Much of this attention has focused on energy and environment, especially in relation to climate change. What has been most encouraging in the dialogue this past year among the world's leading economies is the recognition that between now and the

[1] A phrase used by President Obama in commenting on why he is accepting the Nobel Peace Prize in order to empower all nations. October 9, 2009.

mid-century there will be a revolution in how we capture and use energy to fuel our economy and meet human development needs. This, in turn, will influence the design of our communities, our food production, transportation and other key aspects of human existence, and will shape the next phase of globalization.

In meetings of the G20 and at the OECD this year, the call has been for a sustained and urgent effort for *green growth*, which is generally defined in terms of innovation and investment that will promote environmentally and socially sound economic development. Green growth is a means to an end—a prosperous, thriving society. A society of equitable distribution of wealth and opportunity, and one where the ecological support systems and services are well maintained. It is a society where people are satisfied with their way of life. In short, *Green Prosperity* is an aspirational outcome that deals with key quality of life factors, not only financial wealth and economic growth.[1] Both green growth and its outcome of green prosperity are inextricably linked to how the world and how countries, including China, deal with their energy and environment relationship, and particularly on how countries build their pathways of *low carbon economy, low carbon development, and low carbon prosperity.* Whatever the term used, it is essential to decouple energy use from economic growth, and to minimize environmental impacts, including those of climate change.

China’s leaders propose that, domestically and internationally, long-term transformative change should be towards *Ecological Civilization*[2] This transformation must take into account China’s enormous economic and social development challenges. These challenges include br-inging some 250 million Chinese citizens (mainly located in rural areas) above the World Bank poverty line standard

[1] Attempts to provide an index of prosperity along these lines have been started, notably the *Legatum Prosperity Index* based on *economic competitiveness* measured by 9 indicators and 12 indicators of *comparative liveability.* In the 2008 Prosperity Index, the leading nation was Australia, the USA and Germany ranked fourth and China ranked 54th. http://www.prosperity.com/ranking. aspx

[2] This term was introduced in a speech by Hu Jintao at the 17th Part Congress in October 2007. A concise point of view from a 5 June 2009 speech by Minister Zhou Shengxian is that “ecological civilization is to mend the ills of industrial civilization, instill the concept and requirement of environmental protection into social and economic development and create a major line of defence that will effectively prevent environmental pollution and resource waste.” For a detailed overview of the concept, see China Society for Hominology (eds.) June 2009. *Ecological Civilization, Globalization and Human Development.* Conference Proceedings. p388 . Sanya, China.

of US$1.25 per day.[1] As well, the massive planned migration of people to cities creates enormous demand for construction of both public and private infrastructure, and for hundreds of millions of new employment opportunities. The dual goals of quadrupling China's GDP by 2020, while also seeking to build an environment-friendly society remain formidable challenges, even though progress has been made on both goals during the first three years of the 11th Five-Year Plan. Vice-Premier Li Keqiang has noted the need for new economic growth points, focusing attention on efforts to tackle climate change, developing clean energy, and strengthening environmental protection.[2]

An example of the resolve that is emerging is the "New Chinese Road towards Environmental Protection". Minister Zhou Shengxian in his thoughts about this New Road has laid out a clear set of needs:

(1) a proper relationship between environment and economy with accelerated efforts for environmental protection; (2) a holistic perspective on environment fitted within a Chinese macro-strategy and conditions; (3) a precautionary system that places emphasis on pollution prevention and control; (4) cost-effective environmental measures that are efficient and practical in their application; (5) improved policies, standards and laws in order to create advanced production capacity within China; (6) a more complete environmental management system in which public participation is the major social force and government takes a leading role for environmental protection. [3]

And internationally, there are new initiatives such as the Global Green New Deal promoted by UNEP and others.[4] China is very actively engaging with others on how to address climate change, and other energy and environment concerns.[5]

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[1] Liu Zhenmin, China Deputy Permanent Representative to UN speaking to the 5th Committee of 64th Session of the UNGA. China Daily 7 October 2009. *China Ready to Contribute More to United Nations.*

[2] China Daily 6 July 2009. *Making Chinese Officials See Green.*

[3] See speech by Minister Zhou Shengxian, Minister of MEP. 5 June 2009. Actively Exploring a New Path to Environmental Protection with Chinese Characteristics under the Guidance of Ecological Civilization. Beijing, World Environment Day Forum.

[4] http://www.unep.org/greeneconomy/docs/ggnd_Final% 20Report.pdf.

[5] Examples include the China-USA Energy and Environment Agreement, the dialogue underway via The Major Economies Forum on Energy and Climate, and the UN preparatory meetings on climate change since the Bali Action Plan was signed in 2007.

Internationally, however, during this time of economic stimulus and recovery, there is a perhaps grossly unfair perception that "as China goes, so goes the world". Some expectations are simplistic and overblown, for example, that China's shift towards greater domestic consumption will support renewed economic growth for the rest of the world, that China's efforts to improve global financial institutions will lead the way to stability, and that China, either single-handedly or with one or two other nations (e.g., the USA and/or India), can make-or-break a favourable outcome of the Copenhagen climate change negotiations.

International cooperation depends up-on complex alignments in which China is rapidly becoming a more important player, but one primarily still concerned with getting its own development directions right. As Liu Zhenmin noted to the UN in discussions concerning Chinese financial contributions: "in 2008, China's per capita GDP stood at US$3,000, ranked about 100th in the world and still far from the average per capita gross national income (GNI) of $7,119." [1]

China's growing prominence in the world, however, is not built so much around per capita measures, as around its overall performance. China currently leads the world in its rapid return during the past year to high economic growth rates (8% target). It is projected to become the leading exporting nation in the world, outpacing Germany. And, China is now believed to be the leading contributor to global greenhouse gas emissions in large part due to its reliance on coal-burning. But China also is now a leader on production of solar panels and on installation of wind turbines. It leads on the production of batteries needed for electrical vehicles and for storage of renewably-generated electricity.

China is at a critical crossroads in its development pathway. If the transformative path towards green growth and prosperity is followed to its fullest extent, the country should be able to meet its economic and social objectives and greatly improve its own environment and development—while con-tributing to improvement of the global env-ironment and to development opportunities for other countries.

[1] China Daily 7 October, 2009. *China Ready to Contribute More to United Nations.*

This Issues Paper focuses on concepts and efforts within China and internationally for Green Prosperity, and how these efforts relate to environment, energy and renewed economic growth. The Paper examines: (1) economic stimulus and environmental performance; (2) some key issues for energy, environment and climate change, especially those such as low carbon economy addressed through CCICED task forces; (3) green growth and prosperity; (4) 11th Five-Year Plan performance to date, and some potential areas for CCICED recommendations concerning the 12th Five-Year Plan. The paper draws upon valuable conclusions and recommendations drawn from the CCICED Round Table held in April 2009.[1]

Stimulus and Environmental Performance[2]

1.G20 leadership in economic recovery

The financial meltdown and global economic recovery effort has perhaps forever changed the landscape of international power sharing. This was acknowledged at the G20 Pittsburgh Summit—that from now on it will be the G20 rather than the G8 providing key directions for coordinated global economic action. Following the 2008 financial meltdown, most G20 nations rushed to put in place economic stimulus packages that would avoid disastrous financial ruin, and would stimulate renewed growth. From the start of this effort there were serious concerns about the environmental effects of short-term stimulus packages and also on the longer influence of deficit spending on a remarkable scale. As well, much has been written about the potential effects of the global financial crisis on development progress within poorer countries, and on the potential of the crisis to derail the global climate change negotiations.

At the London meeting of the G20 in April 2009, leaders[3] noted that:

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[1] CCICED 2009 Roundtable Meeting Proceedings. *Green Development: Opportunities for China in Times of Economic Challenge.* 79pp. 16-17 April, 2009.

[2] This section has been prepared in part from a background paper prepared for this Issues paper by Dr. Zhou Guomei and Dr. Yu Hai.

[3] G20 Leaders Statement, 2 April, 2009.

…We agreed to make the best possible use of investment funded by fiscal stimulus programmes towards the goal of building a resilient, sustainable, and green recovery. We will make the transition towards clean, innovative, resource efficient, low carbon technologies and infrastructure…We will identify and work together on further measures to build sustainable economies…

This mantra was repeated during the latest G20 meeting in Pittsburgh, but with the addition of a proposal to develop a Framework for Strong, Sustainable and Balanced Growth. This Framework is intended to …move towards greener, more sustainable growth, (and) to phase out and rationalize over the medium term inefficient fossil fuel subsidies while providing targeted support for the poorest. The G20 Pittsburgh commitment provides the str-ongest support yet for green recovery including the pledges noted in Box 1. China is a signatory to these pledges.

That the efforts towards economic recovery have had a positive short-term effect on turning around a potentially devastating destabilization of the world economy appears certain. But there are still strong warnings concerning the fragility of today’s situation, plus the additional concern that deficit spending in the years ahead will foreclose options for the coming generation. While it is encouraging that political leaders of the world’s major economies agree on the need for a green recovery, for an end to destabilizing booms and busts, and for structural reforms, the path ahead may be fraught with practical macroeconomic and other difficulties too numerous to discuss here. What is clear is that China’s position in the recovery is one of relative strength, and of significance to the rest of the world’s recovery.

In fact, both China and the USA have been front and centre since September 2008, but for somewhat different reasons. China has demonstrated a more rapid recovery, and greater stability in its banking and financial system. The USA has plunged itself into a high level of indebtedness, even though it has undertaken major steps to avoid a repeat of what is now regarded as senseless folly on the part of its financial sector. It has supported huge recovery packages that place much of the funding into the hands of foundering industries such as the domestic auto sector. But the USA, along with Western Europe also has taken major steps towards an integrated recovery process that places major faith on innovation, especially towards

green growth and transformation of energy-economy relationships.

Box 1 Excerpts from the Statement by G20 Leaders at the Pittsburgh Summit, 25 September 2009

…As leaders of the world's major economies, we are working for a resilient, sustainable, and green recovery.

Increasing clean and renewable energy supplies, improving energy efficiency, and promoting conservation are critical steps to protect our environment, promote sustainable growth and address the threat of climate change Accelerated adoption of economically sound clean and renewable energy technology and energy efficiency measures diversifies our energy supplies and strengthens our energy security. We commit to:

Stimulate investment in clean energy, renewables, and energy efficiency and provide financial and technical support for such projects in developing countries.

We, the Leaders of the countries gathered for the Pittsburgh Summit, recognize that concerted action is needed to help our economies get back to stable ground and prosper tomorrow. We commit to taking responsible actions to ensure that every stakeholder– consumers, workers, investors, entrepreneurs – can participate in a balanced, equitable, and inclusive global economy.

We share the overarching goal to promote a broader prosperity for our people through balanced growth within and across nations; through coherent economic, social, and environmental strategies; and through robust financial systems and effective international collaboration.

We have a responsibility to secure our future through sustainable consumption, production and use of resources that conserve our environment and address the challenge of climate change.

We have a responsibility to invest in people by providing education, job training, decent work conditions, health care and social safety net support, and to fight poverty, discrimination, and all forms of social exclusion.

We have a responsibility to recognize that all economies, rich and poor, are partners in building a sustainable and balanced global economy in which the benefits of economic growth are broadly and equitably shared. We also have a responsibility to achieve the internationally agreed development goals.

2. Environmental spending in stimulus packages

Monitoring of environmental spending in stimulus packages has been relatively difficult to do since categorization of expenditures is somewhat arbitrary and commitments have shifted as plans were implemented. Lord Nicholas Stern sug-

gested that at least 20% of recovery packages should be devoted to environment, especially for addressing climate change. Joseph Stiglitz proposed that at least 1% of stimulus packages should be directed to meeting the needs of poorer developing nations. And, of course stimulus packages have ranged from a relatively moderate commitment in relation to GDP to massive packages such as those of the USA and China.

The first major assessment of "eco-friendly" stimulus expenditure was carried out by HSBC in January 2009. This assessment noted that the leader was South Korea with almost the entire package focused on green growth. China's commitment was also noted as one of the highest at more than 35%, and USD 200 billion (4.8% of the 2008 GDP), figures that likely erred on the high side. It was higher than the USA which was USD 94 billion, about 12% of the package.1 Green stimulus funding appears to be spent primarily on four areas of concern: green infrastructure including buildings, transportation; renewable energy; electrical grid; water & sewers; environmental restoration in rural areas, cities & industrial areas; protection of ecosystem services for sustainable land, water and air use; and sustainability technologies from the R&D stage to commercialization for new approaches for clean coal, advanced biofuel, solar, and many other energy-related technologies.

That stimulus packages can have positive and negative impacts on environment is a concern. A study by E3G and WWF[2] suggested that, of 5 countries surveyed, plus the EU stimulus efforts. Italy was the only country with a net negative impact due to its major focus on road-building. All 5 countries had some negative as well as positive environmental contributions. The EU contribution was considered exclusively positive, with a focus on renewables, electrical grid infrastructure and carbon capture and storage (CCS). This study did not include analysis of China's situation.

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[1] These figures are from 3 April 2009 issue of The Economist, based on the HSBC study by N. Robins. February 2009. A *Climate for Recovery. The Colour of Stimulus Goes Green. See also naturenews 30March2009, based on Edenhofer & Stern Towards a Global Green Recovery.*

[2] E3G & WWF. April 2009. Economic/climate recovery scorecards.

3. Environment and development in China's crisis recovery

The key question for CCICED is what are the immediate impacts of economic stimulus on China's environmental protection? And, more generally, what longer-term consequences will there be for environment and development as a consequence of China's recovery strategy and actions.

1)Economic stimulus efforts.

Without a doubt, China has launched a major environmental effort through its two-year stimulus plan. The overall plan gives priority to welfare projects, infrastructure construction, ecological protection, and post-quake reconstruction in Western China. The focus is to generate more income for citizens, particular poor groups so as to ensure sound and fast economic development. Some funding will come from central government (29.5%); the rest (70.5%) will come from local governments, bank lending and the private sector. There are many initiatives specifically labeled as environmental contributions, and other elements that should have positive environmental effects. But early on there were concerns expressed that some projects might be undertaken without adequate environmental safeguards or environmental assessments. These problems have emerged at a significant level. Initiatives specifically earmarked as environmental (emissions reduction and ecological protection) amount to RMB 210 billion, about 5.25% of total stimulus spending (see Table 1)[1] If all the other environment-related investment for structural reform, post-quake reconstruction and infrastructure construction, the total investment for environment protection in this package could be as high as 10%.

The environmental efforts undertaken via the stimulus effort in China are linked to the 11th Five-Year Plan, including the mandatory energy intensity (20% reduction per unit GDP) and pollution intensity (10% reduction per unit GDP) targets, the promotion of Circular Economy, the 2007 Climate Change Action Plan, and an improved economic incentives approach for environmental protection in-

[1] The major projects for environment protection include the following: to build 290 million mu forests; to expand water treatment capacity by 2.83 million ton/day and increase garbage treatment capacity by 3 155 ton/day; to build new pipeline network (water and sewage) 2 458 km; to cut COD by 65 thousand ton; to dispose chromium residue 320 thousand ton; to save energy by 6.16 million ton of standard coal; to save water by 120 million ton; and to recycle 2.7 million ton of waste.

cluding greater attention to policies such as environmental taxation, green credit, green insurance, green securities, emissions trading, ecological compensation, as well as green trade.[1] The attention given to green credit is particularly important given that there has been a massive increase in the number of large loans during 2009.

Over the next three years from various sources China will raise a total of RMB 1 trillion for environmental protection, including the stimulus funds. As for current progress, the Central Government allocated RMB 12 billion from the newly-added RMB 100 billion investment budget in the fourth quarter of 2008 for emission reduction and ecological protection. In addition, the Central Government also arranged RMB 2.5 billion investment in ten large energy saving projects, circular economy projects, and industrial pollution control programs in key river basin areas.

Table 1 Elements of the 4-trillion RMB Economic Stimulus Package to the End of 2010

Investment Theme	Investment Amount (billion RMB)	Proportion (%)
Total	4 000	100
Welfare housing projects for poor people	400	10
Infrastructure construction in rural areas	370	9.25
Key infrastructure like airports, railways and express ways, and grid facilities in urban areas	1 500	37.5
Social undertakings like medical care, education, and culture projects	150	3.75
Emission reduction and ecological protection	210	5.25
Innovation and industrial restructuring	370	9.25
Post-earthquake reconstruction	1 000	25

Source: National Development and Reform Commission.

All is not rosy, however. The huge economic stimulus could revive the energy-intensive, heavy-polluting sectors and result in overcapacity in low-end industries. Even though the environmental and ecological sectors will receive in-

[1] These aspects of China's efforts are reviewed in more detail in the background paper by Dr. Zhou and Dr. Yu.

vestment from the package, the proportion is merely 5.25%. And in terms of this year's central fiscal budget, the proportion of expenditure in 2009 for environmental protection has dropped from the previous 2.86% to 2.82%. If we consider the boom in fixed-asset investment, environment protection investment is only a small part, and its proportion to the overall investment generally has been on a downward trend from 2001-2005, a demonstration that investment in environment protection still lags behind economic growth.

Importantly, due to the current circumstances where economic growth stimulus is the predominant goal, many investment projects, even if they have passed environmental assessments, will likely pose some level of environment risk and threat in the longer term as they are so large-scale and concentrated. In February 2009, MEP investigated 71 project applications from 2008, which were either waiting for approval or had been refused. According to preliminary findings, 8% of these projects started the construction without approval and 3 projects even started operations without approval. So 15% of the projects violated the rules. In addition, the MEP conducted a sampled investigation into 118 project applications at the provincial and municipal level, and found that the rule-breaking rate was as high as 24%.

2)Revitalization plans for 10 key industries.

To address the bottlenecks in industrial operation and development, to secure future economic growth and job creation, as well as to promote industrial upgrading and structural adjustment, in early 2009, the State Council unveiled a total of ten industrial sector revitalization plans, covering steel, auto manufacturing, shipbuilding, petrochemical, textiles, light industry, non-ferrous metal industry, equipment manufacturing, electronic information industry as well as the logistics industry. These plans will be translated into reality from 2009 to 2011.

These ten industrial sectors are significant pillars for China's economy as they are major source of industrial output and fiscal revenue. They create huge numbers of job opportunities and play a key role in driving China's GDP growth. The aggregate of employees in these ten industrial sectors amount to 100 million, and the livelihood of about 300 million rural people is related to these industries.

The nine industries (excluding the logistic sector) contribute 80% of the total industrial added-value in China, accounting for roughly one third of the GDP. In addition, large enterprises in these industries pay around 40% of the total tax revenue to the government.

Reviewing the revitalization plans for 10 key industries reveals that most give full consideration to factors including structural adjustment, technical upgrading, environment protection, emission reduction, and cutting low-end manufacturing capacities, etc. The plans take into account the environmental effects in the process, and map out corresponding strategies and measures to prevent and try to address potential environmental problems and risks. In some plans, there are specific chapters and indicators for emission reduction.

For instance, the auto industry plan proposes that China should follow a structural reform approach, seek breakthroughs in developing environment-friendly new cars, increase the research capacity for such cars, encourage the innovation, technological renovation, and mass production of electric-powered cars, and launch a new energy-efficient car strategy. In addition, that plan also contains a number of "green policies" including new green tax revenue, green government expenditures and green standards, all intended to make environmental protection less burdensome.

By comparison with the industrial revitalization in developed countries, China's revitalization plans remain focused on traditional industries to a considerable degree. This is closely related with China's situation as the plans have to accommodate specific constraints in economic development and industrial structure, and also have to address the major social issues like job creation. Therefore, some industries included in the 10 plans still belong to energy-intensive, high-polluting and resource-dependent industries, such as iron steel and petrochemical. These industries have experienced over-expansion and over-capacity during recent years. Most are manufacturing low-end products that consume huge amounts of energy and resources, with heavy pollution. As they are relying on overseas markets, they have been heavily hit by the financial crisis. In terms of their total capacity, structure and geographical distribution, revitalization of these

sectors will likely exert heavy pressure on environment, with uncertainties that may trigger significant environment risks in the future.

Table 2 Energy Saving and Environmental Content in 10 Key Industry Revitalization

	Targets, tasks and measures for energy-saving and environment protection			
10 key industries	Structural reform	Technical upgrading	Emission reduction	Cutting low-end manufacturing capacity
Auto	√	√	√	√
Iron steel	√	√	√	√
Electronic information		√		
Logistics				
Textile	√	√	√	√
Manufacturing	√	√	√	√
Non-ferrous metal	√	√	√	√
Light industry	√	√	√	√
Petrochemical	√	√	√	√
Shipbuilding				

(Information for Logistics and Shipbuilding is not available)

3)Deepening structural economic reform.

On May 19, 2009, the State Council distributed the *Opinion on Deepening Structural Economic Reform* (hereinafter "the Opinion"), which was drafted by the NDRC. The Opinion is the overarching document to guide in-depth structural economic reform. It is aimed at overcoming obstacles, seizing opportunities, and addressing the most difficult issues in economic reform. The Opinion requires that China should identify opportunities in the crisis, move ahead with reform in key areas and address critical links with the purpose of expanding domestic demand, securing economic growth and benefiting ordinary households. This shift towards stimulating consumption on the part of citizens and domestic businesses is a complex matter from a sustainability perspective, as will be discussed later in this Issues Paper.

In effect the Opinion proposes institutional arrangements for meeting scientific development and social harmony objectives. Key areas for reform are shown in Box 2.

Box 2 Deepening Structural Economic Reform in China(May 2009 State Council)

Changing the government's role in managing the economy to tap vitality in market-based investment:

- *Deepening the reform in monopoly industries to expand the investment scope and areas for private funds;*
- *Promoting reform in price mechanism for resource products and environment protection to shift the development pattern;*
- *Focusing on optimizing industrial structure and ownership structure to boost service sector and private sector development;*
- *Accelerating reform in welfare projects to increase people's consumption capacity and will;*
- *Deepening the reform in technological, educational, cultural and health care sectors to encourage the growth of social undertakings;*
- *Deepening the rural sector reform to establish sound mechanism for coordinated urban-rural development;*
- *Accelerating taxation reform to make the taxation regime more suitable for scientific development;*
- *Deepening the financial sector reform to build a modern financial system;*
- *Deepening the external-related economic sector to build an open economy; and*
- *Promoting the pilot programs for comprehensive reform to set examples for other areas to study and follow.*

The Opinion is important as a means to recognize the current difficulties and environmental risks, deepen reform in environment protection areas, and overcome long-term entrenched obstacles. Implementation should bolster environmental protection efforts and highlight various institutional and structural needs as noted below:

(1) Improving legal and regulatory framework to set up long-term mechanism for environment protection, such as amending the Law of Environment Protection;

(2) Participating in the reform of public utility sectors to increase investment in environmental and other infrastructure construction in these sectors;

(3) Improving the performance assessment indicators for emission and pollution reduction, and circular economy programs to create innovative approach for

environment protection in the 12th Five-Year Plan;

(4) Deepening economic policy for environment protection, and integrating environment protection into economic development;

(5) Accelerating reform in the administrative arrangement for environment protection in rural areas;

(6) Implementing relevant environment policies in environment-friendly and resource-con-servation pilot program areas, to gain and distribute experience across the country.

4)Additional challenges and opportunities.

In the short term, the financial crisis has reduced the break-neck speed of growth that has created negative environmental impacts. This is particularly true for some emissions, therefore helping to achieve pollution reduction targets. In highly industrialized areas such as the Yangtze River Delta and Pearl River Delta, many firms have shut down. In Qinghai Province the local energy-intensive sectors relying on Qinghai's power advantage were seriously affected. As the commodity prices plunged in the global market, production of many energy-intensive products was greatly reduced or suspended—as of mid-November 2008 the suspension rate on the production of iron alloy, silicon carbide, calcium carbide, and electrolytic aluminium in Qinghai was 71%, 46%, 83% and 15.5% respectively.

The demand and price for raw materials such as iron and steel have declined. Electric power consumption dropped for the first time in years, although consumption started to increase again by mid-2009. Central and local government agencies have increased investment in environment protection including infrastructure construction on water treatment plants and so on. All these factors have contributed to eased pressure on emission reduction.

In the medium term, the financial crisis could have certain negative impacts on China's environment protection. If the macro-economy remains sluggish and corporate sector profits stay thin, businesses may choose to sacrifice their environment protection efforts first. Maintaining their profits and jobs will be very high priority. Some firms that already have installed environment protection facilities may stop using them. This will in turn result in more pollution, possibly worsening

future environmental crises.

With the need to stimulate employment, some measures taken earlier to change incentives towards improved energy and environment efficiencies may suffer. An example is the reinstatement of tax rebates on some energy intensive export products. China also could face non-tariff trade barriers on some exported products—protectionism masquerading as environmental safeguards by developed countries.

As in the case of other countries, actions taken by China in support of stimulating domestic consumption may be inconsistent with sustainable development strategies. Incentives for private automobile purchase are an important example.

The stimulus package has spurred new investment, much of it located in central and western China. These regions are becoming the new economic growth centres of China. Will they behave similarly to many eastern coastal areas in earlier days, placing growth ahead of environmental protection?

China has taken advantage of the decline in stock prices to purchase companies abroad, especially in various resources sectors. This is fully understandable, not only to take advantage of bargain prices, but also, most importantly, to guarantee long-term supply access. But China is still at an early stage of setting out regulations to ensure these overseas investments are managed well from environmental and other considerations. It is a welcome development that Chinese banks that may provide funding are putting in place environmental considerations, and that new regulations are being prepared to regulate environmental aspects of overseas investment by Chinese firms. Corporate social responsibility requirements are needed on the part of Chinese firms wherever they operate.

China has affirmed that it will continue to be involved in African development efforts, no matter what the economic crisis may bring in the year ahead. China is in the fortunate position to do so not only for Africa but for other poor regions of the world, including some parts of Asia. The environment will need to be taken into account in these international cooperation efforts. Ultimately such a commitment could accelerate the transfer of green technology, experience in addressing climate change adaptation, and many other aspects of environment and development.

5) Some conclusions.

Firstly, China’s environment protection is facing very daunting challenges to address the multiple crises of the recent past. To offset negative impacts, China has worked out one of the world’s largest economic stimulus packages and comprehensive industrial revitalization plans. On one hand, this has brought opportunities for better environment protection, but on the other hand, it has created potential environment risks. In some cases, the risk may be even greater than the benefit of environmental improvements.

Secondly, at present, China’s overall plans in response to financial crisis could be described as pro-growth, pro-con-sumption and pro-restructuring. An important aspect of these plans should be to pursue growth based on conditions of improving quality, optimizing structure, increasing efficiency, cutting energy use, and ensuring environment protection. This is, of course a huge and long-term challenge.

Thirdly, the multiple crises have brought about historic opportunities for green innovation in both China and other major economies. Well established industries can become more eco-friendly; growth of new clean technology and industries will mushroom; and developing clean energy is a high priority of many governments. Most industrial countries would like to tap the opportunities provided by the multiple crises, promoting a new-round of economic restructuring with green economy and green policy initiatives. They will gain globally competitive advantages and at the same time help to secure their sustainable development. It is safe to say that developing a green economy has become an irreversible trend for key decision-makers in China, and is a direction that is essential for China’s contribution to achieving global environment and development goals.

Fourthly, China is well placed to take advantage of these green growth opportunities, as this new concept requires economic restructuring of the type China proposes, along with continued social growth. The key point is that green growth can help China to achieve its strategic goal in environment protection while building a more diverse and efficient economy. There are important sub-themes to green growth, especially Cleaner Production, Energy Productivity and Efficiency, Circu-

lar Economy and Low Carbon Economy.

If we look at the issue of economic growth from a long-term perspective, and presume that the Central Government's policy package will deliver some sound reforms, with full implementation of various environmental protection measures, then China's economic restructuring could create a great longer-term success out of the crisis. In this case, the economic pattern in China will have impressive changes with significant shifts in economic structure, industrial structure and products mix. With a variety of environment-centred policy incentives, an array of technological advances, and a comprehensive process of environment management, China should be in a position to strengthen its efforts towards becoming a resource-conserving and environment-friendly society. The key is to identify the new and sustaining driving forces for economic growth, which could both help propel economic development and promote environment improvement and sustainable development.

Sustainable Consumption and Green Growth

1. Sustainable consumption

The shifting emphasis in China from export-driven growth to a greater balance with domestic consumption presents an opportunity—even a necessity—to ensure that the new patterns of economic growth reflect a sustainable consumption pattern. This is not a simple undertaking by any means. The trap facing China is that of over-consumption, especially in the richer cities. Sustainable consumption is defined in various ways, for example, by Canada's Office of Consumer Affairs as the use of goods and services required to meet basic needs and improve quality of life without placing at risk the needs of future generations.

1) Avoiding over-consumption.

OECD notes that: It is resource use and environmental pollution that have to be brought to sustainable levels, not the consumption of products and services as

such.[1] Yet, while energy and materials have been used more efficiently in recent times, the level of over-consumption in both goods, including houses and autos, and high energy consumption service industries such as those related to recreational travel has shot up.[2] The global economic downturn may have a significant influence on future levels, but the warning signals are clear—the ecological footprint of consumers in rich countries is already far too large and it is still growing.

The OECD has suggested that five general conditions are needed in a general framework for sustainable consumption:[3]

(1) A price structure for consumer goods and services that internalize environmental costs and benefits;

(2) A policy and regulatory framework that makes clear the priorities and direction of change;

(3) Availability of a range of environment-friendly goods and services;

(4) Technology and infrastructure that includes environmental quality criteria in the design and running of transportation networks, housing, waste management, etc.;

(5) An educational, learning and information-rich environment that motivates and enables consumer action.

A combination of instruments could then be applied, along with life cycle analysis to determine points of intervention, with appropriate sustainable consumption indicators.

2) China and sustainable consumption.

With its huge population and rapidly growing wealth, China will have a significant impact on global consumption, certainly driving up the total level in coming decades. But can this consumption be done in a fashion that is different than the OECD nations? This is a very difficult question to answer. It requires an examina-

[1] OECD. July 2002. Towards Sustainable Household Consumption? Trends and Policies in OECD Countries. Policy Brief, OECD Observer.

[2] For example, vehicle stock in OECD countries totals 550 million, of which 75% are private autos. This total number is projected to grow by more than 32% to 2020, and with a 40% increase in kilometres driven. Municipal waste in OECD countries is projected to grow by 43% from 1995 to 2020. (OECD Policy Brief, 2002)

[3] http://www.oecd.org/document/52/0,3343,en_2649_34331_ 35145204_1_1_1_1,00.html.

tion of the characteristics of Chinese consumers today, including structural issues in the economy that influence current behavior, and various policies or actions that might change consumer spending habits in the future. It also requires a look at the external influences on China. These influences include: global media and advertising; the limited level of access to the most highly advanced energy and material efficient durable products, and the positive influence of other nations that have made some progress in addressing sustainable consumption—Norway, Swe-den and the Netherlands, for example,[1] it is helpful that China has enunciated a philosophy of *Xiaokang*[2], where wealth and consumption should be modest and distributive.

China currently has the lowest domestic consumption level of any major economy, about 36% of GDP. This is a level half that of the USA and about 2/3 that of Japan or EU nations. In fact, consumption in China has dropped about 15% relative to GDP since 1990. Commonly it is believed that Chinese dedication to saving is the result of limited or inadequate social benefits such as pensions, health and education. Thus addressing these problems via new policies would help to stimulate a higher level of consumption by households. In addition, short-term measures such as those within China's stimulus package might hasten the transition, or at least signal the government's intent to place more emphasis on the growth of domestic consumption.

The McKinsey Global Institute recently published an interesting, in-depth study of the future of Chinese consumerism development which points out key barriers to increasing the level perhaps to as much as 50% of an expanded GDP, by 2025.[3] Whether this goal is reasonable from a sustainable consumption perspective

[1] See Cohen, M. J. 2004. Sustainable Consumption and Global Citizenship: An Empirical Analysis.Paper presented at the annual meeting of the American Sociological Association.

[2] Wikipedia notes that: "The vision of a Xiaokang society is one in which most people are moderately well off and middle class, and in which economic prosperity is sufficient to move most of the population in mainland China into comfortable means, but in which economic advancement is not the sole focus of society. Explicitly incorporated into the concept of a *Xiaokang* society is the idea that economic growth needs to be balanced with sometimes conflicting goals of social equality and environmental protection."

[3] McKinsey Global Institute. 2009. If You've Got It, Spend It: Unleashing the Chinese Consumer. Also, McKinsey Quarterly. August 2009. A Consumer Paradigm for China.

is debatable. A key hypothesis of the McKinsey study is that if this expanded consumption goal were to be achieved, the actual pressure on the environment and natural resource use could be reduced since the intensity of water, land and fossil fuel use would be lessened as a consequence of a smaller burden from the export economy and other reasons. And, while China's overall share of world consumption would rise to between 11% and 13%, it would still be well below China's portion of world population.

The McKinsey study highlights structural change in the economy as the key element to accelerate change in domestic consumption. This is important and recognized by Chinese economists and leaders, even though it is a difficult matter to address. China is investing a large portion of its wealth in developing basic infrastructure for the nation, including transportation, water treatment, and other basics of cities and countryside areas, energy networks, etc. Much of this is public sector spending, and therefore opens to influence through green procurement policies. But investment in large-scale industrial development has a very large share of GDP. In fact it is believed that overinvestment has taken place in some sectors such as iron and steel. This part of the economy, especially in the case of state owned enterprises does not contribute as much to employment growth as does the growth of SMEs and the service sector. And therefore consumers do not have as much money for consumption. Furthermore, in poorer rural areas, household income in excess of meeting basic needs will be quite limited for years to come by comparison to urban areas.

The study suggests that without structural change towards a more balanced economy, China's domestic consumption will remain at a very low level, possible around 39% to perhaps 42% of GDP. Furthermore, some steps already taken, such as the current efforts to make home appliances available in rural areas at subsidized prices, are unlikely to make much of a long-term difference in consumption patterns.

If it is the creation of wealth through the creativity of small businesses and a flourishing service sector that is most needed, then attention will need to be given to mechanisms to make credit more freely accessible to both individuals (including

families seeking to have their children enroll in expensive post-secondary education) and smaller enterprises. There are many ways to do so, but at the moment progress is slow, and access to money is still much easier for larger, state-owned businesses. According to the McKinsey analysis this transition will be key:

A more consumer-centric economy would allocate capital and resources more efficiently, generate more jobs, spread the benefits of growth more equitably—and grow more rapidly—than China will if it remains on its present course. The narrowing of the trade surplus and the Chinese consumer's larger contribution to global growth would make foreign ties more harmonious.

But a consumer-centric society is not necessarily a society of sustainable consumers. How can progressively wealthier Chinese citizens avoid becoming over-consumers in coming decades? There is ample evidence that some fraction of urban residents already fall into this category. North American, Japanese and European luxury auto makers certainly see Asian markets and especially China as a major market for their large vehicles, even if there are punitive taxes on such vehicles.[1] And whose rules should apply? Governments can only do so much to channel consumer behavior in desired directions.

Much has been written about whether Chinese cultural characteristics might or might not predispose people towards a conserver type of society. The current tendency towards frugality could well be reversed quite dramatically if some constraints are removed, as suggested by the McKinsey study. It must be presumed that if household income share of the national income increases significantly (currently it is 56%; by comparison US households get more than 70%), and if credit is easier to obtain, then people will enlarge their debt loads perhaps setting off buying binges. The auto industry in China has seen this development in the previous few years prior to the world financial and economic crisis, and most recently in August 2009, when 2 000 new vehicles per day entered the streets of Beijing, aided by the government stimulus efforts.

There are several urgent tasks for making the transition to an environmentally

[1] http://www.chinaluxculturebiz.wordpress.com/tag/porsche/.

ultra-responsible consumer society in China a possibility.

The first task is to accelerate the pace of implementing green growth initiatives so that consumers will have a wider range of "green" products to choose from, at competitive prices; and in general, that any products purchased will have lower embedded energy, carbon and pollution costs related to production processes and material content. Governments at all levels within China can also assist through green procurement policies that are even more robust than today's.

The second task is to ramp-up public education and information campaigns that explicitly reveal the true cost of unsustainable actions, expose non-compliant businesses and poor performance on the part of administrators and others entrusted with protecting public goods, and that provide sufficient knowledge about what constitutes sustainable consumption. Some programs already are well established for green labeling but a broader range of efforts is needed, for example, related to major purchases such as apartments.

The third task is to continue developing and promoting green standards for all the main purchases that people are likely to make. As much as possible this should be done on a public participatory basis, and for both urban and rural settings.

The fourth task is to make China even more of a leader in the application of Circular Economy. Already China has made great inroads within the country and in transforming pathways for recycling globally. But the next generation of autos, in which China has a huge stake, should be super-easy to recycle completely. Building materials should be of a type and quality that minimizes embedded energy and can be reused or recycled with minimum cost and difficulty.

The fifth task is certainly to use design more effectively to promote sustainable development. This has still not been done to a desired level in the design of Chinese cities and there will be significant opportunities in development of the New Socialist Countryside. Utility infrastructure is one of the most important elements, for example, "smart electrical grids" and "smart metering"[1]. Part of the need is engineering and architecture, but it is also in the design of management

[1] The Economist. 8 October 2009. Wiser Wires.

systems, institutional arrangements and incentive systems.

China's leaders have been promoting many aspects of sustainable consumption in recent years, and backing up rhetoric with action. Their efforts are quite impressive although sometimes inconsistent, but the task is very difficult, and likely to have major surprises in the years ahead. It should not be presumed that even with all the right economic moves and incentives that the desired move to sustainable consumption will occur smoothly. Therefore the processes to bring about this move must be as adaptive as possible and should maximize the involvement and commitment of both large and small scale enterprises, the financial sector, and community groups.

2. Green Growth

International Perspectives

The UN ESCAP defines green growth as environmentally sustainable economic progress to foster low carbon, socially inclusive development. ESCAP suggests five pathways for policy intervention: sustainable production and consumption, greening business and markets, sustainable infrastructure, green tax and budget reform, and eco-efficiency indicators.[1] Green growth in the Asia Pacific region and in other parts of the developing world needs to be pro-poor, with a major emphasis on sustainable livelihoods.

In a Financial Times article,[2] Mr. Ban Ki-Moon (with Al Gore) wrote that:

A successful (climate change) deal in Copenhagen offers the most potent global stimulus package possible. With a new climate framework in hand, business and governments will finally have the carbon price signal businesses have been clamoring for, one that can unleash a wave of innovation and investment in clean energy. Copenhagen will provide the green light for green growth. This is the basis for a truly sustainable economic recovery that will benefit us and our children's

[1] http://www.greengrowth.org.

[2] Financial Times (London). 17 February 2009. Green growth is essential to any stimulus. http://www.huwu.org/sg/ articleFull. asp?TID =92&Type=Op-Ed.

children for decades to come.

This linkage of innovation, investment and green growth is essential not only for addressing climate change, but for most other pressing environment and development issues.

In June 2009 the OECD countries, plus several others, committed to development of national efforts and international cooperation on a green growth strategy. The OECD Council's Ministerial Declaration included several points noted in Box 3.[1] This is a significant statement that will lead to a reshaping of OECD perspectives on growth, since this new approach will be brought forward for further development during 2010-2011.

Box 3 OECD Council Ministerial Declaration on Green Growth, June 2009

STRENGTHEN our efforts to pursue green growth strategies as part of our response to the current crisis and beyond, acknowledging that "green" and "growth" can go hand-in-hand.

ENCOURAGE green investment and sustainable management of natural resources…We will consider expanding incentives for green investment, in particular in areas where pricing carbon is unlikely to be enough to foster such private sector responses...Approaches to recognise the value of biodiversity should be encouraged through appropriate instruments and consistent with relevant international obligations. We are resolved to share information on green investment flows and policies, and best practices.

ENCOURAGE domestic policy reform, with the aim of avoiding or removing environmentally harmful policies that might thwart green growth, such as subsidies: to fossil fuel consumption or production that increase greenhouse gas emissions; that promote the unsustainable use of other scarce natural resources; or which contribute to negative environmental outcomes. We also work towards establishing appropriate regulations and policies to ensure clear and long-term price signals encouraging efficient environmental outcomes. We call on other major economies to follow the OECD countries' lead.

ENSURE close co-ordination of green growth measures with labour market and human capital formation policies. We note that these can support the development of green jobs and the skills needed for them…

STRENGTHEN international co-operation. In this respect:

We recognise that special efforts need to be made at the international level for co-operation on developing clean technology, including by reinforcing green ICT activities, fostering market

[1] http://www.olis.oecd.org/olis/2009doc.nsf/LinkTo/NT 00004886/$FILE/JT03267277.PDF.

mechanisms, and augmenting, streamlining and accelerating financing and other support to developing countries in their fight against climate change and the loss of biodiversity, and support in their water management. We also recognise the need to ensure that each country pursues green growth policies, including to tackle climate change, in accordance with existing international agreements and based on the principles of free trade and investment.

We are resolved to make every effort to reach an ambitious, effective, efficient, comprehensive and fair international post-2012 climate agreement at COP15 in Copenhagen in December 2009… by which all countries will take measurable, reportable and verifiable nationally appropriate mitigation commitments or actions as well as adaptation actions, reflecting the principle of common but differentiated responsibilities and respective capabilities.

We recognise the importance of the liberalisation of trade in environmental goods and services in fostering green growth. We are resolved to ensure that measures taken to combat climate change are consistent with our international trade obligations.

We underline the special need to co-ordinate international development cooperation activities in order to help developing countries promote green growth.

The remarkable rise of green growth as a major hope and objective for new economic growth and development among the richer countries is here to stay, and by no means is it restricted to Europe and North America. China has embraced the concept and in following sections, we will explore issues of implementation, with special attention to energy, environment and climate change.

3. Conclusions about sustainable consumption and green growth

Consumers with access to sizeable disposable income levels generally seek high energy and high resource and environmental-consumptive life styles. The additional burden on the planet is not generally within the power of the individual to fully address, except through life style choices and a conservation philosophy. In fact, with the constant influence of media and other communications there is a strong compulsion towards consumption. Chinese consumers, with their exceptional behaviour towards saving rather than spending, and their relatively small share of the national GDP, perhaps stand a better chance than people elsewhere of

avoiding the endless cycle of over-consumption that plagues western society. But this is by no means a certainty over the longer-term.

The great challenge is to build enabling mechanisms that help consumers to create and enjoy sustainable lifestyles with a relatively low material consumption but high satisfaction levels. This is a challenge that has failed in most western countries over the past few decades, and continues to fail at the present time. The greatest challenge lies ahead—with climate change as a driver. It is certainly too much to expect of China or many other developing countries that they should be the leaders, when industrialized countries are still consuming such a large portion of the earth’s environmental resources. But the reality is that both should converge towards intermediate levels of consumption, largely decouples from harmful emissions and wasteful production techniques.

The hope, of course, lies with green growth. That is why the growing resolve towards this topic on the part of countries throughout the world and on the part of their leaders is so important at this transformative time for globalization and search for sustainable growth.

Energy, Environment and Climate Change

1. Crossroads for international cooperation

The relationship between energy, environment and economy is at a crossroads that will test cooperation between rich nations and poor, will shape trade and consumption, and will determine whether and how well global society and individual nations address the pressing issue of climate change. Nations cannot claim to be sustainable without ensuring that their economic growth is eventually decoupled from energy consumption levels, especially from fossil fuel sources.

Those nations that have high existing per capita uses of energy must reduce these levels as quickly as possible, and seek sources and patterns of use that have a drastically lower level of Greenhouse Gas (GHG) emissions. Countries such as China, India and Brazil, already in a stage of rapid development and high economic growth, need

the opportunities to become as eco-efficient as possible in energy use, but also to have access to energy sources and a share of GHG "space" sufficient to meet their expanding needs. No single nation, single region or grouping of countries can fully address the issues created by energy, environment and economy on their own. It is a vast concern demanding unprecedented levels of international cooperation.

In fact, the unprecedented level of global cooperation on tackling the financial and economic crisis has had the co-benefit of setting the stage for: (1) reaffirming the importance of addressing climate change, including innovations needed to hasten progress as well seeking agreement at forthcoming meetings, and (2) linking the outcomes more concretely to economic recovery based on green growth.

Global agreement on action for climate change is only part of the larger puzzle to be solved on energy and environment. But it is front and centre at the moment in part due to the urgency of seeking a robust accord to replace the Kyoto Protocol of the UN Framework Convention on Climate Change (UNFCC). The December 2007, Bali Plan of Action laid out the groundwork. This Plan of Action noted that:

All Parties should cooperate to build a low-carbon global economy that ensures continued growth and sustainable development, increases global supplies of secure, and affordable clean energy, and strengthens the capacity of all Parties to adapt to the adverse effects of climate change. All Parties shall support long-term cooperative action to achieve an aggregate reduction in global greenhouse gas emissions of at least 50% by 2050.

In December 2009 at Copenhagen, the hope is that a workable and effective follow-up agreement will be set in place for the next phase of implementation of the UNFCC. As Lord Nicholas Stern has said, the world can act now, pay less—or wait, and pay many times more, with greater damage arising from climate change. While the UNFCC Meeting of the Parties in Copenhagen will be an important event, it only marks the beginning of what will be a long journey. Fortunately it should be a path filled with new opportunity as human creativity, markets and innovations make their contributions. The situation might develop along the time frame shown in Box 4.

Another very useful way of looking at how to tackle energy and environment,

and of the various options for addressing climate change, is the McKinsey Cost Abatement Curves.[1] These demonstrate that many of the energy efficiency actions needed are profitable (for example improved insulation of buildings and some transportation options). The curves also show the relative costs of most other proposed solutions including biofuels, CCS and reforestation. Some options would be very costly. The value of these curves, which have been prepared globally and for individual countries such as China, the USA and Germany, is that they point out many excellent opportunities that can be taken now, without the need to resort to international agreements, etc.. For it is vital that nations and businesses have the flexibility and means to take action as swiftly and efficiently as possible.

Box 4 Time Frame of Future Action on Environment, Energy and Climate Change

2010–2012 Fine-tuning Copenhagen Outcomes. Global, regional & sectoral; ratification & national strategies.

2010－2015 Emphasis on efficiency, cost effective solutions with increased tech transfer between rich & poor countries. Maximum impact of economic recovery stimulus.

2010－2020 S&T Energy and Environment investments lead to new, often disruptive technology options. Useful to rich & poor nations.

2013－2020 International agreements focus on major credibility & equity concerns. Greater attention given to actual impact of accords on mitigation and adaptation success.

2010－2030 Behavioral changes towards Low Carbon Economy. A focus on new economic opportunities, and with greater integration among economic, social and environmental international accords.

2030－2050 50% to 80% reduction in GHG emissions from the 1992 baseline achieved.

This section of the Issues Paper highlights both challenges and opportunities that China, and really the world, face now and for the foreseeable future on making energy use compatible with sustainable development. While this part of the Issues Paper started with the globally urgent matter of addressing climate change, it is certainly but one of the key focal points on energy and environment. From

[1] http://www.mckinsey.com/clientservice/ccsi/costcurves.asp.

China’s perspective at present, perhaps the most significant question is how to ensure that relationships among energy, environment and economy become mutually supportive in ways that permit human development to occur in a satisfactory fashion.

2. Energy and environment in China

CCICED has examined energy and environment relationships in the past, especially through its Energy Working Group during earlier phases of CCICED.[1] The attention being given to the subject of energy and environment within the 11th Five-Year Plan, China's rapid overall increase in energy use, and the potential to gain competitive advantage in the low carbon economy of the future have led this year's CCICED AGM to focus on energy and environment. This effort has involved five task forces and a cooperative project within Ningxia Province.

Until the Beijing Olympics, relatively few people outside of China fully recognized the rapidity of change in China's energy and environment relationship, or of the many actions that are shaping it, hopefully towards a sustainable future. Yet over the past half decade, a large number of international cooperation initiatives have started in addition to the very substantial efforts China has undertaken entirely on its own. An example is the rapidly evolving relationship between China and the USA on environment and energy cooperation.[2]

China will face: the possibility of future energy shortages, on-going and perhaps additional environmental and human health concerns related to energy use; energy efficiency and design concerns as it faces large scale construction of cities, transportation and utility networks; and high energy demands from the continued modernization and expansion of its industrial base and development in rural areas. There is a need, already well recognized by China's national leaders, to create a broad societal understanding that as China continues its economic growth, energy use cannot follow the profligate ways of industrialized countries. The Chinese people and businesses must have access to better energy alternatives, and that is where government, communities and enterprises need to provide the right mechanisms, incentives and goods and services to make sustainable choices possible.

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[1] Energy for Sustainable Development, Vol. V. No. 4, published a Special Issue covering findings of the CCICED Working Group on Energy Strategies and Technologies, December 2001.

[2] An agreement for a 10 year cooperation effort on energy and environment was signed in 2008, and in July 2009 a further agreement on energy, environment and climate change was signed.
http://www.brookings.edu/papers/2009/09_us_china_energy_cooperation_lieberthal.aspx.

There are three key pillars for improving energy and environment relationships in China. The first is sustainable use of coal, since this is such a key element in China's energy mix. The second is energy efficiency, for which there are co-benefits with the economy, health, and environment. There is a great deal of room for improvement, for example, China uses up to 3 times as much energy per unit of output as the USA and up to 9 times as much as Japan. The third is the longer-term transition towards a low carbon economy, which will drive green growth as well as assist in climate change mitigation. These three pillars need to be considered in both rural and urban areas and in relation to industrial and service sectors.

The transitions toward greater efficiency, developing new sources of energy and better ways of dealing with existing energy use, and toward a low carbon economy need to start now in China and in other major economies. There are five considerations that may help in this process, and to some considerable extent, China has made progress on each.[1]

1) A bottom-up approach, eventually moving towards a globally-hom-ogenous system for energy and environmental action.

It is not realistic for every country to adopt identical approaches towards environment and energy. Instead, coordination of varied autonomous efforts should be encouraged to achieve the best possible result. Diversity should be recognized and promoted. This is the basis for the principle of common but differentiated responsibility, but also of recognition that countries need to take into their specialized needs for energy security, available sources of energy, and socio-economic development requirements. It is also a means to maximize the value of the mosaic of local initiatives and creativity that will be unleashed in the years ahead through green growth and innovation strategies.

2) Institutional and management Innovation.

Policy integration is an important need. Sectoral policies still drive most deci-

[1] This discussion is drawn from a paper prepared for the CCICED Chief Advisors Group and the CCICED Secretariat in the early planning stages for the work of the current task forces on various energy and environment topics. Zhang Jianyu and A. Hanson. 2007. Framework on Energy and Environment Policy Studies. Discussion Paper. 15pp.

sions in China, often with limited coordination and understanding of cross-sectoral impacts. Along with policy integration is the need for timely goal-setting so that appropriate staging of development can be achieved. Getting the right mix of regulation and enforcement, incentives and voluntary action is important, especially in an era when there are new mechanisms such as cap and trade, payment for carbon credits, and the possibility of new energy taxes and subsidies. Institutional and management innovation should be an important driver for new technology applications and acceptance, and be designed to take into account policy integration.

3) Promoting national efforts.

China has set out major legislation and action plans related to renewable energy use, energy conservation, promotion of circular economy, and climate action over the past several years. At some point there will be carbon intensity reduction goals. As a follow-up to the 11th Five-Year Plan energy efficiency and renewable energy targets, there will be new goals in the next Five-Year Plan. All of these efforts will require careful monitoring and commitment to more rapid improvements. Most will help to satisfy energy security, efficiency, environmental, climate change efforts simultaneously.

4) Technical innovation.

The bottom line for the various energy and environment technology introductions and improvements needed in China is that they should be good for the environment but also be more efficient and sometimes much more financially viable than what they replace. As well, they need to be socially acceptable and beneficial. Government’s role in stimulating and guiding research and development is essential, and so is the development of an enabling framework, including appropriate laws and enforcement policies, standards, pricing and incentives. The private sector will become increasingly important as a means for rapid implementation. Fostering Chinese entrepreneurship in environment and energy technologies is a key role to be shared by both government and the private sector.

5) Improved international cooperation.

The international enthusiasm for green growth based on energy, environment and climate change now must be turned into more productive cooperation. This is

especially true for such major topics as developing clean and innovative use of coal, carbon capture and storage (CCS) of GHGs, smart electrical grids, and next generation biofuels, implementation of more robust energy and environment technology transfer arrangements, and carbon trading mechanisms. There is also a growing need for China to share the technology it is developing, for example, in rural biogas, with other developing nations.

Over a relatively short period (mainly 2006-2009) China has developed considerable analytical capacity on energy and environment issues, and coordinating mechanisms such as the Leading Group on Climate Change, chaired by Premier Wen Jiabao. The focus on mandatory targets in the 11th Five-Year Plan for energy efficiency and pollution control, on standards for industrial operations, buildings, auto fuel efficiency and emissions, and changes in energy pricing are all examples of where progress is being made on developing a new relationship between energy and environment.

Despite these efforts, the path ahead is still uncertain, especially as economic growth rates accelerate, and as domestic consumption increases. There is little doubt about China's will at the senior level of central government to take the issues of energy, environment and climate change very seriously. But what is needed is a high level of performance across a wide range of decision-makers at all levels of government, and within China's state owned enterprises and private sector interests. As well, at the community level and within universities, academies and the growing number of non-governmental organizations, these issues need to be given priority as action items.

In the remaining parts of this section of the Issues Paper we present a brief overview of China's energy use, some of the key issues associated with each of the five CCICED energy and environment task forces, and some general conclusions.

3. China's energy use

The energy use pattern of China is summarized in Figure 1. This flow diagram reveals the pervasive influence of coal, and also the degree to which industrial use of energy prevails. A comparison of this diagram with a similar one for the USA reveals

a much more even spread of energy supply for the American case, and with coal use mainly restricted to power generation, while a large portion of petroleum use is for transportation. In China, residential and commercial energy uses take a smaller portion of the whole by comparison to the USA.

Even with the great amount of energy devoted to the production of goods for export, China's per capita energy use is still small by comparison to Europe, the USA and Japan. However, to a considerable extent, this low per capita energy use masks a number of important trends and differences within China. First, the difference between per capita energy use of urban dwellers and rural people are substantial. And even within cities there are major differences between relatively rich and poorer people. Second, within industrial sectors there also are substantial differences, particularly between small, older operations and new ones. The figures are striking in the case of steel mills, for example. Third, with the expansion of transportation networks and the emphasis on private car ownership, gasoline and diesel fuel use will increase substantially, with attendant supply and environmental issues. Fourth, China's dependence on coal is a key concern. While there are many decades, or even hundreds of years of supply, the environmental and health concerns of coal burning are very substantial. And, fifth, the efficiency with which energy is transformed and transported is an important consideration that requires much attention, including development of "smart grids" for electricity transmission, and building of ultra-efficient power generating facilities.

China has substantially reduced its energy intensity in relation to GDP over the past 15 years and particularly during the 11th Five-Year Plan. It will have to continue to do so for the foreseeable future. With efforts to quadruple GDP over the first two decades of the 21st century, even with very dedicated efforts to decouple energy growth it is very likely that substantial energy use increases will take place. High, medium and low estimates by the International Energy Agency are noted in Table 3.

One key issue for CCICED is to suggest policy mechanisms through which China can make much greater progress on reducing the environmental impacts of this incremental energy use, including the impacts associated with energy sourcing, generation, emissions and waste disposal. These require policy innovation, innova-

tions through the use of markets, and structural change in the economy.

Table 3 Estimation of China's Primary Energy Consumption (2005-2030)

(Oil equivalent: million tons)

	2005	2015			2030			Average Growth Rate 2005-2030		
		High Growth	Ref-erence	Alter-native Policy	High Growth	Ref-erence	Alter-native Policy	High Growth	Refer-ence	Alter-native Policy
Coal	1 094	2 037	1 869	1 743	2 910	2 399	1 842	4.0%	3.2%	2.1%
Oil	327	626	543	518	1 048	808	653	4.8%	3.7%	2.8%
Natural gas	42	125	109	126	276	199	225	7.8%	6.4%	6.9%
Nuclear energy	14	34	32	44	82	67	120	7.4%	6.5%	9.0%
Hydropower	34	63	62	75	100	86	109	4.4%	3.8%	4.8%
Bio-energy and waste	227	235	225	223	231	227	255	0.1%	0.0%	0.5%
Other renewable energy	3	13	12	14	43	33	52	11.1%	9.9%	11.9%
Total	1 742	3 135	2 851	2 743	4 691	3 819	3 256	3.2%	3.2%	2.5%

Source: IEA World Energy Outlook 2007, reproduced in the CCICED Low Carbon Economy Task Force Report.

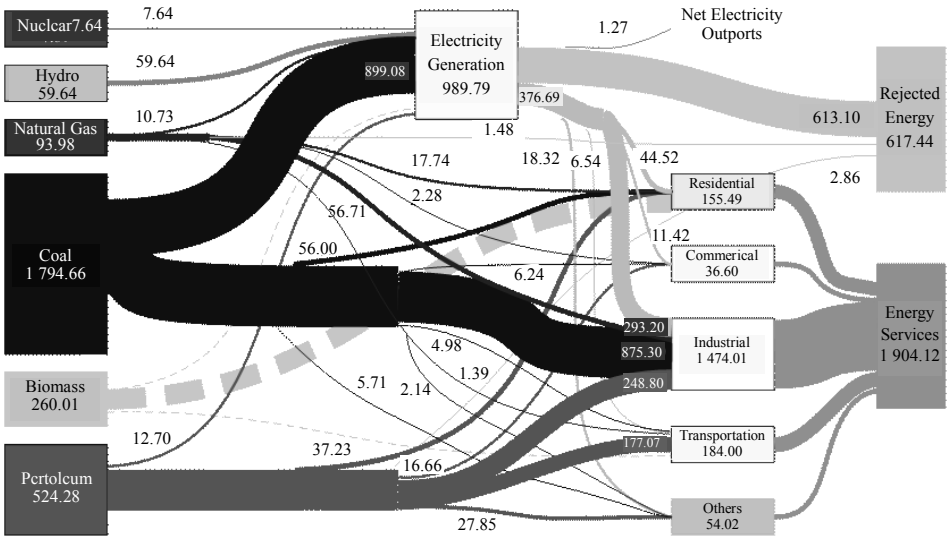

Figure 1 China Energy Flow Chart 2007

(～2 535 million tonnes of coal equivalent)

(This diagram was prepared by the China Energy Research Institute at the request of the CCICED Chief Advisors Group. A similar diagram for the USA is available from the Lawrence Livermore National Laboratory)

The second issue is to identify policies for practical pathways for eliminating harmful emissions altogether, which is the promise of wind and solar energy generation, and for energy conservation practices that substantially reduce demand. This introduces design, information technology and many other S&T innovations that are being supported through China's Mid-term S&T Plan and other means.

The third set of issues are those associated with policies for management innovation, including the energy saving and environmental improvements possible thr-ough more efficient operations, and for car-eful attention to industrial performance and institutional reform.

The fourth set of concerns relate to the need for international cooperation, especially regarding technology transfer and financing, a point that China has repeatedly made in its international interventions on climate change. China's success with the Clean Development Mechanism (CDM) demonstrates the strong capacity that has been developed to utilize international initiatives designed for addressing energy and environment. There has been much less interest on the part of China towards international cap and trade schemes related to GHG reductions.

4. Five topics examined by CCICED Task Forces

1)Sustainable use of coal in china.

China is the number one coal using country in the world. As the IEA and many others have noted, there must be drastic improvements in coal use everywhere in the world, if it is to become a more environmentally acceptable energy source.[1] While a theoretical case can be put forward that China could drastically reduce its dependence on coal over the coming 30 to 50 years, the more likely scenarios suggest continued dependence and possibly a major increase in the total amount of coal used over the coming two or three decades. Over that time span, it is presumed that renewable sources of energy and various innovations to reduce

[1] See, for example, IEA. 2009. Cleaner Coal in China. IEA, Paris. 320pp.

energy intensity will eventually reduce China's coal demands. As well, coal will have to become a much cleaner energy source, stripped of harmful emissions and with its GHG emissions sequestered or utilized. But China is far from having this vision of coal use become reality. Indeed, it is doubtful if China or any other country on its own accord could succeed. While the USA for cost reasons pulled back from its massive FutureGen coal combustion project, China is pursuing a similar effort labeled GreenGen.[1]

Investment in China's efforts towards sustainable use of coal should be in the best interests of other countries in order to create the most environmentally benign and efficient technical and policy approaches. Everyone will benefit. Recognition of this point is spreading, with increasing levels of technical cooperation and joint ventures involving coal. There is a growing capacity within China not only for necessary S&T but also for the investments and the enabling conditions for full scale deployment and commercialization of very advanced coal production, power generation, and chemical utilization facilities. Pilot efforts on carbon capture and storage (CCS), advanced underground coal combustion, and other innovations now underway likely will be mainstreamed over the coming 10 to 15 years.

The most immediate challenges are to make sure that available technology and improved management practises lead to safer, more efficient and cleaner coal production and use throughout the value chain. There is evidence of this happening, including a substantial decline in coal mining deaths, reduction in SO_2 emissions from power plants and boilers, and modernization of many mining, transportation and electrical generation facilities. But there is still a danger of technology lock-in, particularly if there is resurgence in power demand, and if there is any breakdown in the effort to make local officials responsible for meeting environmental quality, safety and other standards. Furthermore, some important pollutants related to coal

[1] According to the company's owners, which include leading power companies and coal companies, *GreenGen's business goals include: coal gasification, oxygen production, hydrogen production, syngas purification, hydrogen turbine and fuel cells generation, carbon dioxide capture and sequestration; and also research on advanced materials, instrumentation and control technology, related technologies of applications development; advisory services, technology transfer, power plant construction, operation and management.* GreenGen's objective is to design, build and operate the first IGCC power plant in China in 2009 and a coal-based, near-zero-emission GreenGen power plant in China with independent intellectual property rights. http://www.greengen.com.cn/en/aboutus_02.htm.

use, for example heavy metals like mercury are still inadequately controlled.

What would a longer-term vision of sustainable coal use in China look like? The starting point is definitional. Two key conditions must be met for sustainability[1]: the energy system must have good pro-spects of enduring indefinitely in provision of high quality and sufficient levels of energy services; and must not impose unacceptable environmental, health or social impacts and risks. A nonrenewable energy source like coal where, if it is very abundant, could be considered as a sustainable source if its use helps to build conditions that will eventually permit use of alternative energy sources. For example, if coal use helps to support district heating that could also utilize heat from sewage water, or if wellhead coal burning helps to build a more efficient national power grid that can utilize solar, wind or local hydro energy.

A question of interest to China’s coal industry and many others is what level of coal might be used sustainably? The 2.8 billion tons of coal production in 2008 is only a small fraction of the available resource, even though it places a tremendous demand on China’s transportation capacity. But China’s coal use currently does not fully meet environmental, health or safety criteria at any stage along the value chain, although improvements are being made and some facilities are exemplary. If coal production levels reach projected levels of 3.5 billion tons in 2020 and more than 4 billion tons by 2030, the challenges will become much greater. Once GHG emissions associated with coal are factored in, the task of achieving sustainable use become monumental since there are no fully proven, economically-viable large scale solutions for CCS available at present.

There are several key policy needs that must be addressed in order for coal production and use to be placed on a sustainable path: modernization and consolidation of coal-dependent enterprises; policies that encourage deployment of best available technologies and avoid technology lock-in to outmoded types; mechanisms for rapid development and commercialization of advanced coal technology, including advanced environmental technology such as CCS; policy changes to

[1] These conditions have been suggested by the CCICED Task Force on Sustainable Use of Coal in China.

pricing and subsidies that work against efficient market mechanisms; and enforcement policies; and possibly new policies for cap and trade emissions systems and/or carbon taxes.

If China is able to bring about substantial use of its vast coal resources, it will contribute to its own energy and environment security as well as improving regional air and water quality, and helping to meet global climate change objectives. It is a remarkable challenge but the rewards to China will be of great economic value, since China will have access to a wide range of technologies and intellectual properties related to coal and other advanced energy uses, great improvement in management capacity of these energy systems, and marketable products and services for the international marketplace. Therefore, the coal sector in China will be one of the key demand areas for a strategy of green growth.

2)Urban energy and environment.

Action at the level of cities and towns in China will make a crucial difference to China's energy saving and transformation to an environment-friendly society. Urban settings are the source of great innovation potential and the powerhouses that will help to fuel green growth in industry and commerce. Urban households likely will hold the key to sustainable consumerism in China. The massive migration of Chinese from countryside to city over the coming decades will create one of history's greatest construction efforts, including remarkable investments in environmental infrastructure, transportation networks and buildings.[1] The embedded energy in this construction is immense, but what is most important are the implications of urban design, and of the behavior of China's urban citizens. Will communities, businesses and urban residents continue or develop patterns of conservative energy use, or will they become more profligate as happens in most industrial countries? Will Chinese cities become not just energy efficient, but exemplary models of energy saving and innovation? What factors are the most important in determining these behavioural outcomes?

CCICED's Urban Energy Use Task Force has examined energy consumption

[1] McKinsey & Company. February 2009. *Preparing for China's Urban Billion.* 540pp. http://www.mckinsey.com/mgi/publications/china_urban_billion/ and China Academy of Social Sciences. P.200. City Blue Report Competitiveness.

in various Chinese cities, and compared these levels to cities abroad. Building energy use is of particular interest. The hypothesis is that Chinese behaviour is to minimize energy consumption from air conditioning and lighting, for example. Thus some older office buildings tend to have lower consumption than modern western-style office buildings, even though the latter have more advanced design characteristics. Yet in cities like Beijing and Shanghai it is the western styled buildings that now fill the horizon. Similarly, cities incorporating massive road networks into their structure are locking communities into high energy use for generations to come. So-called eco-cities are showcased within China but in reality these are not yet making serious inroads into overall energy conservation nationally.

The most critical areas of concern for energy and environment urbanization policy include the layout and design of new communities; the relationship between urban centres and surrounding suburban communities; regional design of transportation and public utility infrastructure and energy efficient buildings, including construction techniques and materials; and design of communities that promote low energy activities such as neighborhoods that provide for most shopping, recreational and other needs without driving. Provision of green space and urban forest areas such as much of the Beijing Olympic Park provide energy and environment benefits. Policies that reward such efforts need to be instituted throughout China.

China already is investing heavily in public transportation within and between urban areas, with some of the most advanced technology in the world being built, but it is failing to keep up with demand. Furthermore, purchase of automobiles is being encouraged as part of the overall plan for stimulating economic growth and specifically encouraging domestic consumption. While this plan is being shaped to include an emphasis on energy efficient and low emission vehicles, the overall energy consumption and the environmental impacts of private vehicles has continued to rise. Creation of an automobile culture in China is one of the most significant policy decisions taken anywhere in the world. It is hard to see how this decision has promoted sustainable development, especially since it is in part stimulated by incentives such as tax cuts. China already has surpassed the USA as the world’s

largest auto market.

Although small vehicles are the norm and encouraged through some policies such as a progressive consumption tax on higher emission vehicles, China has become the largest market in Asia for luxury vehicles—larger than the market for Korea, Australia and Japan combined. J.D. Power Asia-Pacific has estimated that this market for vehicles above 400 000 RMB (USD 57 000) in price will reach almost 600 000 vehicles by 2015.[1] And it is a Chinese enterprise (Sichuan Tengzhong Heavy Industrial Machinery Company) that has offered to purchase the iconically-unsustainable Hummer brand from General Motors.

Urban energy and environment management systems in China, as elsewhere, will increase in extent and level of sophistication in the coming years. Examples include computerized traffic flow management that reduce traffic jams and unnecessary waiting at stop signals, smart electrical grids and interactive metering and management of electricity use, energy and methane capture from solid waste and from urban wastewater, LED lighting, mandated limits on cooling and heating of buildings, etc.. Many of these innovations are in practice today within some Chinese cities, especially in support of both energy efficiency goals and air pollution reduction. Yet the policies regarding urban management are still not optimal, and they are not always enforceable across the many hundreds of cities within China.

Furthermore, creating the urban advances that will be required to address GHG challenges is a daunting task. Many cities elsewhere in the world, especially in some OECD countries, have been in the vanguard of climate change action. ICLEI-Local Governments for Sustainability, for example, notes that some 700 communities participate in its worldwide Cities for Climate Protection™ campaign. The ICLEI approach is to establish five milestones focused on practical policies that can be implemented largely through improvements in public infrastructure and buildings.[2] China does not appear to have a comprehensive urban climate change

[1] T. Dunne. 2009. *China's Luxury Vehicle Market: A Bright Future Ahead.* J.D. Power and Associates. http://www.jdpower.com accessed 23 August 2009.

[2] ICLEI's Five Milestones for addressing climate change: (1) Conduct a baseline emissions inventory and forecast, (2) Adopt an emissions reduction target for the forecast year, (3) Develop a Local Action Plan, (4) Implement Policies and Measures, (5) Monitor and verify results. www.iclei.org.

policy of this type in place covering all cities.

Urban and suburban areas are home to China’s major technology innovation clusters, on themes such as wind and solar power, and also have invested heavily in green industrial parks where many of the sunrise industries powering green growth will be located. These parks themselves can be exemplars of energy efficiency and advanced pollution control. For instance, funded through China’s economic stimulus is an industrial park in the City of Hengyang, Henan Province, for the production of “environment-friendly” lead batteries. This technology has been developed by China Ritar Power Corp., a Shenzhen-based, NASDAQ-listed company that specializes in sale of such batteries in China and abroad, with a special interest in deep cycle batteries for wind and solar power and batteries for light electrically-powered vehicles.

The transformation of China from 46% to 70% urban population over the next two decades is perhaps also its greatest energy and environment challenge, especially since it will be accompanied by a rise in urban wealth that may or may not be accompanied by patterns of sustainable consumption. With over 200 cities expected to have populations of over a million by 2030, some 40 billion m^2 of building construction and perhaps 50 000 new skyscrapers, there will be enormous scope for innovation. The 2010 World Expo in Shanghai with its theme of “Better City, Better Life” will provide the perfect venue for both China and the World to take stock of progress on urban energy and environment and future opportunities for appropriate 21st century urban development.

3)Rural energy and environment.

Building the “New Socialist Countryside” offers the potential of improved energy availability, and economic development related to energy production and use. Most of China’s poor and those who only marginally escape poverty live in rural areas. They are among the most vulnerable to climate change effects, and therefore their needs should figure prominently in both mitigation and climate change adaptation strategies. Rural areas are of course where many energy sources serving the country are located including coal mines, hydropower dams, energy biomass sources, and the new wind and solar energy farms. Therefore rural areas

are vital to the solutions for many of China's energy and environment problems. Yet the rural regions for the most part are not fully equipped for the tasks—not having the education and scientific skills, or full access to the full range of technologies and enterprises that promise a new road ahead.

Rural people are still well behind urban dwellers in terms of their household income levels, and therefore cannot be expected to take full advantage of the current drive to create greater domestic consumption. Very likely, as their incomes rise, they may have different priorities on such expenditures. How their rising wealth, anticipated in coming years, will influence sustainable consumption in China is hard to predict. But at present rural dwellers help considerably with maintaining low per capita national energy use statistics low.

Rural residents have special energy needs, notably inexpensive, clean and healthy sources of energy for heating and cooking. Traditional use of coal and biomass fuel presents respiratory problems, especially for women and young children who spend longer periods indoors. Biogas is an ideal solution in some situations. Rural buildings generally are not being build to high enough energy efficiency standards. Another special need is off-grid electrical power, especially in remote western areas. The emphasis on solar and wind energy, and small scale hydro is therefore a good solution with the co-benefit of reducing coal burning. Rural populations benefit from dams that provide irrigation water and which also may guarantee access to reliable sources of electricity not only for household use but also for operating modern farm machinery, agricultural processing plants and cold storage. China has moved quite dramatically to meet these rural needs and therefore help meet its national Millennium Development Goals (MDGs).

The modernized rural countryside is intended to have more livelihood opportunities, including local industries appropriate to the regions, and to have greater, more efficient and productive agriculture. Also, given China's commitment to reforestation and grassland protection, more attention will be given to eco-compensation for ecological services. Some of the new occupations are related to biofuel production, to intensified agriculture, which requires more energy for fertilizer applications and other inputs, and to agribusinesses involving more spe-

cialized crops such as fruits, animal production, etc.. The net result is higher energy use, sometimes accompanied by serious environmental impacts. Turning materials such as manure from a waste to a useful product such as biogas; plant stalks and other wastes into cellulosic ethanol; and reducing energy use associated with cultivation by low-till agriculture are examples of how energy and environment can be addressed in the context of modernizing China’s countryside.

The issues of energy and environment in rural areas therefore fall very much within the purview of extension workers, local community leaders and county level officials. At this level there is much work to be done in order to build the necessary resolve and understanding of appropriate policies and to improve practical implementation.

The concerns of climate change may be even more important to address at this level. As noted recently by China’s Ambassador for Climate Change Yu Qingtai[1]: Around 150 million Chinese citizens are mired in poverty, based on a UN benchmark of those living on less than USD 2 per day…lifting tens of millions out of poverty must remain [China’s] primary goal. The real issue is how to ensure that poverty reduction becomes part and parcel of China’s climate change effort, with good progress on both topics.

Rural populations are vulnerable to the greater intensity of severe weather events such as typhoons, floods and droughts. It is farmers and herders who are most directly affected by the melting of glaciers and other effects in western China. Human, animal and plant diseases and pests may spread, and ecological effects including changes in vegetation zones, crop ripening and biodiversity, all need to be taken into account via a combination of adaptation and mitigation of effects. Rural climate adaptation strategies are therefore an essential need for all areas of rural China. Part of this need will be adequate mechanisms to compensate losses suffered by these residents and producers. Some of this compensation could be through international funds linked to REDD[2] or other mechanisms based on agri-

[1] Reuters Wed. 5 August 2009, interview with Yu Qingtai in Beijing.

[2] REDD is the UN Program for Reducing Emissions from Deforestation and Forest Degradation in Developing Countries. A special fund has been established for this purpose and REDD is under discussion for future international agreement.

cultural or forestry practices that lead to carbon sequestration. Climate adaptation is still at an early stage in China and elsewhere and the necessary policies still need to be developed.

4)Economic instruments for energy and environment.

CCICED has pressed for improved incentive-based regulation concerning energy and environment for many years. Recommendations on pricing, reduction and elimination of environmentally-perverse subsidies, and greater use of taxes have been proposed. China is gradually moving towards a greater use of these instruments, and bringing resource prices into line with those of international markets. But the job is far from done. Indeed to some extent what has so far emerged is a patchwork quilt. The quilt has a variety of patterns, a number of holes, and is quite ragged. In other words, incentive policies are characterized by inconsistencies in their application, offer easy ways to be circumvented, and lack enforcement.

In the coming years development of a system of market-based incentives and mechanisms will be required to address energy and environment problems that are, at their core, economic and financial issues. What is of crucial importance is to increase energy productivity—ability to squeeze more value from a given amount of energy use. Stronger incentives are needed to make this happen. A growing part of the effort will need to be directed towards climate change. We are seeing the emergence of a variety of proposals for cap and trade systems and for pricing and taxing carbon, for example. The incentives for taking action on specific environment and energy matters often are not yet large enough to be attractive within China, or elsewhere. But sometimes larger incentives may only reinforce what people are already prepared to do (e.g., subsidies for taking older high polluting gas-guzzling autos off the road in the USA and Europe), or do little to actually tackle the problem they are intended to address (e.g., first generation, highly-subsidized biofuels from grain or corn).

Policy failure involving energy and environment economics has been high throughout the world. There are a number of reasons why: politics trumps economic rationality, fierce lobby pressures, inadequate scientific knowledge or use of existing knowledge, and long histories of subsidizing hydrocarbon energy sources

and uses. The recent announcement at the Philadelphia G20 Summit of a commitment to eliminate environmentally harmful hydrocarbon subsidies will be an extremely important test case.

A problem of reforming entrenched pricing and other financial support systems involving energy and environment is that there never seems to be a right time to do so. Otherwise, we might have expected much more support for emerging renewable energies over the past decades and public transportation, and less for fossil fuels, automobiles, etc. This has certainly been the case in North America and Europe, where artificially low energy prices held back energy technology development. The combined energy, financial and climate change crises is increasing the pressure for positive change of incentives, but certainly the signals are mixed, especially given the massive bailout of the automobile sector.

In the case of China, it is certainly true that there have been many more good suggestions made about market-based mechanisms than fully satisfactory action to date. One reason for limited action is that there are complex agendas, for example, the concern for stimulating domestic consumption while at the same time seeking sustainable development. Another is for maintaining social stability, which is threatened when prices rise suddenly. A third is to create fiscal mechanisms that avoid negative impacts on the poor, or on particular regions within China. Fourth, there has been a tendency in environmental programs everywhere in the world to resort to command and control first.

But what about the future? If it is reasonable to argue that without full application of market-based mechanisms the problems of environment, energy and climate change will remain intractable, then the question is not whether, but how a comprehensive system of incentives can be put into place. China cannot expect to undertake green fiscal reform totally on its own, since it must maintain competitive advantage in global trade, and it also must have access to the necessary technology solutions, etc., at fair prices. Furthermore, highly-volatile commodity prices internationally make green fiscal reform more difficult. And carbon pricing is a necessary part of GHG emissions reduction strategy nationally and, ultimately, globally.

The entire financial sector can participate in market-based approaches to en-

vironment and energy. Banks in China are beginning to add environmental conditions to their loans, and there are efforts to create environmental liability and compensation mechanisms within the insurance industry. Green securities measures are beginning to appear in China's stock markets. Industries from sectors with a history of heavy pollution must undergo an environmental inspection before making an IPO, and there are regulations demanding greater public disclosure of possible environmental effects of operations.[1] These are definitely works in progress, with a considerable potential for major improvements on their impact in the years ahead.

Better balancing is needed among command and control regulation, use of economic instruments for environmental cost internalization, and voluntary measures. This balancing demands fundamental rethinking of environmental laws and regulations, new standards, and strong monitoring and enforcement. These are challenges that need to be addressed quite urgently, for China's framework has been designed in an era when administrative measures and command and control were the predominant elements. However, it must be emphasized that this does not mean a new era of less regulation. In fact, it should be a time for more efficiently applied and enforced regulation, sometimes called smart regulation.

5) Low carbon economy (LCE).

CCICED has been exploring the potential value of Low Carbon Economy to China since April 2007, when it convened an exploratory workshop that attracted considerable Chinese and international interest. Since that time, LCE has become a topic of considerable interest in many OECD countries, and within China. Statements by Chinese leaders have demonstrated support. At the 15th APEC Economic Leaders Meeting held in Australia in September 2007, President Hu Jintao indicated to APEC members that:

We should improve energy mix, upgrade industries, promote low-carbon eco-nomy, build an energy-conserving and environment-friendly society and thus address the root cause of climate change…We should step up research and development as well as the application of energy efficient technologies, environmental protection

[1] http://www.climateintel.com/2008/03/04/china%E2%80%99s-green-securities-policy.

technologies and low carbon energy technologies, increase capital investment in these areas, and boost technological cooperation and transfer of technologies.

Since that time, this subject has rapidly gained ascendancy with senior policy makers.

Recently, the topic has been discussed at a cabinet meeting of the State Council in mid-August 2009 where it was noted that several key tasks would have to be undertaken to cope with climate change, including: developing a green economy by cultivating new economic growth with low-carbon emissions and speeding up the construction of low-carbon industrial architecture and transportation systems.[1] Furthermore, the meeting noted that governments at all levels would have to incorporate climate change measures into their development plans. This has been interpreted as a signal for incorporating LCE into future Five-Year Development Plans. On August 27, 2009 the Standing Committee of the 11th National People's Congress (NPC) passed a resolution on climate change that states: China should make carbon reduction a new source of economic growth, and change its economic development model to maximize efficiency, lower energy consumption and minimize carbon discharges.

At the UN Climate Change Summit on 22 September 2009, President Hu made the following commitment for action on energy, environment and low carbon economy[2]:

In the years ahead, China will further integrate actions on climate change into its economic and social development plan and take the following measures: First, we will intensify effort to conserve energy and improve energy efficiency. We will endeavor to cut carbon dioxide emissions per unit of GDP by a notable margin by 2020 from the 2005 level. Second, we will vigorously develop renewable energy and nuclear energy. We will endeavor to increase the share of non-fossil fuels in primary energy consumption to around 15% by 2020. Third, we will energetically increase forest carbon sink. We will endeavor to increase forest coverage by 40 million hec-

[1] http://www.china.org.cn. China Underscores Climate Change Strategy. 13 August 2009. Quoted from MEP website media service.

[2] http://www.china-un.org/eng/zt/hu2009summit/ t606111.htm.

tares and forest stock volume by 1.3 billion cubic meters by 2020 from the 2005 levels. Fourth, we will step up effort to develop green economy, low-carbon economy and circular economy, and enhance research, development and dissemination of climate-friendly technologies.

LCE is rapidly moving from being a theoretical concept debated by academics and others in China towards becoming a principal driver of future green growth in China. It is therefore an immensely important topic that requires careful study for its economic, social and environmental implications. Of particular concern is the macroeconomic impact of such a major shift, and also just how quickly it should initiated? Some would argue that the shift is well underway with China's growing commitment to renewable energy and to the energy efficiency goals of the 11th Five-Year Plan and other initiatives including energy technology commitments in the economic stimulus package. But these are only starting points for what will be a long-term effort that must involve not only China but also strategies implemented by many other countries.

The American Progress Institute, for example, suggested 10 policy steps to move the USA towards a LCE[1]:

(1) Create an economy-wide, greenhouse-gas-emissions cap-and-tra-de program;

(2) Eliminate Federal tax breaks and subsidies for oil and gas;

(3) Increase vehicle fuel economy;

(4) Increase production and availability of alternative low-carbon fuels;

(5) Invest in low-carbon transportation infrastructure;

(6) Improve efficiency in energy generation, transmission and consumption;

(7) Increase the production of renewable electricity;

(8) Use carbon capture-and-storage systems to capture and bury the carbon emissions from burning coal;

(9) Create a White House National Energy Council and make the Federal government a low-carbon leader;

[1] J. Podesta, T. Stern and K. Batten. November 2007. *Capturing the Energy Opportunity Creating a Low-Carbon Economy* American Progress Institute. 88pp. www.americanprogress.org.

(10) Lead efforts to advance international global warming policies.

Great Britain has introduced legislation, strategies and transition plans that would lead towards a Low Carbon Economy. Other European countries and the EU are at various stages of the same.

Based on these and other efforts, the common elements of a LCE approach are to: (1) articulate a definition appropriate for the country that decouples economic growth from carbon content; (2) link the effort clearly to climate change mitigation but also to competitive advantage in the form of green growth; (3) create a strategic roadmap of key intervention points and potential outcomes; (4) focus on sectoral shifts including an industrial plan, an energy and environment plan, etc.; (5) estimate costs and revenue sources over a defined time frame of 20 to 30 years at least; (6) define necessary science and technology needs; (7) set out a LCE transition plan; and (8) build public and private sector understanding, support and participation for LCE initiatives.

Policies, legislation and regulations, incentives and institutional arrangements to support LCE are still more or less at an early stage, although certainly rapid progress will be needed. Most importantly, LCE ultimately must be tied to pricing of carbon and then to workable mechanisms such as carbon taxes, cap and trade or other means to reduce GHG emissions.

Some issues about applying LCE within China include the following questions:

(1) Is it more appropriate to focus on Low Carbon Development rather than LCE?

(2) How can the transition to LCE improve development that favours poorer people and regions, and avoids negative impacts on them?

(3) Is use of coal as a main energy source compatible with LCE, especially if economically-viable solutions to carbon capture and storage from coal uses can be developed?

(4) Is it necessary for China to develop cap and trade or other limiting targets as part of a national or global LCE?

(5) What are the best means for China to finance LCE?

(6) How can access to needed LCE technologies be improved, including both domestic and international sources?

(7) What would provincial and municipal LCE strategies look like?

There is a need to provide some assurance to decision makers that deciding to move towards a LCE will have manageable economic impacts, and, hopefully, rising economic benefits. This requires substantial on-going scenario development using credible macroeconomic models. As well, employment costs and benefits, impacts on poorer people within society, and regional or sectoral impacts need to be carefully considered. Fortunately there are co-benefits such as pollution reduction that can be gained through LCE investments and these need to be carefully identified and calculated. Thus China, and many other countries will need to undertake on-going socio-economic analysis, and assessment of environmental and other benefits, especially during the early stages of constructing and implementing LCE strategies.

On the basis of these assessments and analyses it will be possible to undertake corrective and adaptive measures. The important point is to start small but soon on creating a Low Carbon Economy. Pilot projects and other experimental efforts will be valuable in the immediate future, but certain essentials are also needed soon. These essentials include a national strategy for LCE that can be readily understood by the public, enterprises, and people at all levels of government; mechanisms for pricing of carbon and setting of carbon reduction intensity targets, a roadmap with strategic points for initial intervention, and an incentives-based system to promote rapid change of technologies, institutions and management systems towards new approaches.

Looking Ahead

This AGM comes at a time when inputs into the 12th Five-Year Plan are desirable, and also in the aftermath of the difficult first year of the financial crisis. Therefore it is a good point in time to consider mid-term assessment of what has been accomplished on the mandatory environment and energy goals in the 11th

Five-Year Plan, progress on other environmentally-related objectives, and on sustainable development progress. This performance should set the stage for defining objectives of the 12th Five-Year Plan. A variety of task force recommendations have come forward over the period of CCICED's Phase Ⅳ that may be relevant to the 12th Five-Year Plan. In the final part of this section of the Issues Paper we lay out a number of suggestions, mainly as a summary for discussion during the AGM.

Some of the important questions: Can China meet or surpass relevant environment and energy goals? Which ones are most likely to be in trouble and why? If the goals are met across the board, are the results credible, given the problems of statistical data, and the pressure on lower administrative jurisdictions to be judged favourably? What are the most significant outcomes that appear to be emerging from the 11th Five-Year Plan and who/what will they benefit most? Are there significant social groups that have not benefited? What can be changed at this midpoint in order to strengthen eventual outcomes? Has the experience of the 11th Five-Year Plan been transformative? How can the 11th Five-Year Plan experience be useful for setting goals and approach of the 12th Five-Year Plan? We will not try to answer all these questions here. But they should be kept in mind as potential issues, not only for the current Five-Year Plan, but also future ones.

1. 11th Five-Year Plan

1) Meeting China's 11th Five-Year Plan Mandatory Environment and Energy Goals.[1]

In 2007 a CCICED Task Force[2] noted that meeting energy and environment targets[3] would be difficult due to the very high economic growth rates and the relatively slow progress made during the first two years of the 11th Five-Year Plan, even though there also were expressions of hope that vigorous action would lead to

[1] This section draws upon a background paper prepared for this Issues Paper by Chen Gang and Wang Xiaowen. *Mid-term Assessment of Obligatory Indicators for Energy Conservation and Emission Reductions in 11th Five-Year Plan Implementation.*

[2] CCICED Task Force on China's 11th Five-Year Plan Environment and Development Performance.

[3] The Chinese Government has required that the energy consumption per unit of GDP should be cut by 20% from 2005 to 2010, and the total pollution discharge should be reduced by 10%. These two targets are binding ones on all levels of governments.

success. Of course much has changed since that time: lower economic growth rates in 2008/09; lower imports and exports since September 2008; lower FDI; shift to domestic consumption; efforts to shift from low-value, high embedded carbon exports; and improvements to rural social spending and economy. Government leaders have vigorously pressed all provinces and levels of government to achieve 11th Five-Year Plan targets established for particular regions and sectors. The effort appears to be having some good results and there now is the possibility that even the most difficult targets might be reached.

According to official statistics, by the end of 2008, the total energy consumption per unit GDP had been reduced by 10.1%. And the total discharge of SO_2 and COD were reduced by 8.95% and 6.61% respectively. In the first half of 2009, there were further reductions of 5.46% and 2.46% for SO_2 and COD, and 3.35% for energy intensity. While these results are very encouraging, there are still significant worries about overall energy and environmental performance. MEP indicates that the average SO_2 atmospheric concentration in key cities went down by 15.8 percentage points compared with that of 2005. And the accumulated energy saving is 290 million tons of coal equivalent over the past 3 years, equivalent to the reduction of 660 million tons of CO_2. However, as recently described in a speech by Minister Zhou Shengxian, environment conditions remain very serious within China and form a grave situation globally.[1] China believes that by continuously improving its own environment, it also will be improving the global situation.

Two years remain to accomplish the obligatory environmental and energy indicators. Assuming emissions are reduced at a fixed rate over the two years and the obligatory indicators are realized as due by 2010, the fixed rate can be calculated.[2]

For COD, a year-on-year reduction of 1.83% should be made in 2009 and 2010 in order to achieve the indicator goal, annual COD reduction should be 8.32% and 10% in 2009 and 2010 respectively in relation to the baseline year of 2005. The somewhat unfavorable situation for COD reduction is due to several factors: first, new industrial emissions continue to increase rapidly, where pulp &

[1] http://www.english.mep.gov.cn/Ministers/Activities/200909/t20090929_161949.htm.

[2] Calculations are from the background paper by Chen Gang and Wang Xiaowen.

paper, brewery and textile industries, which contribute over 60% of COD emissions, remain on a fast track of growth; secondly, the engineering of emissions reduction is lagging—the construction of water projects with a daily treatment capacity of 6.8 million tons at urban sewage treatment facilities required by the 11th Five-Year Plan is running far behind schedule; and thirdly, the progress in structural emissions reduction is less than ideal, where essential advances have not been made in closing down backward production capacities for pulp & paper, brewery, MSG and citric acid.

For SO_2, a year-on-year reduction of 0.58% is needed in 2009 and 2010. The annual reduction should be 9.5% and 10% in 2009 and 2010 respectively in relation to the baseline year of 2005. It is believed that the SO_2 goal could be met a year ahead of schedule. There are several reasons for this optimistic outlook. First, the pressure from newly added emissions sources has somewhat eased. Power generation, steel production and non-ferrous metal production, which contribute over 70% of industrial SO_2 emissions, have for the first time dropped or stayed even. Secondly, engineering emissions reduction has been progressing steadily with 82 desulphurization systems newly installed at coal thermal power plants—an installed capacity of 3.6 million kW, which is 72% of the annual plan. Thirdly, major advances have been made in structural emissions reduction, where 3 382 small thermal power generation units with a installed capacity of 19.89 million kW were shut down over the first 6 months—some 54.07 million kW accumulatively, a planned shutdown that was accomplished one and a half years ahead of schedule. And fourthly, the effects of emissions reduction supervision have started to show.

For each unit of GDP, the energy consumption should be reduced by 5.89% in 2009 and 2010 year on year, and the annual reduction should be 15% and 20% in 2009 and 2010 respectively in relation to the baseline year. These are very difficult goals to achieve.

2) Progress towards sustainable development.

The 11th Five-Year Plan addressed many aspects of sustainable development, which is, of course, a more complex topic than environmental protection on its own. An independent review of 11th Five-Year Plan progress was released by The World

Bank in mid-December 2008.[1] It concluded that:

(1) Economic growth has far exceeded expectations;

(2) Considerable progress has been made toward the 11th Five-Year Plan's most important social objective: Improving basic public services in social protection, education, health, and conditions in rural areas, even though income disparities between rural and urban areas continue to widen; and

(3) Progress on the environmental objectives has been mixed: insufficient progress had been made in energy conservation, but improvements were seen in reducing air and water pollution, treating industrial solid waste, increasing the efficiency of water use, and expanding forest coverage.

Furthermore, the Bank concluded that the economic structure had shifted further towards dominance of the industrial sector, and, within the industrial sector, the energy intensive heavy and chemical industry had gained further dominance. The lack of rebalancing the overall economy had offset in part the gains at the micro level. The efficiency improvements gained through mandated efficiency standards and closure of inefficient capacities would become harder to tap in the future. Without making more fundamental changes in the economic and industrial structure, it was viewed as unlikely by the Bank that the 11th Five-Year Plan's 20% reduction target in energy conservation could be achieved.

The Mid-term Report on 11th Five-Year Plan Implementation reported to the NPC by NDRC points out that the overall progress has been good. In terms of fulfillment of the main socioeconomic development indicators, expected progress had been achieved for most of the 22 main indicators. 10 of the 14 indicators reflective of economic growth and livelihood improvement had been as expected or better, while progress was less than expected for 3 of the 4 economic structure indicators besides the rate of urbanization. Progress greater than required has been achieved for 5 of the 8 obligatory indicators, while forest coverage failed to be accurately assessed due to inadequate annual data, and advances in the 2 indicators for energy conservation and emission reductions were lagging.

[1] World Bank China Office. 18 December, 2008. *Mid-term Evaluation of China's 11th Five-Year Plan*. Report No. 46355-CN.

There are a number of other environmentally-related goals where good progress has been achieved according to the NDRC assessment. For example, water consumption per 10 000 Yuan industrial production growth was reduced by 16% by 2007, accomplishing 53% of the goal, and the effective utilization coefficient was increased by 0.02 for agricultural irrigation, reaching the 11th Five-Year Plan requirement. Goals for comprehensive utilization of industrial solid wastes were achieved ahead of schedule.

3) Regulated projects and activities.

Over 1 100 paper factories causing severe pollution, 16.69 million kW of small thermal units, 14 million tons capacity of obsolete iron factories and 6 million tons capacity of backward steel factories were shut down through regulatory action in 2008. Meanwhile, some of the backward production facilities in non-ferrous metal, cement, coke, chemical engineering and dye printing were closed down. Factories generating excessive pollution and backward productivities in pulp & paper, leather making, dye printing and brewery were shut down around Lakes Taihu , Chaohu and Dianchi as well as along the key water systems.

The MEP reviewed and responded to 365 projects between December 2008 and May 2009, accounting for a total investment of 1 442.8 billion Yuan. It suspended or did not respond to 29 chemical, oil, steel or thermal power generation projects worth 146.7 billion Yuan to prevent launching of 2H1R (Heavy energy consumption, heavy pollution and resource-related), duplicated or access productivity projects. There is the worry that if such 2H1R projects are launched or go into operation thanks to economic interests or local protectionism, they will cause severe damage to the public, environment and health.

4) Innovation technologies.

China’s commitment to green growth has shown some solid results over the years of the 11th Five-Year Plan. This is partly the result of the large S&T investment, but also from the realization that opportunities can be quickly realized with the right combination of technology. This subject has been discussed in considerable detail by the CCICED Sustainable Development Innovation Task Force which reported to the 2008 AGM.

4) Conclusions.

The 11th Five-Year Plan will set a new baseline for action on environment and energy within China. Clearly the process has not been easy, and to some considerable extent success has been dictated by external factors, especially the economic turn-down of the past year. But it is also clear that momentum is building, and that the use of mandatory targets on environment has been a positive feature in this process. There are concerns about how accurately current statistics represent reality across the vast reaches of China. But it is highly encouraging news that substantial progress is being made on both energy and environment indicators.

With renewed economic growth definitely a strong prospect, the reliance on intensity indicators (tied to GDP) rather than total loading is dangerous in that absolute amounts of pollutants and energy use are still likely to be on the increase. Furthermore, many important pollutants such as NO_x, ground level ozone, mercury and other heavy metals, and POPs are not subject to targets, or even control strategies. Furthermore, GHG and carbon reduction strategies were not incorporated into the 11th Five-Year Plan.

The social and economic impacts of the environmental results so far of the 11th Five-Year Plan do not appear to be systemically tracked. Thus it is difficult to know the extent of impacts on either rural or urban areas in the different regions of China. Also, while in general it might seem to be a safe assumption that environmental improvement in China is good for the whole planet, this is still an untested hypothesis in the minds of many people abroad. The reason for this is in part the credibility issue that China actually can make such quick progress on environmental clean-up. Therefore it would be useful for China to devote greater effort to scientifically measure how its domestic improvements directly affect the global environment.

2. Environment and development highlights for the 12th Five-Year Plan

Broad guidelines for the next Five-Year Plan are already under consideration, with various research efforts underway. The MEP and others have set out some ini-

tial guidelines for research on national environmental protection, shown in abridged form in Box 5. There are other topics relevant to the theme of this Issues Paper that are not included on the list in Box 5, including various aspects on environment, energy and climate change. And certainly, it might be expected that green economic growth would be an important component for consideration.

Box 5 Tendering Guidelines for Initial Research Projects on National Environmental Protection for the 12th Five-Year Plan

(Issued in 2009 by the Department of Planning and Financing, National Environmental Protection Ministry and the China Environment Planning Institute)

(1) The national environmental protection objectives of the 12th Five-Year Plan are to be regarded as phase requirements for realizing an all-round welfare society by 2020, featuring fundamental improvements in environment quality.

(2) Methods to control the total amount of pollutant emissions are to be improved and optimized, issues such as control of total N, P, nitrogen oxide and other new pollutants to be studied, and practices for total amount control to be furthered.

(3) Control of water pollution is to be furthered by applying systematic management of pollution in key waters such as changing from target total amount control to volume total amount control.

(4) Total amount control of air pollutants, especially prevention and control of nitric oxides and regional joint prevention and management of air pollution, is to be the leading direction.

(5) Eco-environmental protection and soil pollution prevention and management is to be one of the key tasks for the 12th Five-Year Plan.

(6) Integrated utilization of solid wastes such as domestic, hazardous, medical and industrial wastes and the relevant key projects are to become important work during the 12th Five-Year Plan, requiring innovative technologies and techniques, improved support policies and laws, and strengthened social administration.

(7) Support from public financing for environmental protection is to continue to grow as the Chinese economy keeps growing rapidly, and a designated financial funding assurance mechanism, which is stable, well-oriented and specifically targeted in spending, is to be built up.

The Five Changes pollutant emissions reduction recommendation from the CCICED 11th Five-Year Plan Task Force has not been fully implemented and remain

highly relevant for the 2011-2015 period. The Five Changes are: (1) change from sole emphasis on reduction of total amount of emissions to a combination of total emissions reduction and environment quality improvement; (2) change from priority of key industries to comprehensive reduction; (3) change from control over total emissions of single pollutants to synergic control over multiple pollutants; (4) change from emphasis on capacity to implement reduction programs to emphasis on the quality and actual effects of the programs; and (5) change from reliance on administrative methods to market-based economic instruments.

There are a number of key needs for improvement and updating of environmental laws and regulations in order to address the more complex environmental protection situation that exists within China today, and to address the greater use of economic incentives. To complement an enhanced regulatory framework, there is a need to build and to enforce an indicator system that emphasizes both total emissions control and environment quality improvement. There are many specific needs to be met in relation to expanding the range of pollutants to be controlled and to o enhance local implementation of total emissions control. Examples include: boiler emissions reduction for coal-burning industries and to transform approaches to SO_2 emissions reduction; steps to carry out total emissions control of nitrogen oxides for the thermal power generation industry; choose key river systems and lakes for ammonia nitrogen control; choose some sensitive lake reservoirs for pilot total nitrogen and phosphorus control; provide pilot total non-point source pollution control in some areas. There is a need to create active prevention and control of such newly emerging environment problems as POPs, mercury pollution and VOCs; and to develop and implement pilot programs such as restoration of pollution sites, polluted soil and neutralization of electronic wastes.

Five very important items on energy and environment include:

(1) Strategy for sustainable use of coal.

(2) Immediate and longer-term steps towards Low Carbon Economy and Development, including implementation in both urban and rural settings, in various industrial sectors, and shifts towards green growth for both domestic and export products.

(3) An energy productivity strategy, including a progressive, predictable approach to energy pricing and the use of an improved mix of regulatory and economic incentives.

(4) Carbon pricing, which may be based on carbon tax, cap and trade, or other arrangements.

(5) Targets for energy efficiency and energy-related environmental con-cerns, with some based on absolute amounts rather than intensity.

In summary, there are many specific drivers that should be taken into consideration in the design of the 12th Five-Year Plan goals for energy and environment. Among them are the followings:

(1) Energy conservation and energy efficiency needs in a variety of sectors to bring energy intensity in line with or better than existing international norms.

(2) Reduction in energy intensity for urban buildings, infrastructure construction and operations, and urban transportation.

(3) Continued efforts to expand as rapidly as possible the use of renewable energy sources in China, focusing particularly on wind, solar, marsh gas (methane), and small-scale hydro.

(4) Specific actions related to international arrangements on energy, environment and climate change, including carbon pricing and possible trading, CDM, bilateral and multilateral agreements on technology transfer and partnerships, IPR, and investment arrangements.

(5) Adaptation needs concerning climate change.

(6) Mandatory targets for reduction in GHG emissions and carbon intensity of development.

(7) Continued improvement in environmental quality through more stringent reductions in pollutants covered under the 11th Five-Year Plan mandatory targets, plus a broader range of pollution control (e.g., mercury from coal burning, NO_x).

(8) A system for reduction in total pollution load for some sectors and regions.

(9) Improved protection for ecological services, and ecocompen-sa-tion.

(10) Environment and health targets designed to reduce or eliminate mortality and cases related to specific causes, and improvement in environmental safety as-

sociated with key sectors such as coal mining and various types of industrial sectors.

(11) Full achievement of the MDGs within China, including those related to environmental sustain-ability.

(12) Strengthening frameworks to improve green growth opportunities, including scientific R&D, innovation technology investment, institutional strengthening and capacity building related to advanced efforts that will provide China with new economic growth opportunities and export potential related to meeting international demand especially those related to environment and energy.

(13) Improvement to the statistical information base for both energy and for environmental performance.

According to some views, the Low Carbon Economy could characterize a new approach to implementation of scientific development and harmonious society for the 12th Five-Year Plan, since it represents not only such a major turning point in sustainable development, but also because it will open great new opportunities for China's future economic growth and development.

Conclusion—Prospects for a Green Prosperity Future

This Issues Paper has taken on an almost impossible task of trying to examine the implications of several major global shifts of historical dimension taking place virtually simultaneously. A year ago it appeared that they were on a track of imminent collision, perhaps even leading to global collapse. The issue of financial meltdown and economic recession has been turned into a series of hopefully manageable problems—mainly for the major economies of the world to resolve. China has been vaulted into a role of greater international responsibility and consequences due to its favourable path of economic recovery. Certainly the problems with the global economy China and others will face in the coming five years are massive: restructuring the world's financial system, including the problems of moving away from high levels of deficit spending in some countries; ensuring adequate safeguards on trade and investment; and other issues highlighted during

the recent G20 Leaders Summit in Pittsburgh. Yet there is a sense of optimism gradually emerging, in part due to the rapid action by political leaders to avert worst-case scenarios. It also is clear that without a credible and stable global financial system in place, sustainable development goals will be very difficult or impossible to achieve globally and therefore within countries as well.

The second great shift has been the depth of dialogue on the issue of climate change in this year of lead-up to the Copenhagen climate change meeting that will take place in December 2009. There is now a reasonably well-entrenched view that climate change—along with poverty elimination—are defining problems for our common future and security during this century. Unless they are addressed well and soon, the costs will be perhaps unbearably high. Unfortunately getting a solid agreement about the best approach, with high levels of immediate action, is proving to be extremely difficult in the lead-up to Copenhagen. This problem has implications for green growth, for development of international markets for new technologies, and, very importantly for domestic consumption patterns in both industrialized and rapidly developing countries in particular. The Copenhagen climate change meeting is of historic significance to be sure—a beacon that will send its beam far into the future. But whatever the outcome, it is the start of a new way of thinking about our planet, and particularly about developing the Low Carbon Economies needed for the future.

The third shift is international cooperation concerning poverty reduction, and global capacity to address this serious problem. China’s strides towards meeting its Millennium Development Goals present a remarkable success story, but one that is tempered by growing inequalities in wealth, and the realization that a fair part of China’s population remains far too close to the poverty line. Yet China also can contribute much through expanded international cooperation throughout the developing world. The technologies that China is diffusing in its rural areas, its experience with renewable energy, and the advantages it brings in driving down the costs of production of many products are examples of unique contributions China can bring to many others in the world. The multiple crises that have emerged in recent times, including high prices for natural resource and energy commodities,

the high price and scarcity of food, threat of pandemics and, in many parts of the world, natural disasters of increasing intensity and frequency. These problems will need to be dealt with in more systemic ways and with fresh visions and solutions. Poverty is interlocked with climate change impacts and adaptation, especially for water issues, and with improving environment and development relationships.

The fourth and hopefully very enduring shift is towards societies based on innovation that can more rapidly address the changing circumstances and demands on productive forces within national economies and globally. Green growth involves new forms of both production and consumption. It should influence all sectors of economic productivity, ranging from primary and secondary industries to the commercial, tourism, telecommunications and other aspects of modern tertiary activities. It is understandable that much of the focus on green growth currently centres around energy, environment, and climate change, but ultimately it is transformation of lifestyle, infrastructure design, and the way business is carried out that will determine better outcomes— a future of Green Prosperity.

Will China be the global leader in developing this new future? It is difficult to answer this question because it depends upon China's own willingness to take on this role as part of its rise in the world. And in part it depends upon the wealthier countries undertaking their own transformations. China's potential is great because: (1) it has the means to address key challenges and opportunities precisely at the point in time when it is building the infrastructure to house, transport, meet energy and water supply needs of its people at a better level; and (2) it is prepared to invest in social improvements, especially for health and education. China also has demonstrated its tremendous capacity to succeed in the global marketplace. Whether it is LED lighting, wind turbines, advanced coal plants, or a myriad of other advanced green technologies, perhaps including electrical vehicles, through the great size of its domestic markets, its export marketing skills, and its ability to be adaptive, smart and fast, China has advantages that will be put to good use in coming years.

Green Prosperity also depends upon expanded international cooperation. This will involve a greater degree of sharing, and not only of wealth, knowledge and

experience. The power sharing that is taking place in the restructuring of global institutions, and in the decision-making among the world's major economies is an outcome that would have hardly been believed possible only a year ago. China has strengthened its potential for international cooperation as a result. This is seen in the case of environment and energy where there has been a rush of many countries to engage with China on matters of energy, environment and climate change. This new engagement is often on the basis of solving problems of mutual interests. Ultimately many of the results will be helpful not only to China but to the other countries involved. This is a pattern that should be encouraged.

It is well to seriously consider the meaning of Ecological Civilization, a phrase used mainly in China. If nations can prosper at low levels of ecological damage—with a deeply felt respect for nature and the ecological services provided by the global commons and by the rich resources of the planet—then we might achieve an Ecological Civilization globally. China's leadership has called for this state of harmony between people and the planet, and we must presume that it will become a central part of China's on-going development philosophy. Other countries will have much to learn, and hopefully much to contribute, during this common journey towards a prosperous future.

Part Ⅲ

Reports on the Progress on Environment and Development Policies in China

Since 2008, the CCICED Secretariat has entrusted the Chief Advisors and Supporting Team with the task of formulating a Report on the Progress on Environment and Development Policies in China along with observations on the impacts of CCICED's annual Policy Recommendations. The methodology to track impacts is still in development and will be addressed starting from 2010.

The following two reports summarize major developments in the field of environment and development, key policies and other measures adopted. They cover major areas of progress in the field of environment and development in China over 2007-2008 and 2008-2009. The two reports do not seek to assess how many CCICED recommendations are being implemented by the government. Rather they aim to report on overall progress and achievements China has made on environment and development during each of the two years so far documented, and to provide a policy context for readers to make their own judgments in terms of practical impact of those policy recommendations.

These two reports are based on information compiled from Chinese official sources and represent opinions of Chinese experts of the Chief Advisors Supporting Team. The material is for the reference of CCICED Council Members and stakeholders.

Report on Progress on Environment and Development Policies in China (2007-2008)

The past year[1] witnessed a turning point in environment and development undertakings in China. In October 2007, the 17th CPC Congress set out guiding principles for handling the relationship between the two, and for future policy making. The year 2008 represents a critical year of transition, in which action for the shift of the economic growth model, and building of an energy-saving, environmentally friendly and well-off society must speed up. Starting from the end of 2007, besides implementation of existing policies and targets in the 11th Five-Year Plan, the China government has accelerated energy conservation, and emissions reduction, releasing a series of major policies and measures to address pressing issues.

Guidelines for Development and Environmental Protection

The Communist Party of China (CPC) 17th Congress Report serves as a guiding document for future development in China, including environmental protection. It is pointed out that future development in China needs to be guided by the concept of scientific development, sustainable development and a development approach featuring growth, prosperity and a sound ecological environment. It also stresses the need to build an energy-saving and environment-friendly society, to achieve both growth and structural readjustment, and harmony between people, resources and environment so that people can enjoy a sound and healthy ecological environment and achieve sustainable economic and social development.

The 17th CPC Congress also has indicated that an *Ecological Civilization* is the new requirement for building an all-round well-off society: forming industrial

[1] The past year in the report refers to the past 12 months instead of the calendar year.

structures and growth and consumption models that save energy and protect the ecological environment. Circular economy needs to be applied on a larger scale, and renewable energy needs to take up a significant proportion in the energy total. Emission of major pollutants needs to be under control, with considerable improvement of the ecological environment. The idea of building an ecologically sound society needs to be firmly established.

The Congress' Report put environmental protection at an unprecedented level of attention, indicating that environmental protection has entered a historical transition period. The idea is to integrate environmental protection into the overall development planning, explore ways to achieve harmonious development and a sound ecological environment; address environmental problems at a macro level, promoting economic development and environmental protection at the same time; extend environmental protection into all aspects of production and establish a comprehensive pollution prevention and control system; and align environmental protection and improve living standards. [1]

Framework and Thoughts for Environmental Protection

The State Council released the 11th Five-Year Plan for National Environmental Protection ("the Plan") on November 22, 2007. Based on principles of prioritizing, measurable counting, quantitative assessment, the major indicators are reduced from 27 in the 10th Five-Year Plan to 15 in the current Plan, including two indicators for aggregate control and three for environmental quality (see Table 1) . The Plan centers on the solution to urgent environmental problems that hamper public health and sustainable economic and social development; emphasizes overall planning; targets 10% reduction of all pollutants; stresses pollution prevention and control as top priority; seeks safe drinking water for all residents; and develops overall planning. It proposes objectives, tasks and measures for 8 major concerns, including water, air, solid waste, ecological environment, rural pollution prevention and control, marine environment, nuclear and radiation-related environmental safety, and regulatory capacity.

[1] Excerpt of a speech by Zhou Shengxian, Environment Minister, at a meeting of EPB chiefs in 2008.

According to the Plan, an investment of about 1.35% of the GDP is needed to attain the environmental objectives that have been set. The Plan identifies 10 major projects based in the 8 areas of concern: capacity building in environmental regulation, disposal of hazardous and medical waste, chromium residue treatment, urban sewage treatment, urban waste disposal, water pollution prevention and control in major rivers, sintering machine off-gas desulphurization in coal-burning power plants and steel industry, building of major ecological zones and nature reserves, rural environmental protection actions, nuclear safety and radiation.

Table 1 Indicators of Environmental Progress in the 11th Five-Year Plan

	Indicators	2005	2010	Increase during the 11th Five-Year Plan
1	Total COD emission (10 000 tons)	1 414	1 270	−10%
2	Total SO_2 emission (10 000 tons)	2 549	2 295	−10%
3	Ratio of surface water in state-controlled sections inferior to water quality Category V (%)	26.1	＜22	−4.1%
4	Ratio of state-controlled sections in 7 major rivers over water quality Category Ⅲ (%)	41	＞43	2%
5	Ratio of major cities with more than 292 days of air quality over Category Ⅱ (%)	69.4	75	5.6%

The Plan requires improving monitoring and analyzing of greenhouse gas emissions, identities emission reduction targets and measures, and encourages adaptation to climate change. The Plan also proposes the following measures to support implementation: coordinating regional development and environmental protection; speeding up economic structural readjustment by institutional improvement, accountability and innovation; increasing investment; strengthening rule of law and regulation; developing environmental industries via technologies; mobilizing social support; and actively engaging in international environmental cooperation. It is also required in the Plan that governments at all levels fully perform their duties and make very real efforts to achieve accountability. Inter-departmental cooperation needs to be strengthened; assessment mechanisms shall be set up, with the information disclosure of major pollutant discharges every 6 months, for mid-term and final assessment of implementation of the Plan; stress shall be laid upon implementation and assessment.

The 2008 Government Work Report listed environmental priorities for the year, emphasizing that, in a year critical to attaining the binding reduction targets of the 11th Five-Year Plan, intensive efforts must be made for better results in the following areas:

1) Phase out outdated technology/infrastructure in power generation, steel, coal, paper making, while also building advanced capacity in these industries.

2) Pay special attention to energy conservation in major enterprises and development of major projects; speed up implementation of energy conservation in the 10 major projects; boost urban sewage treatment capacity with an aim to collect and treat all sewers in 36 major cities; raise discharge fees, sewage treatment fees and waste disposal fees; improve and strengthen construction standards, promoting innovation in materials for walls and energy conservation; steadily promote urban heating delivery system and utility reform.

3) Develop and promote technologies in saving, substituting and re-using energies and controlling pollution; apply key technological breakthroughs and carry out demonstration projects; develop energy-saving service industry and environment-related industry; explore clean and renewable energy such as wind and solar energies.

4) Improve the prevention and control of pollution in the Three Rivers and Three Lakes, water diversion source areas and downstream areas, the Three Gorges Dam region and the Songhua River region, among other major river basins; implement the Master Environmental Plan for the Bohai Sea; put in place more stringent national discharge standards for major rivers.

5) Protect sources of drinking water in rural areas; promote control of pollution caused by households and industrial pollution in rural areas; and strengthen control of pollution from animal husbandry and aquatic farming.

6) Encourage and support developing Circular Economy; promote recycling, reusing, and clean production.

7) Protect and make intensive and economic use of resources such as land, water, grassland, forest, and minerals; rigorously penalize those illegally exploring mineral resources; protect and properly use marine resources to develop marine

economy; invest more in basic research in meteorology, seismology and mapping, and strengthen capacity building in these areas.

8) Implement national plans to respond to climate change and strengthen capacity building in this aspect.

9) Improve the incentive system for energy conservation and environmental protection; enforce monitoring and accounting systems for energy conservation and emission reduction, improve auditing and inspection systems; strengthen law enforcement and accountability.

10) Raise social awareness for preserving a sound ecological environment, and mobilize the public to commit to an energy-saving and environmentally friendly society; recognize the need to persist through generations in order to achieve a green and clean living environment.

On July 1, 2008, Premier Wen Jiabao presided over the State Council working group meeting for energy conservation and emission reduction, at which the following priorities were identified for the attainment of the targets:

1) Strengthening assessment and appraisal of responsible parties in their accomplishment of targets; disclosing results for public supervision; and for the parties who fail to attain targets, explaining the reason for failure and proposing corrective measures.

2) Resolutely containing the rapid growth of industries featuring high energy consumption and emission; enforcing regulations on new projects and strengthening land use review and approval; energy conservation assessment and review and environmental impact assessment; implementing stricter EIA to restrict the number of projects in a given region; strengthening management of production permits; and continuing to restrict the export of products featuring high energy consumption and emissions, and heavy resource reliance.

3) Accelerating the phase-out of outdated technology/infrastructure. Shutting down small heat and power plants with a total capacity of 13 million kW, and phasing out outdated capacity in such industries as cement, steel, iron, electrolyzed aluminum, iron alloy, small coking, calcium carbide, plate glass, paper making, etc.; implementing regular reporting and checking in the phase-out.

4) Focusing on key projects on energy conservation and emission reduction. Allocating state funds to support the 10 major energy conservation projects, including the development of urban sewage treatment facilities and supporting drainage networks, treatment of industrial waste water in major rivers and capacity building in energy conservation.

5) Stressing key areas to ensure that at least 80% of new construction projects meet the compulsory energy conservation standards by the end of 2008; establishing standards for limiting the fuel consumption of transportation vehicles and vessels.

6) Speeding up the development and promotion of technologies in treatment and control of water pollution; promoting key technologies with great potential and wide application in major industries and areas.

7) Facilitating development of circular economy and preparing plans for developing circular economy in key industries and areas; drafting incentive policies, and establishing and improving accounting systems in this area.

8) Strengthening information management. Making public the list of flue gas desulfurization power plants to be built this year, and releasing information concerning their construction at year end; establishing as soon as possible an information system for urban sewage treatment management, an online monitoring system for urban waste water discharge and treatment facilities, a system for inspection and notification; strengthening the urban water discharge permit system and the waste water treatment licensing system; ensuring that the major 113 cities that adopt centralized supply of drinking water meet all the key requirements for the protection of surface water sources.

9) Adopting economic policies helpful to energy conservation and emission reduction. Properly pricing resource-reliant products, improving regulations on pricing of power produced by biomass; carrying out discharge fee reform; initiating reform of a user fee in mineral resources.

10) Further improving rules, regulations and standards regarding energy conservation and emission reduction.

11) Strengthening supervision and administrative enforcement.

12) Initiating a campaign of "every one for energy conservation and emission reduction" throughout the nation.

Major Environmental Policies and Supporting Measures

1. Establishment of Ministry of Environmental Protection, with Enhanced Institutional Capacity Building

The first session of the 11th National People's Congress (NPC) in March 2008 adopted the reform proposal to establish the Ministry of Environmental Protection (MEP) . On April 23, 2008, MEP released its Work Rules of MEP, positioning itself as a State Council agency responsible for environmental protection across the nation. These Work Rules focus on the shift of functions, strengthening macro-regulation, coordination, supervision, and public service. Its functions include planning and coordinating environmental efforts; drafting and implementing environmental plans, laws, regulations, policies and standards; preparing environmental functional zoning and conducting environmental quality monitoring and assessment in prevention and control of pollution, ecological preservation, nuclear and radiation safety; and addressing key environmental problems. On June 25, the Standing Committee of the State Council reviewed and adopted the Rules of Procedures, reorganization and staffing of the new ministry, based on which three new departments of environmental monitoring, aggregate control, and information and education are added, with a total new staff of 50 people.

To ensure the attainment of environmental objectives for the 11th Five-Year Plan, the MEP prepared the Plan for National Environmental Regulatory Capacity Building in the 11th Five-Year Period. The Plan was jointly approved by NDRC and the Ministry of Finance and released as Development, Reform and Investment Document No.639 [2008]. The Plan sets aside an investment of RMB 14.959 billion, with 7.847 billion from central budget, for 50 major projects. It focuses on the development of a current environmental monitoring and early-warning system and a sound environmental enforcement and regulation system, coordinating efforts in monitoring and inspection of nuclear and radiation matters, research, information collection and analysis, and education.

The Capacity Building Plan identifies 13 tasks:

Improving environmental quality monitoring network; strengthening regulating capacity for source regulation; enhancing emergency monitoring capacity; stepping up monitoring capacity in nuclear and radiation matters; promoting standardization of environmental inspection agencies; developing automatic monitoring system for major state-controlled sources; improving nuclear and radiation regulation capacity; strengthening regulation capacity in solid waste treatment; enhancing stewardship of nature reserves; improving infrastructure and working conditions in national environmental agencies; developing a research platform; strengthening standardization of environmental information and education agencies; and stepping up capacity building in environmental information collection and analysis.

2. Developing Supporting Measures and Achieving Initial Results in Energy Conservation and Emission Reduction

Environmental protection during the 11th Five-Year Plan period is centred around energy conservation and emission reduction. In 2007, preliminary achievements were made in this regard, with a 3.27% cut in energy consumption per capita GDP, a reduction of 89.8 million tons of standard coal, and reductions of 4.66% and 3.14% in SO_2 emission and COD, the first time in recent decades.

On November 17, 2007, the State Council issued the Scheme for Implementation of Per Unit GDP Energy Consumption Indicator System, the Scheme for Implementation of Per Unit GDP Energy Consumption Monitoring System, and the Scheme for Implementation of Per Unit GDP Energy Consumption Evaluation System (referred to as the 3 Schemes) , the Measure for Calculating Reduction in Aggregate Emission of Major Pollutants, the Measure for Monitoring Reduction in Aggregate Emission of Major Pollutants, and the Measure for Evaluating Reduction in Aggregate Emission of Major Pollutants (referred to as the 3 Measures) ; a joint effort by the NDRC, Bureau of Statistics, SEPA and other competent agencies. Energy conservation and emission reduction performances are integrated into the overall assessment system for social and economic development, as a major performance assessment indicator for government officials and enterprise executives. In

combination with a stringent accountability system, this should serve as a major basis and institutional guarantee for achieving targets of energy conservation and emissions reduction in the 11th Five-Year Plan.

On July 7, 2008, in accordance with the State Council rules and regulations on the monitoring and assessment of energy conservation and emission reduction, MEP, together with NDRC, Bureau of Statistics, Ministry of Supervision, completed an assessment of reduction in total major pollutants in all provinces, autonomous regions, municipalities and five major power generation corporations, and made the following decisions: suspending EIA approval of new development projects with COD emissions in Yingtan of Jiangxi Province, Sanya of Hainan Province, Hechi of Guangxi Province and Yuxi of Yunan Province; suspending EIA approval of all thermal power generation projects of Huarun Power Holding Co. Ltd., Guizhou Jinyuan Co. Ltd., and Shanxi Power International; and issuing penalties to 7 power plants including Shajiao B power plant under Shenzhen Energy Group.

Nationwide, coal desulphurization facilities of a total capacity of 120 million kW were put into operation; urban daily sewage treatment capacity rose by 13 million tons; total COD emissions was down by 13.818 million tons, 3.2% lower than that of 2006; SO_2 emissions declined by 4.7% compared with 2006 to 24.681 million tons. SO_2 emissions from the power generation sector decreased by 9.1% from that of 2006, with a 13.2% cut in SO_2 emissions by the five major national power corporations. For the first time, China realized reduction in both emissions.

On July 27, 2008, NDRC released the notice on the assessment result of energy conservation target performance for 2007, disclosing information of 30 provinces, autonomous regions and municipalities: among good performers were Beijing, Tianjin, Liaoning, Shanghai, Jiangsu, Shandong; and poor performers included Shanxi, Inner Mongolia, Hainan, Guizhou, Ningxia and Xinjiang, with the rest in between. For the progress toward achieving conservation targets of the 11th Five-Year Plan, Beijing and Tianjin achieved 40%; 15 regions including Fujian, Shanghai, Shaanxi 30%; 10 regions including Yunnan, Sichuan, Hunan, Chongqing, Hebei, Guizhou, Inner Mongolia, Shanxi, Jilin, Ningxia between 20% and 30%;

and Xinjiang, Hainan and Qinghai less than 20%.

To enhance energy efficiency, mitigate pressure from oil and power supply, and promote sustainable development, on August 1, 2008 the State Council issued the Notice on Further Promoting Economy in Oil and Electricity Consumption (State Council No.2008[23]) . The Notice pointed out that to address China’s energy problems, the key lies in conservation, and development with conservation as priority. At present, importance shall be placed in major equipment and products with extensive application, huge potential and immediate results, such as automobiles, boilers, motor systems, air-conditioners, and illumination. Comprehensive supporting measures shall be adopted to form effective incentive and constraint mechanisms, with promotion of energy conserving products and technologies for higher efficiency in oil and electricity use.

Five major measures for motor vehicles have been established:

1) Strictly enforcing the phase-out mechanism. All motor vehicles in operation shall meet fuel consumption limit standards by 2013;

2) Encouraging the use of low-fuel-consumption autos and clean-energy autos; further expanding tax rate differences for vehicles of different emissions levels; listing fuel-efficient and environment-friendly vehicles and clean energy vehicles on government procurement list;

3) Improving standards for fuel economy of vehicles and enforcing compulsory reporting, disclosing and labeling systems for vehicle fuel consumption;

4) Strengthening conservation management of the transport sector;

5) Promoting public transit systems; speeding up development of express bus and rail transport, enhancing connection of public transport, intra-region transport and inter-region transport and boosting efficiency of the public transit system. City governments shall increase investment and subsidy for the public transit system, with lower charges so as to encourage the use of the system.

Fuel-efficient measures for boilers (furnaces) have been established.

All thermal power plants (including newly built ones) shall adopt minimum petrol ignition technology and low load stable combustion technology for coal-burning boilers. China will continue to shut down oil-fired units as a major

means to close small capacity thermal power plants. In power generation, oil-fired units shall only be used as supporting units. Investment from central budget and central fiscal funds shall be more supportive of oil conservation projects and oil-alternative projects.

Power-efficient measures for electric motor systems are being promoted.

1) Accelerating the phase-out of low-efficiency motor systems and motor-driven equipments.

2) Promoting high-efficiency and energy-saving motor systems and related equipment; those in compliance with the provisions of the Catalogue of Preferential Income Taxes for Enterprises Manufacturing Energy and Water Conservation Equipment shall enjoy the prescribed preferential treatment. Projects involving energy conservation for motor system shall be rewarded.

3) Strengthening management of power conservation in motor systems; Formulating high-efficiency motor product standards and improving the compulsory energy efficiency standards and operation standards for motors and motor-driven equipment. Establishing motor-testing agencies, and including energy efficiency indicator as a key part of quality control for motor systems and related equipment.

Power-saving measures for air-conditioners have been introduced.

1) Promoting air-conditioners with high energy-efficiency performance. Strictly enforcing compulsory national energy efficiency standards for air-conditioners as well as energy efficiency labeling rules. Implementing fiscal and taxation policies encouraging purchase of high energy-efficiency products, encouraging development of non-electric air-conditioners.

2) Strengthening management of air-conditioning use by strictly enforcing temperature control in public buildings.

3) Improving renovation and maintenance of existing air-conditioning systems.

Power-saving measures for illumination purposes.

1) Speeding up the phase-out of low-efficiency products.

2) Cutting urban power use for illumination purposes.

3) Improving management.

4) Optimizing lighting systems operation through improving wiring and control modes.

5) Using natural light whenever and wherever possible, and gradually installing automatic switches in public places.

Power-saving measures for offices. The Notice also requires promoting management of oil and electric power conservation in assessment and review of fixed asset investment projects, strengthening management of major oil and power users, improving power demand prediction management, implementing pricing policies for oil and power conservation promotion; accelerating technological innovation and application; enhancing supervision, strengthening enforcement, conducting information exchange and education campaigns, etc..

In a bid to discourage the production and consumption of high-emission vehicles and eventually to achieve the national emission reduction targets, the Ministry of Finance and the State Taxation Administration decided to readjust the automobile consumption tax rates, The new policy prescribes that the tax rate for vehicles with an emission of above 4 liters will be raised from 20% to 40%; the rate for vehicles with an emission between 3 liters and 4 liters from 15% to 25%; and vehicles with an emission of no more than 1 liter will be lowered from 3% to 1%.

On August 1, 2008, the State Council released the Regulations on Energy Conservation in Public Organizations, prescribing management standards for state agencies, and not-for-profit organizations fully or partly funded by the state budget. The Regulations stipulate that:

1) Departments in charge of intra-organizational matters within the State Council or governments at and above the county level shall enact energy conservation planning for public institutions at the corresponding level, in accordance with the longer-term conservation plan by the government.

2) Public organizations shall adopt an energy consumption measurement mechanism, distinguishing energy use types and systems; energy use shall be measured by accounts, by types and by items, with monitoring to identify and halt energy wasting; public organizations shall designate a specific person to take charge of energy use calculation, keep original energy consumption records and

maintain statistical ledgers.

3) The organization shall adopt a quota system for energy use. Energy quotas shall be put in place for overall consumption levels of different sectors and public organizations, and for the Ministry of Finance to formulate energy use expenditure standards.

4) Priority shall be given to energy-saving products in government purchase. Public organizations shall purchase products and equipment listed in the government procurement catalogues for energy conservation and environmental labelling according to regulations.

5) Conservation management for development projects shall be strengthened. Renovation of newly built and existing structures of public organizations shall follow relevant requirements and standards for energy-conserving buildings. Departments within the State Council or governments at or above the county-level in charge of approving fixed asset investment projects shall control the scale and level of development projects by public organizations, with full consideration of energy conservation investment and returns, and conduct project energy conservation review and assessment.

6) Public organizations shall undergo energy audit, conduct technical and economic assessment of their energy-using systems, operation of equipment and energy use. Measures shall be taken to boost energy efficiency in accordance with the audit results. The Regulations also provide accountability measures for non-compliance.

The State Council also released the Regulation on Energy Conservation for non-government buildings.

3. Attention of Top Officials to Climate Change, with Interests in Low Carbon Economy

On November 9, 2007, the China Clean Development Mechanism Fund and its management centre were put into operation. Approved by the State Council, the Fund is a not-for-profit state equity fund that is policy-development-based, public welfare-oriented, long-term and open-ended, with the Ministry of Finance as its supervisory authority. The development strategy and major operations are decided by a Fund Review Council composed

of the National Development and Reform Commission, Ministries of Finance, Foreign Affairs, Science and Technology, Agriculture, Environmental Protection, and the China Bureau of Meteorology. The source of funding is the state gains the Fund derives from the international cooperation in clean development projects under the Kyoto Protocol. Meanwhile, the Fund is proactive in seeking cooperation with other sources of funding, and based on this, it promotes the participation and coordination of government input, international assistance and cooperation funding as well as private funding in response to climate change.

The Fund uses donations, preferential loans and other instruments to support the state in capacity building, public awareness campaigns, mitigation of and adaptation to climate change, as well as the implementation of China's National Plan for Coping with Climate Change. The Fund bases its operations on extensive domestic and international cooperation and plays the role of a cooperation platform for resources, funding, programs, actions and information exchange.

On June 27, 2008, the CPC Central Politburo held its sixth workshop presided by CPC General Secretary Hu Jintao, focusing on global climate change and capacity building for responding to climate change. Hu stressed the necessity and importance of full recognition of the need to respond to climate change, commitment to sustainable development, more effective policy measures and capacity building. Party branches and governments at all levels shall integrate climate change into development plans, take appropriate measures to boost organization and implementation capacity in response to climate change.

China, upholding the common but differentiated responsibilities identified in UNFCCC and the Kyoto Protocol, maintains that developed countries should take the lead in committing to emission reductions and providing funding assistance and technology transfer to developing countries. China also believes that developing nations should contribute to reversing climate change by pursuing sustainable development.

It was also stated that, in its response to climate change, China should focus on economic development, with priorities in energy conservation, ecological protection and development, and technological advances as supporting tools. China

needs to control and mitigate greenhouse gas emission, boost its response capacity, enhance sustainability, and achieve economic growth and environmental protection.

It was decided that the following measures should be taken to address climate change:

1) Implement measures to cut greenhouse gas emissions, commit to the basic national policy of energy conservation and environmental protection, adopt industrialization patterns with Chinese characteristics, shift growth models, conserve energy and boost energy efficiency, develop Circular Economy and Low Carbon Economy, and increase forestry coverage.

2) Improve climate change response capacity, strengthen basic development of farm land, rationally develop and optimize water resources, continue major ecological projects, and improve overall climate change impact assessment.

3) Apply technological innovations, invest in R&D and application of major technologies, strengthen basic research, and promote international exchange and cooperation.

4) Improve systems, mechanisms, laws and regulations regarding climate change, promote reform in energy management system and pricing, improve monitoring, early warning and response systems for various disasters, enhance multi-department decision-making coordination mechanisms, public participation mechanisms, and in particular, the capacity in comprehensive monitoring and early warning, in responding to extreme meteorological disasters.

5) Encourage public participation in dealing with climate change by raising awareness and capabilities. Low Carbon Economy is receiving increasing attention in policy discussions. Wan Gang, Minister of Science and Technology, pointed out at the 11th CPPCC (Chinese People's Political Consultative Conference) session that to fight global climate change, new technologies must be adopted to cut emissions and conserve energy, and to build a low-carbon and carbon sequestration economy. During the annual CPPCC and NPC sessions, Wu Xiaoqing, vice Minister of MEP, noted that with the new international developments, China must act promptly to meet the challenges raised by the low-carbon

economy, based on low energy consumption and low pollution. Wu also said that how to reduce the reliance on resources and energy consumption has now become a major challenge for China. Low carbon undoubtedly provides a new approach to sustainable development for China. It may well be the future for social and economic development, thus becoming a strategic choice in achieving energy conservation and emissions reduction, as well as fighting climate change.

4. Increased Investment in Environment, with Fiscal and Taxation Policies as Leverage

The Ministry of Finance (MOF) is adopting a series of policies to conserve energy and cut emissions:

1) Setting up special funds and increasing funding in conservation and allocating more money for research and development through various programs. According to the Temporary Rules on the Management of Incentive Funding for Energy Conservation Technologies, companies will receive state financial grants if they initiate programs that help to reduce energy use by 10 000 tons of standard coal.

2) Adjusting tax systems to encourage conservation, proper exploration and use of energy. The government will expand the consumption tax coverage, and will collect tax on products causing serious pollution or using large quantities of resources, in an effort to let taxation play a larger part in conservation and emissions reduction.

3) Improving government procurement policies by encouraging government agencies to take the lead in conservation.

4) Strengthening the user fee system for resources, environmental deposit system, urban sewage treatment system, and the discharge fee system; promoting full cost accounting in energy to reflect the full cost; tapping into market mechanisms for conservation and reduction, such as pay-for-discharge-right and discharge right trading system; setting up trans-river ecological compensation mechanism; fully promoting the "pay for mining rights" system, and environmental and ecological accountability system for mining companies; and establishing carbon trading systems.

5) Improving fuel tax reform schemes and imposing fuel tax at an appropriate

time; subsidizing special industries and grain-growing farmers to create a stable environment for rationalizing prices of refined oil and to create conditions for a pricing mechanism conducive to efficient and economic use of fuel.

6) Establishing special funds for renewable energy to support the development of renewable energy and new energy sources and to reduce reliance on traditional fuel. Developing supporting financial and taxation policies for restricted biofuel sources, thus avoiding impact on food security and grain price; speeding up the development of financial policies to encourage the use of crop residues (stalks and straw) as energy sources.

In 2008, the MOF set aside RMB 27 billion as special fund for conservation and emission reduction, including 7.5 billion for 10 major projects, 7 billion for sewage pipe network development in cities in the central and western part of China, 4 billion for phasing out outdated infrastucture, 5 billion for cleanup of the three rivers and three lakes as well as the Songhuajiang River, 3.5 billion for environmental monitoring capacity building and basic conservation work. In addition to the 14.8 billion from the Central Development Investment, a total of 41.8 billion is allocated from the central budget for energy conservation and emission reduction.

5. Implementation of Economic Measures for Environmental Protection, with Extensive Application of Market Mechanisms

China had never before so extensively and systematically proposed and applied market mechanisms to address environmental problems as it did in the past year. The newly released Law on Energy Conservation and Law on Promoting Circular Economy both explicitly recommend the use of market mechanisms and economic measures to promote relevant programs. In particular, the new conservation law includes a chapter on incentive policies, stating that the state should adopt fiscal, taxation, pricing, credit policies and government procurement to promote energy conservation and industrial upgrading in enterprises, and prescribing a series of compulsory measures to restrict the development of industries featuring high energy consumption and high pollution, including compulsory energy efficiency labelling.

Green Credit Policy

In July 2007, SEPA, the Bank of China, and the China Banking Regulatory Commission (CBRC) jointly released the Proposal on Implementation of Environmental Requirements to Ward off Credit Risks. Following this, CBRC released the Notice on Warding off and Controlling Risks of Loans to Corporations with High Energy Consumption and Pollution in July, and the Guide on Credit Granting for Energy Conservation and Emission Reduction in November 2007, requiring that financial institutions cooperate with environmental authorities, implement national industrial policies aimed at restricting development of projects with high energy consumption and high environmental risks. Financial institutions and environmental departments in most regions responded positively to these policies.

Green Insurance Policy

On 18 February 2008, SEPA and the China Insurance Regulatory Commission jointly released the Proposal on Environmental Pollution Liability Insurance, as an experiment on pollution liability insurance practices. According to the road map, the two agencies will conduct pilot programs of liability insurance in businesses involved in production, sales, storage, transportation and use of hazardous chemicals; and in petrochemical corporations and hazardous waste disposal facilities most susceptible to pollution accidents; and in particular, in the corporations and industries that have caused major pollution incidents in recent years. During the 11th Five-Year Plan period, the aim is to establish a pollution liability insurance system, conduct pilot projects in major industries and regions, and establish a catalogue of environmental risk-based insurable sources and pollution damage compensation standards. The goal for 2015 is to improve the insurance system to make it applicable nationwide, and to strengthen this mechanism for risk evaluation, loss assessment, liability identification, incident response, and damage control.

Green Securities Policy

In February 2008, SEPA released the Proposal on Stepping Up Environ-

mental Regulation on Listed Companies. Green Securities is the third environmental economic policy following Green Credit and Green Insurance. The Proposal will focus on: developing an environmental verification system and information disclosure of listed companies; containing excessive expansion of industries with high energy consumption and pollution; curbing capital risk; and pressing listed companies to improve their environmental performance. It requires that companies in thermal power generation, iron and steel, cement, electrolyte aluminum, and trans-provincial industries with high energy consumption and pollution (13 categories of heavy polluting industries) , when applying for IPO or refinancing in the capital market, shall conduct environmental verification in line with SEPA rules. In accordance with China Security Regulation Commission's Notice on the IPO Application Documents of Companies in Heavy Pollution Industries, such companies, in the application for IPO, must secure MEP's verification approval; otherwise, the application will be rejected.

Green Trade Policy

On February 26, 2008, SEPA made public the first Catalogue of "High Pollution, High Environmental Risk" Products, covering 141 kinds of products in 6 industries. Among them, 39 products including pesticide, paint, battery, and organic arsenic still enjoy export tax rebate. SEPA made recommendations to the MOF and the State Taxation Administration for canceling the tax rebate, and to the MOC and the Customs to ban the trade of such products.

Emission Trading Policy

Emission trading has been in practice in China for some years. The Government conducted a series of pilot programs in this regard. The Decision to Implement the Scientific Development Concept and Strengthen Environmental Protection in 2006 proposed that emission trading such as SO_2 trading could be conducted in appropriate places. Despite the absence of a national normative document governing emission trading, local governments are active in exploring this market mechanism to promote local environmental protection. In 2007 and 2008, many

parts of China made substantive progress in emissions trading. Jiaxing of Zhejiang province, Shanghai, Beijing, Tianjin, Lvliang of Shanxi province, and Taihu area in Jiangsu province have established environmental trading exchanges, with substantive trading cases. Other places like Hubei province, Changsha city and Chongqing also issued regulations for emission trading. Within the framework of Sino-US SED, MEP has initiated the Sino-US pilot program in SO_2 emission trading, with Heilongjiang province confirming its participation in this pilot effort.

6. Improving the Ronmental Legal System and Developing More Laws and Regulations

Currently, China has 28 laws governing the protection of resources and environment, and 66 regulations enacted by the State Council, all of which provide a legal basis for the protection work. However, with economic development and change of time, loopholes in those laws and regulations emerge, resulting in heavy demand for revision. In 2007 and 2008, 3 laws have been revised and more regulations released.

Environmental Laws

The Energy Conservation Law of China, revised on October 28, 2007, has been in force since 1 April 2008. This revision identifies energy conservation as the nation’s basic policy at legal level, explicitly prescribing that “the nation shall implement the basic state policy of practicing energy conservation, and the energy strategy of ‘conservation and development with priority to conservation’.” China now adopts a conservation target responsibility system and conservation assessment system, incorporating conservation targets into the overall assessment of local governments and officials. The revised energy conservation law expands scope and operability, further defines clauses governing energy conservation in the industrial sector, and adds provisions of energy conservation in construction, transportation and public institutions in response to weak areas for energy conservation.

The revised Law on Prevention and Control of Water Pollution, adopted on February 28, 2008, came into force on June 1, 2008. The revised law says that

"governments at and above the county level shall integrate water protection into economic and social development plans", forming a legal basis for environmental protection in economic and social development, with a more detailed and improved management system for prevention and control of water pollution. The new version establishes the legal status for building accountable management systems and mechanisms for water protection, assessment, ecological compensation, discharge permit, restricted regions, legal assistance for water pollution damage proceedings, thus making the water pollution management system more effective.

It defines the responsibilities of local governments in water protection, establishes the accountability system for governments at and above the county level with regard to the water quality within their jurisdiction, integrates water protection targets into assessment of local governments and the officials in charge, and institutes more stringent legal liabilities for violators. It also increases financial penalties for violations substantially, removing fine ceilings for some violations; it covers more punishable actions by establishing sanctions for failure to perform duties in a responsible and effective fashion. It expands the enforcement authorities of environmental agencies, and grants agencies the authority to impose administrative sanctions in cases of excessive discharge or failure to meet discharge requirements within the designated deadline.

The Law on Urban Planning, revised and adopted on Octoer 28, 2007, has been in force since 1 January 2008. The old version stresses guiding development, while the new edition emphasizes resource protection, covering arable land, natural resources, cultural heritage, scenery spots and places of historical interests, and includes an implementation plan.

The National People's Congress (NPC) adopted the Law on Promotion of Circular Economy on August 29, 2008, which will come into effect on 1 January 2009. Circular Economy refers to all the activities of reduction, reuse and recycling in production, circulation and consumption. The Law has established 6 primary systems: planning system for Circular Economy; aggregate control system for containing resource waste and emission of pollutants; circular economy assessment system; producer-centered accountability system; system for regulating enterprises

of high energy and water use; and an economic statistical system.

To meet reduction requirements, the Law covers areas including information disclosure, reducing resource consumption and waste generation in the designing, adopting advanced or appropriate water saving technology, formulating and adopting water saving plans, strengthening water saving management, adoption of overall planning in development of mineral resources, using processes that are efficient in energy, water, space and materials, as well as small-sized, light and renewable products in the design, construction and building of architectural structures; promoting intensive land use, encouraging and supporting the use of advanced farming, animal husbandry and irrigation techniques that save water, fertilizer and pesticide, giving priority to eco-agriculture and promoting energy saving agricultural machinery. State agencies and state funded organizations shall take the lead in using environmentally friendly products, equipment and facilities that save energy, water, space and materials; service-oriented businesses such as catering, entertainment, and hotels shall use environmentally friendly products that save energy, water and materials, reduce or stop the use of waste-generating products; the state encourages and supports the use of recycled water and restrict the production and distribution of disposable products.

To meet reuse and recycling requirements, the Law states that the industrial sector will promote cooperation among enterprises in comprehensive use of resources in an efficient and circular fashion. Industrial solid wastes, waste water, excessive heat, building materials waste, byproducts in agriculture, used agricultural plastic films, and forestry wastes shall be recycled and reused, and an information system for waste exchange shall be set up. The state encourages and promotes the establishment of waste recovery systems; strengthening management of electronic products recovery; recovery and remaking of motor vehicle parts, engineering machinery, machine tools and tires. Governments at and above the county level shall put in place an overall planning of facilities for sorted collection and recycling of urban and rural domestic wastes to boost recycling.

Normative Documents: Other Environmental Laws, Regulations, Standards

To ensure full and timely collection of discharge fees and correct noncompliance in the collection process, SEPA released the Rules on Discharge Fee Collection Inspection which took effect on December 1, 2007. In 2008, MEP issued a notice concerning discharge fees on waste water and gas.

On 10 December 2007, SEPA, MOC and MOST jointly released the Interim Regulations on National Ecological Industrial Parks which sets rules for the application, construction, management, naming, and acceptance check. The parks are designed based on the theory of Circular Economy, industrial ecology and clean production. The development of such parks helps to improve ecological environment in industrial parks, and promote the shift of growth model and development of new and high technologies.

On 31 December 2007, the State Council Office released the Notice on the Restriction of Production, Sale and Use of Ultra-thin Plastic Bags (SCO DOC 72, 2007) , requiring that, as of June 1, 2008, the production, sale and use of ultra-thin plastic shopping bags shall be restricted; the approach of pay-for-use shall be adopted; supervision and inspection shall be stepped up; used plastics shall be recycled to the greatest extent possible. With the implementation of the restriction, plastic shopping bag use in department stores and supermarkets has dropped by more than 80%.

In November 2007, SEPA released The Rules on Monitoring Reduction of Major Pollutants. On April 9, 2008, MEP released The Measures for Administration of Automatic Monitoring Equipment at Sources, which has become effective since May 1, 2008. The Measure requires the installation of automatic monitoring equipment at sources, which feeds information to the network of environmental agencies.

With respect to electronic waste, hazardous waste, nuclear management, prevention and control of marine pollution, protection of bio-diversity, normative documents were also released. The State Council started the revision of the Regulation on Prevention and Control of Marine Pollution Caused by Marine Construction Projects on January 1, 2008. To prevent and control pollution caused by electronic waste and

improve environmental management, the Measures on Prevention and Control of Electronic Waste Pollution came into force on February 1, 2008. The MEP and NDRC jointly released the revised National Catalogue of Hazardous Waste, based on the Law on Prevention and Control of Solid Waste Pollution. It became effective on 1 August 2008. The Catalogue covers solid and liquid wastes that are corrosive, toxic, combustible , radioactive, infectious, or potentially hazardous; and that need to be handled as hazardous waste. Medical waste is identified as hazardous waste. To regulate the export of hazardous waste and prevent environmental pollution pursuant to the Basel Convention, SEPA released the Measures on the Regulation of Hazardous Waste Export on March 1, 2008.

With respect to nuclear safety management, a series of documents have been released, including the Rules on the Regulation of Imported Civil Nuclear Safety Equipment (HAF604) , the Rules on the Regulation of Welder Qualification for Civil Nuclear Safety Equipment (HAF603) , the Rules on the Regulation of Design, Manufacturing, Installation and Non-Destructive Testing of Civil Nuclear Safety Equipment (HAF601) , and the Rules on the Regulation of Qualifications of Non-Destructive Testers for Civil Nuclear Safety Equipment (HAF602) .

In 2008, the National Standard Committee will focus on the 82 national standards pursuant to the Law on Resource Conservation and the Law on Circular Economy, and the revision and implementation of the General Rules on the Building Standard System of Corporate Energy Conservation. There is also the need to intensify research on market entry standards such as energy efficiency standards for energy-consuming products and equipment, and energy consumption ceilings for high energy-consuming products, in order to achieve targets for energy conservation and emissions reduction. The National Standards Committee and the NDRC prepared the Plan for the Development of Resource Conservation and Comprehensive Utilization Standards 2008-2010. The plan proposes 1 121 standards to be developed or revised for 2008-2010, including 676 national standards and 445 industry standards. The year 2008 has also seen the implementation of standards concerning motor vehicle emission, pesticide use, pollution control in landfills, and technical requirements for environmental products.

7. Environmental Information Disclosure and Public Participation

SEPA released the Rules on the Disclosure of Environmental Information on February 8, 2007 in order to ensure disclosure of information and encourage public participation. This has been in effect from May 1, 2008. It requires that environmental authorities make public 17 categories of governmental environmental information including laws and regulations, policies, standards, administrative permissions and administrative approvals. It also demands that sources with excessive discharges of pollutants shall disclose four categories of environmental information which shall not be withheld on the ground of business confidentiality. In addition, it encourages voluntary information disclosure. The Rules represents the first normative document on information disclosure as well as the first comprehensive departmental rules on environmental information disclosure released by the government following the State Council's Rules on Disclosure of Government Information.

On January 30, 2008, SEPA issued a notice on the applicability of the Rules to EIA reports (EC No. 50 2008) .

On May 6, 2008, MEP released on its official website the first MEP Categories for Information Disclosure and MEP Guide on Information Disclosure. MEP will make public 17 categories of information, and will respond to any public application for disclosure of environmental information within 15 working days from the day of application.

8. Emerging Environmental Concerns and Problems

Some unprecedented environmental challenges are emerging in the wake of urbanization and industrialization in China. This trend forces China to deal with more new environmental problems, such as ecological degradation and rural pollution, while dealing with industrial pollution. In the past year, some efforts have been dedicated to the new challenges by promulgating new regulations, launching new initiatives on research and surveys, and investing more money and human resources for handling new problems.

Ecological Preservation

On December 7, 2007, SEPA released the General Plan for the Protection of Major National Ecological Protection Zones, and the General Plan for the Preservation and Exploration of Animal Species. The Plan identified major objectives for the coming 15 years, with three stages for implementation. It also identified 12 key areas, including animals, plants, microbes, traditional knowledge, import and export management, together with some others. The Plan listed 10 priority actions and 55 priority projects for the 11th Five-Year Plan period, which provides the direction for financial support.

The General Plan for the Protection of Major National Ecological Protection Zones sets forth the guidelines, principles and tasks for the development of ecological function zones. The Plan points out that development activities are restricted within the protection zones. Building of the zones shall follow the principles of overall planning; phased development; commitment and sound organization; protection over development; avoidance of duplication; and a search for complementarity. The Plan is the first of its kind explicitly designed for capacity building, and represents the efforts of the NDRC and MOF in implementing the scientific development concept. With its implementation, the environmental regulatory capacity across the country has been greatly improved, making a stride towards a modernized, standardized and informed regulatory system with Chinese features.

Environment and Public Health

On November 6, 2007, the Ministry of Health and SEPA, together with 16 other ministries and commissions jointly released the National Action Plan for Environment and Public Health 2007-2015 (the Action Plan for short) , an indication of China’s commitment to protection of public health and implementation of environmental protection as a basic state policy. The 17th CPC provided historical opportunities to environmental protection, creating favorable conditions for work in environment and health. The Action Plan, as the country’s first guideline on environment and health, points out development directions and major tasks for en-

vironment and health, identifies roles and responsibilities for different departments, creating cooperation and coordination opportunities in promoting environment and health work. On January 20, 2008, the Action Plan was formally initiated.

Environment in Rural Areas

On November 13, 2007, the NDRC, the Ministry of Agriculture, the Ministry of Construction, the Ministry of Water Conservation, the Ministry of Land and Resources, SEPA, and the Bureau of Forestry jointly released the Proposal on Strengthening Rural Environmental Protection (No.63, State Council Office, 2007) . It is a directive document following the 17th CPC, for implementing the scientific development concept, building a harmonious society, and achieving economic, social, and environmental benefits at the same time.

The Proposal identifies 7 major rural environmental problems in need of solutions:

1) Protection of sources of drinking water and improvement of water quality.

2) Treatment of pollution caused by daily life.

3) Industrial pollution in rural areas.

4) Prevention and control of pollution caused by animal husbandry and aquatic farming.

5) Control of non-point source pollution.

6) Soil pollution control.

7) Ecological preservation.

The Proposal lists the following as main objectives for 2010:

Containing the worsening pollution trend; improving environmental quality in drinking water sources; obtaining knowledge about the nation’s soil pollution and agricultural pollution sources and making progress in controlling non-point source (NPS) pollution; raising application rate of the soil-test-based fertilizer technology and the use of pesticides featuring high effectiveness, low toxicity and low residue by over 10%; improving water supply; ensuring more than 65% of rural toilets meet set hygiene standards; controlling serious health hazards; achieving preliminary results in controlling industrial pollution and household waste pollution; im-

proving environmental regulation in rural areas; raising environmental awareness; better production and stewardship of the living environment.

The objectives for 2015 are:

Considerable improvement in living and ecological environment; containing the worsening trend in NPS pollution; enhanced regulatory capacity and environmental awareness; coordinated economic, social and environmental development. For those objectives, the Proposal suggests the following 6 measures: (1) improving policies, regulations and standard system; (2) establishing and improving rural environmental management institutions; (3) increasing investment; (4) wide application of technologies; (5) enhancing environmental monitoring and regulation; and (6) promoting information, education and training.

Soil Pollution

On January 8, 2008, SEPA convened in Beijing the first meeting on prevention and control of soil pollution. The year 2008 will see the preliminary completion of the setup of a database concerning soil pollution in China, an information system of rules and regulations as well as standards on prevention and control of soil pollution as preparation for the drafting of the Law on Prevention and Control of Soil Pollution and including it into the NPC’s legislative agenda as soon as possible. On June 6, 2008, MEP released the Directive of Strengthening Prevention and Control of Soil Pollution which identifies the following major objectives:

1) By 2010, complete a survey of soil pollution across the nation, with a comprehensive understanding of soil quality situation in China; establish an environmental monitoring network for soil; draft national and local plans for controlling soil pollution, formulate administrative framework for policies, rules and regulations; complete an action plan for conducting soil safety campaigns, resulting in enhanced public awareness concerning soil pollution prevention and control.

2) By 2015, establish an administrative and supervisory system for soil pollution control, with the release of a series of laws and regulations and improvement in the standard system for prevention and control of soil pollution with contingency plans for soil pollution emergencies, improve soil monitoring network; enhance

regulatory capacity, with considerable improvement in public awareness; implement prevention and control plans, and conduct research.

9. International Cooperation in Environment, and Consensus Building in Key Areas

In 2007, Climate change was an important issue in China and received extensive international cooperation. China was increasingly active in international efforts to cope with climate change. In December 2007, China took a proactive stance at the UN Convention on Climate Change held in Bali, and contributed to the formation of the Bali roadmap.

On July 9, 2008, Chinese president Hu Jintao was invited to the G8 summit, at which he made a speech on energy security for economic powers and climate change. Hu presented the guidelines, principles and measures in China's response to climate change, noting that climate change problems, fundamentally development problems, shall be addressed within the framework of sustainable development; international cooperation in climate change shall proceed in the context of economic growth, social development and environmental protection, with economic development as the focus; sustainability as the goal; energy conservation and ecological preservation as priorities; and technological advances as back-up support. Such a framework should improve the capability of the international community in mitigating and adapting to climate change. Countries, differing from one another in terms of economic development, technological achievements and national realities, shall make their own efforts to achieve positive results in coping with climate change on the principle of common but differentiated responsibilities.

President Hu Jintao noted that three factors should be taken into account when looking at China's emission problems:

(1) China, as a developing country in the process of industrialization and modernization, with imbalances in urban and rural development, regional disparity in social development and economic development, still faces the major task of improving people's livelihood and developing economy. (2) Per capita emission level in China is low, and cumulative emissions even lower. (3) Changes in interna-

tional division of labor and shifting of manufacturing activities to China have posed greater pressure for China.

Hu also elaborated on the measures China adopted for emission cuts. The Chinese government, responsible for its own people and people of the world, has been attaching great importance to climate change:

(1) It has identified ecological development as a strategic mission, emphasized the basic state policy for resource conservation and environmental protection, and tried to build an industrial structure, growth model and consumption pattern that preserves energy and resources and protects the environment. (2) It has taken energy conservation and emission reduction as the entry point in responding to climate change, and achieved positive results by taking a series of measure such as conserving energy, improving energy mix, enhancing energy efficiency and forestation. (3) China has been improving its capacity in adapting to climate change in areas such as agriculture, natural ecological systems, and water resources, giving priority to disaster prevention and relief and reducing loss resulting from disastrous and extreme weather conditions.

China has sent delegations to a number of international climate change meetings, for instance, China attended UNEP's 10^{th} Special Council and Global Ministerial Environment Forum on February 20-22, 2008 in Monaco; it also participated in the legislators' forum on climate sponsored by GLOBE International in Tokyo on June 28, 2008.

China's breakthrough progress in many environmental protection areas often starts in bilateral and multilateral cooperation. In the past year, China worked closely with the US and Japan in addressing some international environmental problems of common concern and pressing environmental problems in China.

On December 12 and 13, 2007, China and the US held their 3^{rd} Strategic Economic Dialogue (SED) in Beijing, signed an MOU on Strengthening Cooperation in the Area of Converting Biomass into Fuel, and discussed the possibility of signing an MOU in fighting illegal logging and related trade problems to promote sustainable exploration of forests. China will initiate SO_2 emission trading in the power generation sector nationwide. The US will provide technical support for wa-

ter pollution management projects and adoption of clean energy and its use in motor vehicles. The two sides reiterated their commitment within the WTO framework on "the reduction or, as appropriate, elimination of tariff and non-tariff barriers to environmental goods and services".

On June 17 and 18, 2008, the two countries met at the 4th SED in the United States Naval Academy in Annapolis, Maryland, USA, with the release of a joint statement covering the following: signing of a framework for cooperation in energy and environment in the coming decade; discussing ways of fully exploring energy security principles through dialogue; agreeing to cooperate with international energy institutions and agencies in areas of common concern to address energy security problems facing both sides, including global energy market, strategic oil reserve, energy diversification, energy efficiency and clean energy technology; agreeing to share information and experience in the reuse, disposal and regulation of wastes; consenting to conduct bilateral exchange with regard to product range and modes of the reduction and, as appropriate, exemption of tariffs, so as to achieve a comprehensive WTO agreement on environmental products and services; agreeing to explore the establishment of a mechanism by which information concerning trade in timber and forest products as well as legality of timber can be exchanged on a regular basis, in an effort to promote trade of legal timber and forest products, as well as global forest enforcement and governance.

On December 27-30, 2007, Japanese Prime Minister Yasuo Fukuda paid an official visit to China. The two countries signed the Joint Communiqué of the two governments on the Promotion of Cooperation in Environment and Energy, a document reflecting many consensus, covering strengthening response to climate change, protection of forestry and wildlife, technology transfer in energy conservation and emission reduction, intellectual property right protection, funding and capacity building, personnel exchange and training programs. The two sides will support joint research and pilot programs in pollutant reduction and its synergy effects on the reduction of greenhouse gas emissions, and strengthen concrete collaboration in water, waste and 3R (Reduce, Reuse and Recycle) areas. China and Japan will continue cooperation in water pollution prevention and control in major

river basins such as the Yangtze River, in development of recycling-based cities, and conduct dialogue and technical cooperation for waste management and 3R topics as well as cooperation in the area of environment and health.

On May 7, 2008, Chinese President Hu Jintao signed the Joint Statement by the Government of China and the Government of Japan on Climate Change during his visit to Japan. The two sides will work together to respond to climate change and forge a partnership in doing so. In addition to reiterating their common commitment to international conventions on climate change and principles for addressing climate change, the two sides also expressed willingness to actively participate in negotiations aimed to strengthen the effective progress and framework, before 2012 and beyond, established in the Bali Roadmap, in order that positive results can be accomplished on the Meeting of Signatories to the Convention and Protocol to be held in Copenhagen in late 2009. The Joint Statement also points out that the two countries will strengthen cooperation in technology transfer and capacity building in coping with climate change, and conduct joint research in key areas, particularly research on the impact of measuring industry-specific emission reduction, enhancing technology and capacity for coping with climate change, research in financial input in climate change response, among others.

Conclusions on China's Policies and Progress

Clearly this past year has been perhaps the most active ever for China in terms of the number of initiatives taken for improving the relationship of environment and development. It lends credence to the observations of CCICED in 2006 that China has entered a transformative era, or, as it is sometimes started, "a historic transition." However, this listing of policy changes should not be taken as an assessment of implementation success. That is a more complex task.[1]

The long lists of policy innovations and the specific tasks to be accomplished in a very short time frame are daunting, and elicit a number of concerns that have been examined in the past by CCICED. These include:

[1] See, for example, OECD. 2007. *Environmental Performance Review China*. OECD, Paris. 336pp.

1) Coordination of actions horizontally and vertically within government. The level of inter-agency coordination, potential for duplication of effort, unclear lines of responsibility, and the need for accountability between levels of government remain as serious concerns.

2) Unclear level of commitment to the "Three Transforms" intended to put environmental matters on an equal footing with economic decision-making. On-going subsidies in use of energy, for example, work against the level of conservation that is required.

3) Strength of the new MEP, which is still under-staffed to deal with the coordination needs and responsibilities of its broad mandate.

4) Funding levels for environment and development. The 1.35% of GDP may seem like a substantial investment-and it is-but this level is still below levels considered optimal in some other countries. There is also the major concern about how well this money will be used, especially with the limitations on capacity that need to be addressed.

5) Need for a clear and coordinated approach to such key issues as environmental technology innovation, and a sufficiently strong approach to environment and health-both topics that will be dealt with at the CCICED 2008 AGM.

6) An approach to capacity building for environment and development that is commensurate with the implementation needs, and that fully takes into account the limitations on small and medium-sized enterprises within China, and the need to ensure that poorer parts of China participate fully in environmental protection actions.

7) Improving the quality of environmental justice in China, whether for ensuring sanctions against those damaging the environment are sufficient, for ensuring those who help to improve the environment are appropriately rewarded or compensated, and for removing the problems of corruption that can be as damaging to environmental protection as they are to social and economic development.

8) China's ability to influence international directions on environment and development policies is likely to increase substantially in coming years, and certainly the effort now being undertaken on energy and environment highlights

China’s concern to be a responsible global citizen. But there is little doubt that on issues such as climate change, action by the international community is too slow. This will be damaging to China in the long run, and new ways of meeting such challenges need to be identified.

It will be important to continue strengthening monitoring and analysis of progress. This point certainly seems to be well recognized by China’s decision makers, who have taken a number of steps in this direction. But the perils of gathering good quality information are still considerable, and there is a need for better compatibility of data, and for independent analysis that provides the most accurate picture.

There have been many important milestones on environment and development in this past year which reflect the deepening and broadening of this subject matter in China. Three that stand out for their innovative quality are:

1) The administrative measures taken towards greater openness with the public on environmental information. This is a most important step towards improved public participation in environment and development decision making.

2) The comprehensive involvement of the financial sector in various ways related to credit, availability of insurance, sources of investment, etc..

3) The growing interest in Low Carbon Economy as an organizing focus for planning on energy and environment, and, indeed, for action towards a Circular Economy.

These components of policy and strategy should be of growing significance to China in coming years.

There are certain topics that have not received full coverage in this report. Two that stand out are the policies and action on environment that China undertook during the Beijing Olympics. An example is the policy approach of odd and even numbered license plates for vehicle use. This is a policy that could be put in place elsewhere in the country. And the policies that have guided China successfully through the Wenchuan Earthquake and other disasters have been of considerable significance for setting new directions on natural disasters. This topic has been examined in the CCICED 2008 Issues Paper.

Finally, while it is somewhat early to determine what new policy directions are likely to emerge within China and in China's international relations as a consequence of the global financial and credit crisis, there likely will be consequences for environment and development in the months and year ahead.

China deserves considerable credit for its significant efforts in 2007-2008 to position environment and development as a prominent and transformative component of national policy.

Report on Progress on Environment and Development Policies in China (2008-2009)

Background

In 2008, China maintained its rapid economic development in spite of the adverse impact brought by severe natural disasters and the global financial crisis, with a 9% annual GDP growth rate. In the first half of 2009, China's GDP still increased at an annual rate of 7.1% even though the world was badly hit by the financial crisis.

To address the economic crisis, China has adopted a stimulus package, used economic structural readjustment as a major weapon to overcome the economic turmoil, and, in the meantime, continued to push for energy conservation and emission reduction (ECER) as well as protection of the ecological environment.

1) China continued to improve energy structure by increasing the use of renewable energies. China's annual energy consumption was 2.85 billion tons of standard coal, up by 4.0% compared to the previous year. China installed wind power facilities of 6.3 million kWs, with a total capacity reaching 12.15 million kWs, an annual increase of 106%. Hydropower capacity reached 163 million kWs, and nuclear 8.85 million kWs. Energy consumption per unit of GDP dropped by 4.59% from the previous year. In the first 3 years of the 11th Five-Year Plan, China saw a drop of 10.1% in energy consumption per unit of GDP, saving 300 million tons of standard coal and cutting CO_2 emissions by 750 million tons, cumulatively achieving half of the target set for the five years of the 11th Five-Year Plan.

2) In 2008, COD level and SO_2 emissions dropped by 4.42% and 5.95% to 13.207 million tons and 23.212 million tons respectively. Compared with 2005, COD level and SO_2 emissions decreased by 6.61% and 8.95%. In the first half of 2009, the two indicators further dropped by 2.46% and 5.4%. In July, 2009, ECER

List for 31 provinces was released to the public.

3) By June 2009, China had increased its urban sewage treatment capacity of 40 million tons per day, reaching 90% of the total target in the 11th Five-Year Plan; had newly added 1 204 desulfurization-equipped coal burning power generators with a total installed capacity of 412 million kW; the ratio of generators with desulfurization equipment to all thermal generators had jumped from 12% in 2005 to the current level of 66%.

4) Nationwide, China had closed small thermal generating facilities equivalent to 54.07 million kWs, 1.5 years ahead of reaching the target of 50 million kWs; had eliminated backward production capacities in cement by 140 million tons, iron by 60.59 million tons, steel by 43.47 million tons, and coal by 64.45 million tons, and pulp and paper by 5 million tons, accounting for 80% of the target of 6.5 million tons. China's automatic monitoring and controlling system for key pollution sources had covered 85% of the state controlled enterprises, and China's desulfurization efficiency in power plants had increased from 50% in 2005 to 80% in 2008.

In terms of overall environmental quality, in the first half of 2009, the average concentration level of MnO_4^- for surface water under national monitoring is 5.3 mg/L, a decrease of 1/3 from the 2005 reading of 8.0 mg/L. The quality of the surface waters under national monitoring had a reading of 55.8% belonging in Classes I-III, an increase of 15.3% compared with that in 2005. Of the 113 cities selected as environmental protection priority cities, the average concentration of SO_2 is 0.045 mg/Nm^3, a decrease of 1/3 from 2005 reading of 0.070 mg/L, with fair to good air quality days reaching 91.3%, an increase of 8.2% from that of 2005.

The current year (2009) is critical for implementing the 11th Five-Year Plan. The State Council submitted to the Standing Committee of the NPC its interim implementation assessment report concerning the 11th Five-Year Plan. The assessment reveals sound overall implementation of the Plan. The report points out that, looking into the future, there is a need for further adjustment and balance of economic development in order to reach the targets, including those for environment and development. The assessment report indicates that China, with its good record in achieving longer-term targets, may well be in a position both to respond to current

global economic slowdown and to achieve longer-term targets set in the 11th Five-Year Plan if proper policy adjustments are made.

Responding to Economic Turbulence and Promoting an Environment and Development Strategic Transition

The year 2008 marked the 30th anniversary of China's reform and opening up. Over the three decades, China has worked a world economic miracle with immense economic and social changes. In his speech delivered at the meeting to commemorate the 30th anniversary, Chinese President Hu Jintao reviewed the achievements and experience in the nation's reform drive, expounded on new problems facing China, and shared his vision as to where China would go. Hu reiterated China's longer-term development objectives: turning China into a well-off society by 2020, and realizing modernization by the PRC's100th anniversary. However, China is confronted with daunting challenges in its quest for those goals. He also pointed out that China should harmonize human development and nature, innovate development philosophies, change the growth mode, pursue sustainable development, promote strategic economic restructuring, enhance independent innovation capacity, and build a resource-conserving and environment-friendly society. In particular, President Hu stressed that China would not deviate from its development path as a result of the short-term economic turbulence. China needed to stick to its development course of high productivity, prosperous life, and sound ecological environment, even with the spread of global financial crisis.

In 2008 and 2009, economic turmoil resulting from the global financial crisis has presented adverse impacts and uncertainties for environmental protection in China and in other nations. The 2008 CCICED annual general meeting was held at a time when the impact of the crisis was spreading. In its Policy Recommendations, CCICED, while commending the Chinese economic stimulus package, raised its concern of preventing environmental protection from becoming a sacrifice of the crisis, and also proposed recommendations such as translating challenges into opportunities, promoting scientific approaches to development and achieving sound and rapid development; tightening regulation to ward off the risk of economic

growth at the cost of environmental protection in some localities; increasing green government purchase and fostering development of environmental industries; changing growth mode by speeding up innovation in clean energy and production processes, nurturing clean industries and developing low carbon economy; and accelerating reforms in resource and energy pricing.

At the 2nd session of the 11th National People's Congress convened in March 2009, Premier Wen Jiabao pointed out in his Report on Government Work that in addition to responding to the ongoing economic recession, China needed to pursue ECER and ecological and environmental protection vigorously. The government work report highlighted the relations among economy, energy and environmental protection; took into full account energy conservation, clean and renewable energies, emission reduction, and identified rural environmental protection and adaptation to climate change as priorities. The following areas were stressed by Premier Wen:

1) Focusing on energy conservation in industry, transportation and construction sectors, continuing the development of ten major energy-saving projects, and implementing conservation measures in areas such as motor, furnace, automobile, air-conditioning and lighting, among others.

2) Pursuing circular economy and clean energy; continuing to economize on the use of energy, water and land; proactively developing nuclear, hydro, wind, and solar power, together with other clean energies; facilitating the industrial application of clean coal technology; enforcing national standards concerning energy consumption and environmental protection, promoting energy-saving technologies and products, and strengthening the comprehensive use of resources.

3) Fine tuning policies on energy-saving and environmental protection, and enhancing implementation of those policies in accordance with indicator, assessment and monitoring systems.

4) Launching ECER action for all, with government departments and agencies, SOEs and non-profit public organizations taking the lead.

5) Stepping up pollution prevention and control in major river basins and regions; controlling desertification; speeding up development of ecological projects

such as major green shields, protection of natural forests and controlling sand storms in Beijing and Tianjin; protecting ecological environment in waters, forests, grasslands and wetlands; pressing ahead with overall control of rural pollution; putting mineral resource exploration and development in order; and properly using marine resources.

6) Carrying out national programs responding to climate change and enhancing response capacity; investing more in basic research and capacity building in meteorology, earthquake, disaster prevention and relief, and mapping.

In June 2009, the National Task Force for Responding to Climate Change and the State Council Task Force for ECER convened a meeting, at which the commitment to further institutional reform and achieving ECER was reinforced. Proposed measures include: (1) strictly limiting the development of industries featuring high energy consumption and emission; (2) focusing on major projects and major areas, increasing fiscal investment in major projects and attracting private input, and encouraging "old for new swap" in automobiles and household appliances; (3) pursuing Circular Economy; (4) promoting the use of energy-efficient products; (5) furthering reform by improving economic recovery policies and management policies in environment; (6) stepping up regulation in ECER and stressing accountability; (7) strengthening capacity building through accelerating improvement of statistical, monitoring and assessment systems concerning ECER, training more qualified employees and using more advanced technologies; (8) actively participating in international cooperation, and particularly strengthening bilateral, regional and multilateral cooperation in energy conservation, new energy and low carbon technologies. The meeting also registered China's commitment to a constructive role in facilitating the achievement of positive results at the upcoming Copenhagen UN climate change meeting when hard choices will be made regarding the very survival and development of human beings.

The Ministry of Environmental Protection (MEP) also identified 6 priorities for this year at the 2009 National Environmental Protection Work Conference: (1) zeroing in on pollution reduction; (2) expanding domestic demand and taking environ-

mental infrastructure development as an effective means to accomplish reduction targets; (3) speeding up the initiation of treatment and control projects in major river valleys, by seizing the opportunities presented by proactive fiscal policies; (4) taking rural environmental protection as a new priority area; (5) clinging to environmental security and making environmental monitoring as a top priority for capacity building; and (6) stressing reform and innovation and improving environmental economic policies. China is speeding up the reform of pricing on resource based products and environmental protection levy, which has provided a good opportunity for improving environmental economic policies, a policy support for innovative environmental protection mechanism.

From the 2009 work plan for both the central government and its departments, it can be seen that China needs to achieve a strategic shift in environment and development while simultaneously responding to the economic turmoil. Reflected in the work plan are some of the Policy Recommendations by CCICED in 2007 and 2008, including translating challenges into opportunities to achieve sound and rapid development, avoiding new pollution and damage to ecological environment as a result of new projects, properly balancing government regulation and market mechanism and innovation and stability, and stepping up rural environment management.

Major Policies Developments in Environment and Development over the Past Year

1) Strengthened Environmental Protection within Economic Recovery Efforts.

To address the adverse impacts of global financial crisis, China has adopted measures to expand domestic demand. The 4 trillion RMB stimulus package will focus on livelihood projects, infrastructure, ecological development and post-disaster reconstruction. China will also readjust and rejuvenate ten major industries, promote corporate consolidation and reorganization, support enterprises in their efforts to effect technological upgrading, phase out outdated capacity, enhance industry clustering and resource allocation efficiency. In particular, ECER and ecological protection have become part of the stimulus package, with an invest-

ment of 5.25% of the 4 trillion RMB, or 210 billion RMB in total.

In the stimulus plan, China has put ideas like Green Governance, New Trends in World Industrial Revolution, Technological and Institutional Innovation into policy practice, many of which are also the focus for CCICED. In its 2008 Policy Recommendations, CCICED proposed that China needs to speed up its shift in economic growth model, increase innovation in clean energy and production techniques, nurture and develop clean industries, develop low carbon economy, enhance capacity to deal with pollution and climate change, all aimed to achieve long-term prosperity in China. At the roundtable meeting in April 2009, CCICED proposed again that China needed to promote green development by pursuing green and low carbon economy. In May 2009, Vice Premier Li Keqiang attended a MOF meeting that aimed to support emerging industries such as new energy and energy conservation, stressing the need to keep up with the trends in green economy development worldwide; to combine maintaining growth and expanding domestic demand with structural readjustment and upgrading; to facilitate the development of emerging industries to address new economic problems in China, and to foster new growth area for rapid development in the long run.

Large-scale investments in development projects promised in the stimulus package pose great pressures on environmental regulations. The economic growth and environmental protection once again face off as rivals. Initiation of new projects intended to maintain growth without compromising environmental well-being is the key to delivering on the pledge of economic recovery without damaging the environment. This approach also will determine the outcome of environmental projects in the package and the success of the development model shift.

CCICED 2008 Policy Recommendations noted that the global financial crisis has fundamentally exposed the immense risks accompanied by overconfidence in the market in the absence of effective regulation. The market needs to play a positive role in environmental protection. The functioning of market measures cannot do without effective regulation and capacity building such as emission monitoring, data standardization, emission reduction appraisal and noncompliance penalties. MEP has tightened the review and approval process for new projects, imposing

EIA upon all projects featuring High Energy Consumption, Emission and Resource Reliance (HECERR) , thus emphasizing environmental control strictly from the very source. MEP has postponed or withheld the approval of 14 projects with potential environmental risks in chemicals, petrochemicals, steel, thermal power, pulp and paper, with a total investment of 104 billion RMB.

Noncompliance penalties have been made more severe. In April 2009, MEP and NDRC, together with 6 other agencies announced a plan to launch joint environmental actions, restricting industries with HECERR characteristics, and conducting checkups in iron and steel and arsenic-involving industries. The action plan also deals with noncompliance in sewage treatment plants and landfills, in an effort to reduce emissions from those facilities. In June, MEP terminated construction projects by China Huadian Corporation and China Huaneng Corporation; granted the most severe EIA penalties in China's history against the two power giants; and suspended approval of construction projects proposed by the two corporations other than those involving new energy and pollution control.

The National Audit Office has strengthened environmental audit of SOEs and made public ECER information of 41 SOEs whose performance in this regard has been fair, although still having such problems as lower effectiveness in energy conservation, over-discharge of SO_2 and major pollutants. There are eight underperformers listed by the Office, i.e., Sinopec, China Huaneng, China Huadian, China Guodian, China Datang, China Aluminum, Baogang Steel, and Angang Steel.

In the past year, environmental enforcement, monitoring and inspection have all been strengthened, with improvement in cooperation and coordination among central and local governments. This helps to address increasingly complicated environmental problems and boost effectiveness of environmental policies and measures.

The establishment of Northern China Regional Environmental Supervision and Investigation Institution (RESII) marks the completion of China's environmental supervision system, with the Inspection Bureau under MEP at the national level and 6 RESII sub-offices in 6 regions (South, Southwest, Northeast, Northwest,

East and North regions) . The system will conduct enforcement inspection in response to local governments' non-performance on environmental responsibilities in favor of local economic growth. Multi-ministerial and multi-provincial cooperation in dealing with water pollution has been strengthened. In 2009, cross-ministry joint meetings have been held many times, involving MEP, NDRC, MOF, MLR, MOHURD, MOA, MOC, and MWR, with focus on water pollution control in Taihu Lake area, Songhuajiang River, and the middle and upper reaches of the Yellow River.

2) State Policy to Develop Low Carbon Economy and Respond to Climate Change.

Responding to climate change is another focus of CCICED. In the Policy Recommendations of 2007 and 2008, CCICED stated that China needs to make new contributions to addressing climate change and sustainable development under the principle of common but differentiated responsibilities, translate international environmental cooperation into sustainable development cooperation, and enhance South-South cooperation; in the long run, China needs to develop a low carbon economy, on the one hand to solve domestic environmental and resource problems, and on the other hand to strengthen its capacity to address climate and to boost its international competitiveness; thus, more attention is needed in low carbon economy on the part of the Chinese government; China needs to make technological and policy preparations, set targets for low carbon economy in the 12th Five-Year Plan and integrate it into current strategies and actions.

In March 2009, the working meeting of the State Council presided over by Premier Wen addressed climate change issues. The meeting stressed that China, as a responsible developing nation, was fully aware of the importance and immediateness of addressing climate change issues, and it believed that real and effective international cooperation was needed to address this common challenge faced by all countries. China would adhere to the principle of common but differentiated responsibilities to pursue sustainable development, fulfill its international obligations commensurate with its development stage and capacity, and play its due part in addressing climate change. The meeting made the following requests:

(1) Integrate climate change response into national economic and social development plans; take greenhouse gas emission control and climate change response targets as key criteria for longer-term development strategy and plans at all levels of government;

(2) Implement the national climate change program; strive for the targets of 20% reduction of unit GDP energy consumption and 10% increase of renewable energy use set in the 11th Five-Year Plan; continue to improve and implement the national program in the 12th Five-Year Plan;

(3) Develop a green economy; in light of the strategy of obtaining growth by expanding domestic demand, foster new growth areas featuring low carbon emission, and build low-carbon industrial, construction and communications systems;

(4) Strengthen capacity building to fight climate change; formulate strategies and plans to advance technologies; conduct low-carbon pilot programs; promote energy-conserving, environment-friendly production, lifestyle and consumption; increase monetary input to back the implementation of climate change policies and measures;

(5) Improve legal systems to fight climate change; establish supporting laws and regulations, formulate standards, monitoring and assessment framework, and improve regulatory systems and supervisory mechanisms;

(6) Actively engage in international exchange and cooperation; continue to conduct policy dialogue and exchanges in responding to climate change; expand cooperation channels; speed up introduction of funds, technologies and human resources into China; and absorb advanced low carbon technologies and technologies in dealing with climate change from other countries.

In August 2009, the Standing Committee of the NPC adopted a resolution concerning climate change, recommending integration of adaptation of climate change into legislative proposals. The resolution calls for more efforts by China to conserve energy and cut emission; enhance capacity to adapt to climate change; fully utilize technologies; develop green and low carbon economy; integrate climate change response into sustainable development and national economic and social development plans, with specific goals, targets and re-

quirements; raise public awareness and encourage public participation; and mobilize all citizens to be part of the cause.

In September, President Hu Jintao participated in the UN climate change summit, noting that China would integrate climate change response into its economic and social development plans and take forceful measures: (1) to pursue energy conservation and boost energy efficiency to achieve notable reduction in unit GDP energy consumption by 2020 compared to that in 2005; (2) to further develop renewable and nuclear energy, with a goal of making non-fossil energy account for 15% of the primary energy consumption mix by 2020; (3) to increase forest carbon sinks, with an objective of increasing forest coverage by 40 million hectares by 2020 over that in 2005, and a rise of 1.3 billion cubic meters in stock volume; and (4) to develop green economy, low carbon economy and circular economy, and promote climate-friendly technologies.

3) Legislation Reform on Resources and Environment.

Emergence of new environmental problems requires new laws, regulations and standards, or revision of existing ones. In 2009, legislation proposals, laws and regulations concerning resources, energy and environment in need of revision include: the Laws on Energy, Renewable Energy (revised) , Air Pollution Prevention and Control (revised) , Coal (revised) , and Mineral Resources (revised) ; and the Regulations on Environmental Monitoring, Pollution Prevention and Control in Animal Farming, Management of Ozone Depleting Substances, Water Saving, the Management of Taihu Lake, the Protection of Wetlands, the Discharge Permit, and the Regulation on Urban Water Discharge and Sewage Treatment.

According to MEP statistics, MEP completed the development and revision of 123 national environmental standards in 2008. Currently there are 1 100 national environmental standards.

In addition to all of above, the State Council promulgated the Regulation on the Environmental Impact Assessment for Planning in October 2009. Governed by the Regulation are areas including land use plans, development and exploration plans for regions, river basins and marine areas, and special plans concerning agriculture, industry, animal husbandry, forestry, energy, water resource, communica-

tions, urban development, tourism and natural resource exploration, all subject to EIA, in a bid to prevent pollution and ecological damage from the very beginning and to secure sustainable development.

4) Energy Efficiency and Pricing Policies.

To achieve the binding target of cutting unit GDP energy consumption, two main measures were taken to reduce GDP energy consumption per 10,000 RMB by 20% in 2010 compared to that in 2005, i.e., boosting energy efficiency and restructuring the energy portfolio. CCICED 2008 Policy Recommendations calls for boosting energy efficiency, developing clean energies, and technological innovations. The Council proposed that to stimulate demand and markets for innovative environmental technologies, it would be necessary to provide incentives such as subsidies to businesses and individuals using environmental technologies and products and cut promotional cost, and increase state monetary input in environmental innovations by setting up an environmental innovation fund to support major clean technologies.

To have an effective and standardized energy conservation inspection system that ensures implementation of measures and realization of targets, NDRC has enacted the Rule for Energy Conservation Inspection to enforce the Law on Energy Conservation. Twenty-four provinces and municipalities, including Shanghai, Beijing, Zhejiang, Shandong and Liaoning, have established their own inspection agencies to achieve conservation targets.

Over the past year, China has cut taxes on energy-efficient technologies and increased fiscal support for energy-saving products, covering areas such as industrial equipment, household conservation, transportation and construction. The newly revised policies regarding value-added tax provides tax favors to businesses that use new energy-efficient and conserving technologies to phase out those high in energy consumption. China also presses ahead with the "10 major projects", supports technological upgrading by enterprises, promotes conservation-oriented renovation of public and residential buildings, and encourages the use of contracted energy management. It also provides subsidies to consumers using environment-friendly products and has reduced purchase tax for low-emission automo-

biles.

China also provides subsidies to promote the use of efficient lighting products, and supports conservation and new energy auto pilot programs in 13 cities like Beijing, Shanghai and Chongqing. New energy sources and renewable energy are developing quickly, with booming hydro, nuclear, wind and solar power stations. By the end of 2008, installed wind power capacity had exceeded the 11th Five-Year Plan target, ranking fourth in the world. In March 2009, MOF and MOHURD jointed launched the Solar Energy Roof program, awarding 20 RMB per Watt to homeowners installing solar power generators. MOF is now developing the Golden Sun Program to open the solar PV market in China. It is projected that installed solar PV capacity will reach 20 million kws by 2020.

The 2008 CCICED Policy Recommendations suggested that China speed up the reform of resource and energy pricing and internalize the environmental cost resulting from the use of resources and energy, given the price falls in mineral resources and crude oil. In December 2008, the central government working meeting on economy proposed to conduct further pricing reform and to establish a pricing mechanism that reflects supply and demand, scarcity, and environmental damage cost. In January 2009, MOF, NDRC and MWR jointly issued the Rule for Water Resource Fee Collection, covering hydro and thermal power plants directly under the central government. An extra 50% of the water resource fee will be imposed on enterprises featuring high energy consumption and pollution. For water used beyond the quota, a progressive pricing system will apply.

5) Environmental Economic Policies and Market Measures.

Market-based environmental economic policies have become an indispensable part of China’s environmental management. Over the years, CCICED has stressed the importance of such policies in its Recommendations. The 2007 version emphasized the historic role of economic measures in promoting environmental protection, and proposed to fully leverage market-based economic policies to achieve strategic transition in environment and development, with environment tax, resource and energy tax, green credit, environmental insurance, ecological compensation and emission trading as major measures. The 2008 version also stressed the importance of

regulation on top of economic measures.

Over the past year, a number of measures used in China deserve attention.

The environmental pollution responsibility insurance pilot is progressing steadily. Initial results have been achieved in Hunan, Jiangsu, Hubei, Ningbo, and Shenyang. China's first claim settlement in pollution responsibility insurance has been completed successfully, signaling the initial progress in green insurance practice. In early September 2008, a pesticide maker in Zhuzhou, Hunan province bought an environmental responsibility product from Ping'an Insurance that in late September compensated more than 120 households for a chemical leak from the maker that polluted the vegetable land in its vicinity. Jiangsu Province initiated ship pollution insurance. The city of Wuhan set aside 2 million RMB to subsidize those insurance policy holders to up to 50% of the premium paid.

Four insurance companies in Ningbo city have conducted business in pollution liabilities, and pilots are being carried out in transportation of hazardous substances and chemicals. Shenyang city has taken the lead on incorporating environmental liability insurance into local legislation: the Regulation on Prevention and Control of Hazardous Waste Pollution in Shenyang City, effective as of Jan. 1 2009, provides that 'the city supports and encourages insurers to offer hazardous waste pollution liability products; and enterprises dealing in the production, collection, storage, transportation, use and disposal of hazardous waste to buy such products.

Emission trading is developing. Cross-regional cooperation is strengthened based on emission trading pilots. Shanghai Environmental Energy Exchange has signed a cooperation agreement with Hangzhou Property Right Exchange to build an emission trading platform in the Taihu Lake area. The two parties hope to explore new ways to promote cooperation among regional exchanges. In 2008, the Taihu Lake area became the first area in China to introduce pre-paid use of emission rights and a trading pilot. On August 5, China's first voluntary domestic carbon emission trade was settled: Tianping Automobile Insurance from Shanghai paid 277,699.6 RMB to purchase the 8,026 tons of carbon emission reduction target achieved by Beijing's Green Transit during the Olympics, in order to offset

the carbon emission resulting from the company's operations since its establishment in 2004. It became China's first company voluntarily purchasing emission reductions to offset its own emissions.

Green purchase by the government has been boosted. China is improving policies concerning government purchase by giving priority to energy-conserving products, making green government procurement a key factor in promoting circular economy. State Council agencies have issued purchase lists of energy-saving products and green products. In 2008, green purchase by the Chinese government accounted for over 30% of government's total procurement; some 150 billion RMB out of the total 500 billion RMB of government purchase fund will go for green procurement.

6) Environmental Innovation and Policy Support System.

The 2008 Policy Recommendations points out that China's only way out at this critical moment of meeting challenges is to innovate. Given its reality of less innovations in the environmental area, China needs to strengthen innovation capacity, solve institutional problems hindering innovation, increase monetary input, protect IPR and strengthen all-round impact assessment in the process of innovation; and suggests that China develop and initiate a National Environment Innovation Action Plan 2010-2020.

In January 2009, Premier Wen noted at the State Council technology task force meeting that the extensive growth model has presented huge pressures on population, resources and the environment. Rapid and steady economic development, upgrading of industrial structure, shift of the growth model, and a resource-conserving, environment-friendly society all rely on technological advances and improvement in workforce qualifications.

Over the past year, China has further increased input in major technological innovations in resources, environment and sustainable development. The MOST has initiated major technology research projects in energy conservation, new energy source automobiles, water pollution control, urban sewage treatment, comprehensive environmental control in rural area, recovery and rehabilitation of soil in polluted industrial sites, and biomass fuel use. Meanwhile, national sustainable

development demonstration zones, resource-conserving and environment-friendly community pilots are expanding. The strategy of environmental protection and sustainable development innovation is spreading from the central level to local and corporate levels.

In July 2009, the MOST assessed the implementation in the 11th Five-Year Plan period of the Longer-term National Plan for Development of Science and Technology 2006-2020. One major assessment area is the supporting and guiding role of technological innovation in structural readjustment, changing growth model and improving livelihood, and particularly its positive role in responding to financial crisis, fostering strategic and emerging industries.

With the challenges of pollution reduction targets and technical requirements of controlling pollution sources, emissions compliance, and improving ecological environment, MEP has proposed setting up a national technical supporting system step-by-step for emissions reduction, especially for supporting the standards for cutting and controlling NO_x emissions, and the policies concerning pollution control technologies. Priorities for environmental technology in 2009 are the promotion of environmental technology innovation, the establishment of systems for environmental standards and for environmental technology management; strengthening the capacity for environmental technology innovation and strengthening scientific decision-making mechanism. MEP will accelerate the establishment of innovation projects and set up technological support projects. In terms of environmental standards, the existing standard systems for air and water quality will be improved, and new systems for noise and soil will be established. For major industries like iron and steel, non-ferrous metals, pulp and paper, and power generation, existing national standards for pollutant discharge need to be revised and raised for tighter emission control. Standards for emerging key industries need to be developed. In promoting environmental technology system, the National List of Advanced Pollution Control Technologies and the List of State-encouraged Environmental Technologies will be renewed.

7) National Action Plan for Environment and Health.

The 2008 Policy Recommendations suggest that China adopt effective precautionary measures to ward off environment and health risks; establish a government-led environment and health management system with extensive participation; strengthen legislation; increase fiscal input and boost capacity building; make public information concerning environment and health and encourage public participation; and focus on key regions and major problems.

In September 2009, MEP and MOH convened the 4th National Forum on Environment and Health which identified human health as a core part of environmental protection. MEP has taken actions in the following areas: (1) conducting comprehensive treatment and control of environmental problems in major river basins, urban air and rural soil. More than 500 million RMB was set aside for rural environmental efforts, and 600 villages with severe environmental problems were dealt with; (2) strengthened capacity building in monitoring. In the past two years, MEP invested over 15 billion RMB in environmental monitoring capacity building; (3) conducted national survey of soil pollution and census of pollution sources. By 2008 year end, 78 940 samples of soil and crops have been obtained, and 78 852 have been analyzed; and around 3 million effective survey figures have been collected; (4) promoted the implementation of the National Action Plan for Environment and Health 2007-2015, which has been jointly developed by MEP and MOH. MEP has initiated research work on the impact of water, air, and soil pollution on human health, and further improved the air quality assessment standard system, laying down the foundation for updating the Action Plan.

In 2009, in light of health problems caused by heavy metal pollution, MEP has convened working meetings for heavy metal pollution control to identify countermeasures and made follow-up plans for action. MEP proposed to develop the Implementation Program for Comprehensive Control of Heavy Metal Pollution, through conducting overall inspections, preparing control plans, putting in place special control funds and providing information and public education. It also recommended that a special environment and health survey in major regions and river basins be initiated, followed by development and formulation of relevant regulations and laws, after a baseline is obtained, with an effort to establish a comprehen-

sive monitoring system for environment and health. A prevention, early warning and emergency response system should be established for environmental damage to human health, with the improvement of risk prevention level in this area. Information sharing and public education should be strengthened to help raise public awareness and foster self-protection consciousness.

8) Local Actions: Experience from Green Olympics to Green Shanghai Expo.

The 2008 Policy Recommendations stated that a successful green Olympics leaves precious environmental protection legacy for China: on the one hand, green construction projects have served as role models and urban infrastructure has improved environmental quality and served public interest; on the other hand, deeply-rooted ecological awareness and ideas, enhanced environmental management, information disclosure and public participation have all exerted far-reaching impacts on economic and social development. The 2010 Shanghai World Expo would provide a wonderful opportunity to spread Green Olympics experience, and China needs to make the Expo greener.

Following the Beijing Olympics and Paralympics, many measures adopted during the Games have been retained, such as vehicle bans. In addition, Beijing has intensified environmental efforts, such as the accelerated phase-out of vehicles failing to meet new emission standards, and the development and promulgation of supportive policies to eliminate vehicles causing severe pollution.

Shanghai is striving to stage a Green World Expo by drawing on Beijing's experience. The host city is now implementing a 3-year environmental action plan centering on ECER and environmental quality improvement, with noticeable results in pollution control in key regions, including continued drop of total pollutant discharge and steady improvement in environmental quality. The Environmental Assessment Report on the 2010 Shanghai World Expo released by UNEP in August 2009 points out that, in 2009, Shanghai's investment in environment has tripled that of 2000 to reach 42 billion RMB or 6 billion US dollars. The UNEP Report notes several positive aspects related to environment and development. The number of days during a year with a rating of Excellent Air Quality has reached 101, up by 68% from 60 days 5 years ago. In terms of transportation, Shanghai will build a rail

transit system of 400 kms prior to the Expo opening. Shanghai's management philosophy of "Prioritizing Public Transit" is worth promoting worldwide. Despite challenges common to all cities, Shanghai boasts experience worthy of learning for cities in China and across the world. Environmental efforts in preparing for the Expo will not only benefit 70 million Expo visitors, but leave a green asset for the city's 20 million residents.

9) Information Disclosure and Pu-blic Participation.

Promoting information disclosure and public participation has always been a key proposition of CCICED to improve China's environmental governance over the years. One 2007 Policy Recommendation points out that to realize the historic transformation in China's environment and development strategy, China needs to increase public participation for all to play a role in achieving that change, and encourage the participation of NGOs. The 2008 version reiterates the importance of information disclosure and public participation to other policy recommendations, and it suggests that for China's environmental decision making to have a sound public basis and confidence, China must effectively enforce environmental laws and regulations, adopt more economic measures in environment, and put in place reliable information disclosure mechanism. Behavior change resulting from law enforcement will play a decisive role in fostering technical innovation and improving environmental and health conditions. Likewise, credible information disclosure will form a basis for positive change.

Over the past year, new progress has been made in China's environmental information disclosure and public participation. Both in terms of scope and extent, improvement has been considerable in information disclosure. Hearing of cases involving public environmental interest by local courts marks the historic breakthrough in public participation. No doubt, this has opened a new chapter of public participation in China's environmental protection.

The Rule for Environmental Administrative Review newly revised in December 2008 has further expounded on the application for administrative review, validation period, and conditions, as well as ways and timeframe for environmental agencies to handle administrative review cases. This will help clear access to ad-

ministrative review and safeguard the rights and interests of citizens, legal entities and other organizations. In June 2009, MEP opened environmental hotlines to receive complaints of environmental emergencies, interprovin-cial pollution, and environmental problems falling into the direct jurisdiction of MEP. The public may use the hotlines to report environmental problems not solved at the local level, and check responses to the reported problem via the hotline.

Conclusion

Over the past year, China, together with other nations, has experienced a rare financial crisis and economic downturn. China has adopted proactive measures to overcome the adverse impact of the global recession, containing the downturn in the second half of 2008. The economy is now rallying and China is expected to attain its 2009 GDP growth target of 8%. More importantly, such achievement has not come at the expense of the environment. China has fulfilled its macro economic policy goal for environment and development set at the beginning of the crisis, i.e., China would not sacrifice its environment for economic stability.

Currently, the crisis and turbulence are still very much a reality. It is impossible to foretell what changes will take place in the future. But one thing is for sure. Consistency in environment and development policies will guarantee success for China in the future. And in light of major policy adjustments and trends, it may be positively projected that China is in a position to seize the opportunity presented by the crisis to speed up the strategic transition in environment and development and effect the historic transformation in environmental protection. Some policy developments in the past year deserve attention:

1) Environment and economy have never been so coordinated as in the past year in China’s policy grouping. Within the stimulus package, investment in energy conservation and environment has taken up a large proportion. While other industries were struggling for survival, environmental industries, new energy and energy-conserving sectors have received unprecedented attention, being regarded as a key growth engine for economic recovery. Policy ideas like green economy, low carbon economy have been quickly embraced by the government and adopted by top

decision makers. All these have shown that China's strategic transition in environment and development has entered an acceleration period.

2) China's environmental governance capacity has been greatly enhanced. At the very beginning of MEP's establishment, there were reserved attitudes towards the effectiveness of MEP's institutional reform. The past year's reality showed that regulatory capacity of the environmental authorities has been substantially improved in such a crisis. MEP has insisted on a stronger environmental protection in the stimulus package, and tougher penalties against non-complying behaviors. Environmental agencies had never before convened meetings as frequently as it did last year to coordinate environmental efforts at the central and local levels. This also reflects the fact that the establishment of MEP and its more powerful operational position have drastically enhanced China's environmental administrative capacity and authority.

3) Policy measures for environmental protection and sustainable development are being used in more areas, at more levels, and through more channels. Economic policies and market measures are finding their way into practice with positive roles. The development process of policy measures, from development at the national level to pilot projects at the local level and back to national promotion of the pilot findings, has been quickened. Flexibility and adaptability of economic policies and market mechanisms are well noted.

4) Public environmental awareness has not faded away with economic growth. More channels are open to public participation. Enthusiasm for environmental protection has not waned. This has laid a solid foundation for strategic transition of the China's environment and development in the future. Raised public awareness means the balance between environment and development, and the days favoring one over the other are gone forever.

5) China has become more intertwined with the rest of the world in environmental protection and sustainable development, attracting more attention in global environmental affairs. China's role is not limited to its being the largest developing country with significant influence in world environmental matters. It is more about a more responsible China in addressing world environmental problems, and a more

positive role. In particular, China's stance and proposals in fighting global climate change have demonstrated its willingness to fulfill its international obligations commensurate with its development phase, and to take positive actions.

Looking back at the progress made in China's environment and development over the past year, CCICED should be proud of its work. We would like to see a CCICED that exerts its due influence on the development and adjustment of China's policies in environment and development. We expect that China will effect its strategic transition in a decade or so when the nation still enjoys blue sky, green hills and clear water along with economic prosperity.