中国的低碳能源战略展望

Prospect of China's Low-Carbon Energy Strategy

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一、环境与能源密切相关
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■在中国的总能源中，煤的贡献目前超过70％，这是中国能源结构的特点

■**Of China's total energy, coal contributes over 70% at present, which characterizes China's energy structure;**

■煤的采收和利用总效率约为10％，比世界先进水平低一倍左右；能源浪费大，单位GDP能耗高（中国GDP占世界总量6％，却消耗了世界31％的煤，7.5％的石油）；

■**The overall efficiency of exploitation and utilization of coal is app. 10%, which is about half the advanced international level. The energy waste is huge, and energy consumption per unit GDP is high (Chinese GDP is 6% of the world total, but China consumes 31% of the world's coal and 7.5% of oil production);**

一、环境与能源密切相关
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■ 全国CO_2排放已达55亿吨/年（虽然人均排放远低于一些发达国家），总GHG排放已居世界之首；

■ The national CO_2 emission has reached up to 5.5 bil tons/year (though the per capita emission is far lower than in some developed countries), and the total GHG emission is already No. 1 of the world;

■ SO_2、COD、NOx等污染物排放量中国居世界榜首（尽管近两年有所下降），SO_2达 2500万吨/年。全国一亿以上人口呼吸不到清洁空气；

■ China has the highest emissions of SO_2, COD, NOx and other pollutants in the world (though decreases have been seen over the last couple of years), with SO_2 emission up to 25 mil tons/year. More than 100 million people are not breathing clean air across the country;

一、环境与能源密切相关
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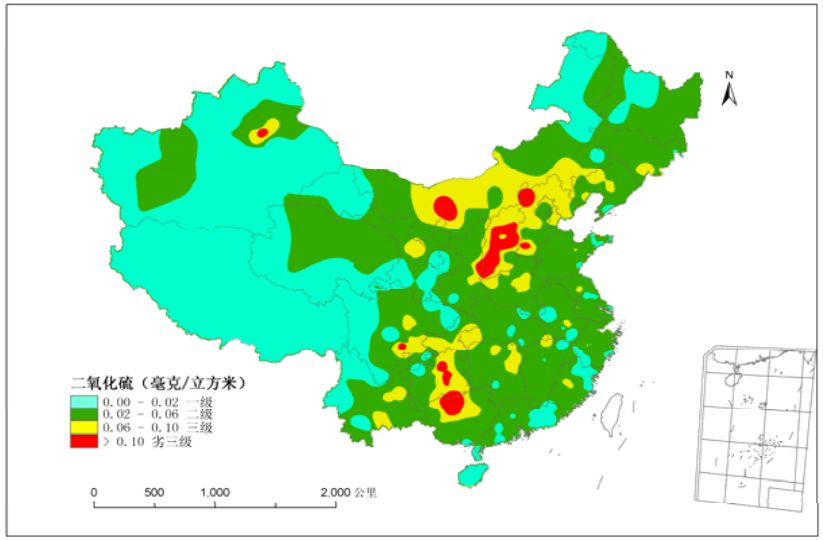
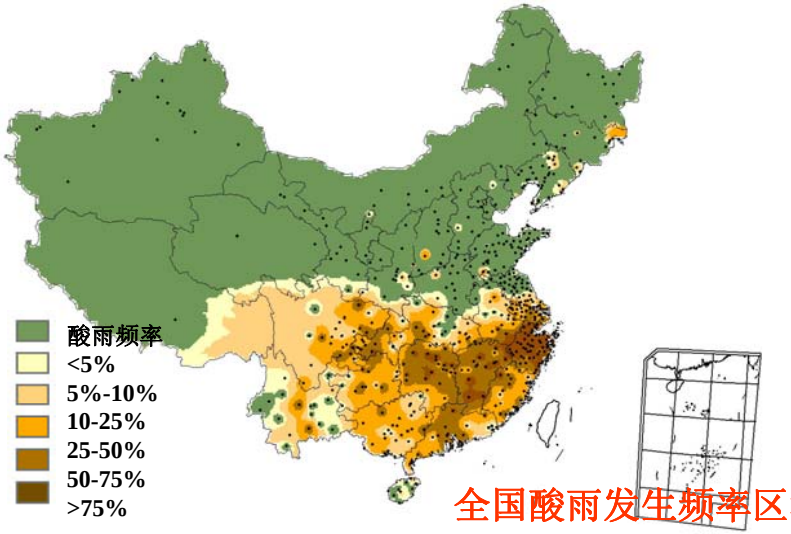
■ 近5年来，酸雨强度在南方和北方均有增加趋势，全国年均酸雨数和酸雨量与总降水量的比值逐年上升。

■ Over the last five years, strength of acid rain has increased in both North and South of China. The average annual number and amount of acid rain to the total rainfall have climbed with year.





全国酸雨发生频率区域分布图

一、环境与能源密切相关
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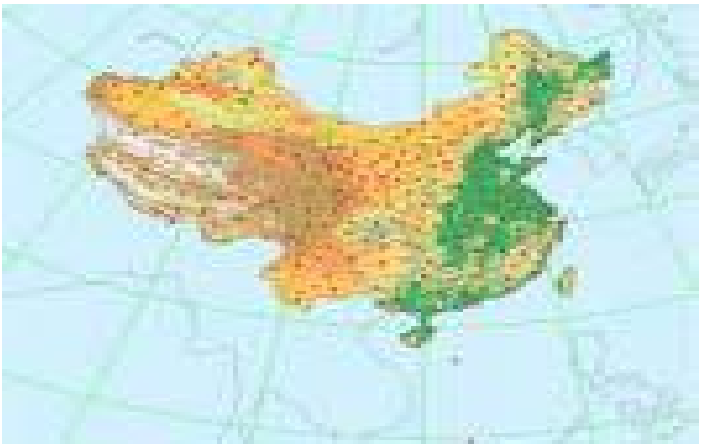
■气候变暖趋势明显：据国家气象局公布的全国各城市1951-2000年平均气温的变化，无一例外呈明显上升态势。

■ The evidence of climate change and global warming: On the basis of China’s Meteorological Data Service System on climate change during 1951-2000, the average annual temperature has showed obvious ascending trend in different cities in China with no exception.



一、环境与能源密切相关
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◆三十年来，中国经济发展的巨大成就举世瞩目。但在经济快速增长的同时，能源需求总量增长过快。本世纪的头几年，能源弹性系数达1.0左右，总能耗从2000年的13亿Tce达到2008年的26亿Tce。表明：经济增长方式是资源消耗型；

◆ In the past 30 years, China's outstanding economic achievements has aroused great attention by the world. However, while the economy rises rapidly, the total energy demand of this country has been increasing excessively. The energy elasticity coefficient reached some 1.0 in the first years of this century, and the total energy consumption increased from 1.3 bil Tce in 2000 to 2.6 bil Tce in 2008, indicating an energy-consumptive type of economic growth;

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◆中国的压缩性工业化进程带来了复合型环境问题，快速扩张的经济带来巨大的排放总量。表明：经济增长方式是以牺牲环境为代价；

◆ Compressed process of China's industrialization brought about complex environmental issues. With fast expansion of economy comes gigantic total emission, indicating an economic growth type at the sacrifice of environment.

◆世界金融危机也给中国带来巨大影响，这对中国即是机遇，也是挑战。

◆ The worldwide financial crisis has huge impact upon China, which means both opportunities and challenges for China.

一、环境与能源密切相关
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机遇：实体经济衰退，导致能源、资源、环境压力减退，为我们提供了转变经济发展方式、调整产业结构、淘汰落后生产力，实现节能减排的机遇；金融危机重创了一些生产低附加值产品的外向型企业，为企业的转型、升级、创新带来机遇和动力。

Opportunities:

Deterioration of real economy leads to decrease the pressure on energy, resource and environment, allowing for a chance to transform our economic development pattern, adjust industrial structure, wash out the backward productivity and make possible for energy-saving and emission reduction. The financial crisis inflicts heavy losses on some export-oriented businesses with lower production added-value and offers an opportunity and motive to transform, upgrade and innovate.

一、环境与能源密切相关
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挑战：能否有效地转变粗放的发展方式不仅是一个挑战，还需防止急于救市的措施（含投资），不顾环境追求增长带来恶果的风险。必须从国家乃至全球的高度，对经济、能源、环境、科技进行统筹，制定应对的综合战略。

Challenges:

Transforming the rough development pattern effectively is more than a challenge, where anxious measures (including investment) to save the market without attending the risks for consequences with increased environmental risks must be prevented. Economy, energy, environment, science and technology must be planned at the national or even global level to develop integrated strategies in response.

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30年发展的经验教训和世界经济危机启发我们：需要认真研究环境能源学，其含义是：

The experiences and lessons gained through 30 years' development inspire that we have to study Environmental- Energetics carefully, which including:

- 定性和定量地研究能源对环境的影响；
- Qualitative and quantitative research into the effects of energies on environment;
- 同时研究环境对能源的制约，把环境容量的概念进一步深化和量化；
- The limitations of environment on energies, further deepening and quantification of the concept of environment capacity;
- 研究环境友好的能源战略；
- Environment-friendly energy strategy;

一、环境与能源密切相关
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- 为实现低碳经济的发展方式，为制定环保政策与战略，为营造一个惠及子孙后代的可持续发展环境，为履行中国应当承担的国际责任提供科学支持。
- Providing scientific support for realizing low-carbon economic development, making environmental protection policies and strategies, creating an environment of sustainable development to benefit future generations, and honoring the international duties of China.
- 显然，环境能源学是一个涉及多学科的交叉学科。
- Apparently, Environmental-Energetics is an interdisciplinary subject involving multiple disciplines.

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※ 对环境能源学的初步的思考研究，导致一个结论：

面对十几亿人口的发展和环境问题，中国必须选择低碳能源战略。

※ Preliminary deliberation and studies of Environmental-Energetics may leads to one conclusion:

Faced up to environment and development for over 1 billion Chinese people, China has to resort to the low-carbon energy strategy.

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中国需要一个经济－环境双赢的、可持续发展的能源战略。

China needs an energy strategy, which is win-win for economy and environment with sustainable development.

◇中国需要发展，虽然中国的GDP总量已是世界第三，但人均GDP只有3000美元，世界排名在100位以下，仍是一个比较落后的发展中国家；

◇Clearly, China still needs to develop. Despite China's total GDP being the third in the world, the per capita GDP is only 3000USD, which is beyond the first 100 across the world, portraying a relatively backward developing country;

◇中国也必须保护和改善环境。否则，钱虽多了，生活质量却下降了，有违“以人为本”的发展初衷，也难以担当起中国应尽的国际义务。

◇China has to protect and improve environment. Otherwise, we become rich while our quality of life falls. It is against the human-oriented intension of development and fails to performing China's international duties.

我们把这个经济－环境双赢的能源战略，概括为“低碳能源战略”。其具体内涵是：发展三种概念的绿色能源，走出一条中国特色的新型能源道路。

We summarize this win-win economy-environment Energy strategy as the low-carbon energy Strategy ,which means specifically: Develop green energies of three concepts, and create an approach to new energy road with Chinese characteristics.

战略之一：大力节能，提高能效，控制总量。节能提效是一项巨大廉价的优质能源，是零污染的绿色能源。

Strategy 1: Make potent efforts to save energy, enhance energy efficiency and control total energy consumption. Energy-saving and energy efficiency improvement is a high quality source with low cost,which is a zero-pollution green source.

* 产业结构节能 Energy-saving by restructuring industrial structure
* 工业节能 Industrial energy-saving
* 建筑节能 Energy-saving in architecture
* 交通节能 Energy-saving in transportation
* 照明节能 Energy-saving in lighting
* 社会节能 Energy-saving in community

战略之一：
Strategy 1：

产业结构节能

Energy-saving by restructuring industrial structure

◇中国目前处于加速工业化阶段，2006年，耗能高的第二产业在GDP中的比重高达48.7%，而能耗低的第三产业仅占39.5%；

◇China is now in a phase of accelerated industrialization. In 2006 the energy-consuming secondary industry made up 48.7% of GDP while the tertiary industry, which consumed less energy, was only 39.5%;

◇将大力发展耗能低的服务业，到2020年，使其在GDP的比重提升至50%左右；

◇Low energy consumption service industry should be strongly developed with its proportion in GDP raised to about 50% by 2020;

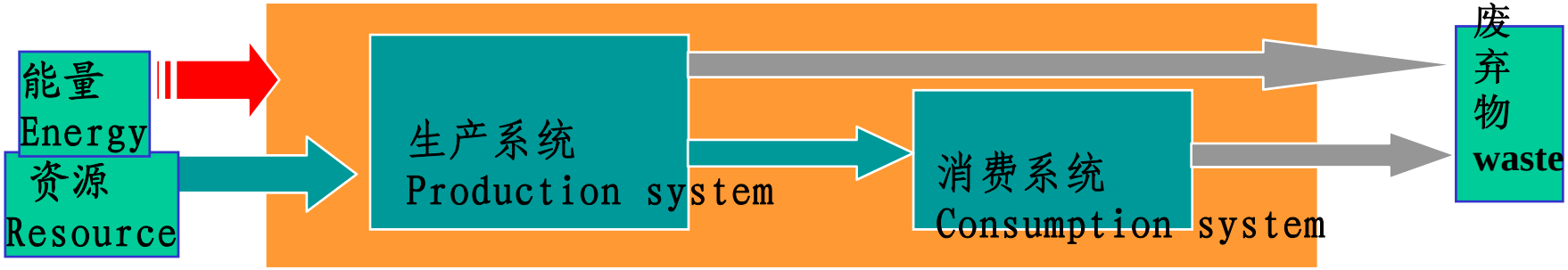
◇淘汰高耗能、高污染的落后企业。

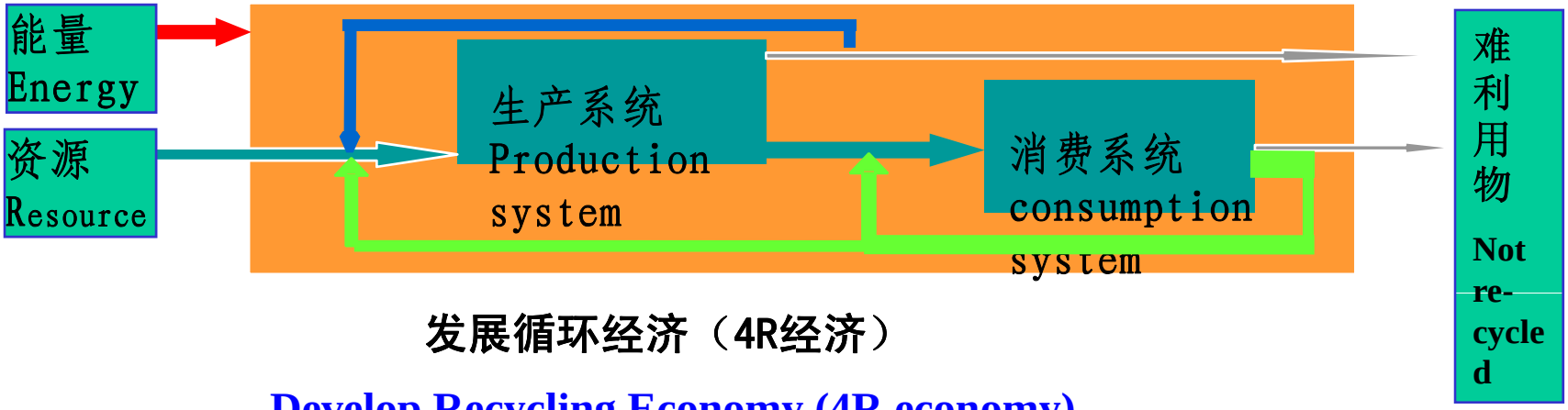
◇Backward businesses with high energy consumption and heavy pollution should be ruled out.

战略之一：
Strategy 1：

工业节能 Industrial energy-saving

发展循环经济（4R经济）
Develop Recycling Economy (4R economy)





发展循环经济（4R经济）
Develop Recycling Economy (4R economy)

战略之一：

Strategy 1：

建筑节能 Energy-saving in architecture

太阳能建筑一体化，以有力措施推行低能耗建筑。

Integrate solar energy in architecture. Make effective measures to promote low energy consumption architecture.

唐山节能建筑试点：

单位面积节能效果：35～37％

Pilot energy-saving in architecture in Tangshan: (energy-saving effect per unit area: 35-37%)

战略之一：
Strategy 1：

交通节能 Energy-saving in transportation

✓交通运输油耗比国际先进水平高10-25%，必须发展新型节能减排汽车；

✓China's oil consumption is 10-25% higher in the transportation department than the advanced levels in foreign countries. New energy-saving vehicles with lower emissions must be developed.

✓不可把“车多”作为小康标准，应从政策上限制豪华车的生产和销售；

✓ “Number of cars” shouldn't be regarded as a standard for be welfare. Policies should be made to limit production and consumption of luxurious cars.

✓必须限制汽车总量。

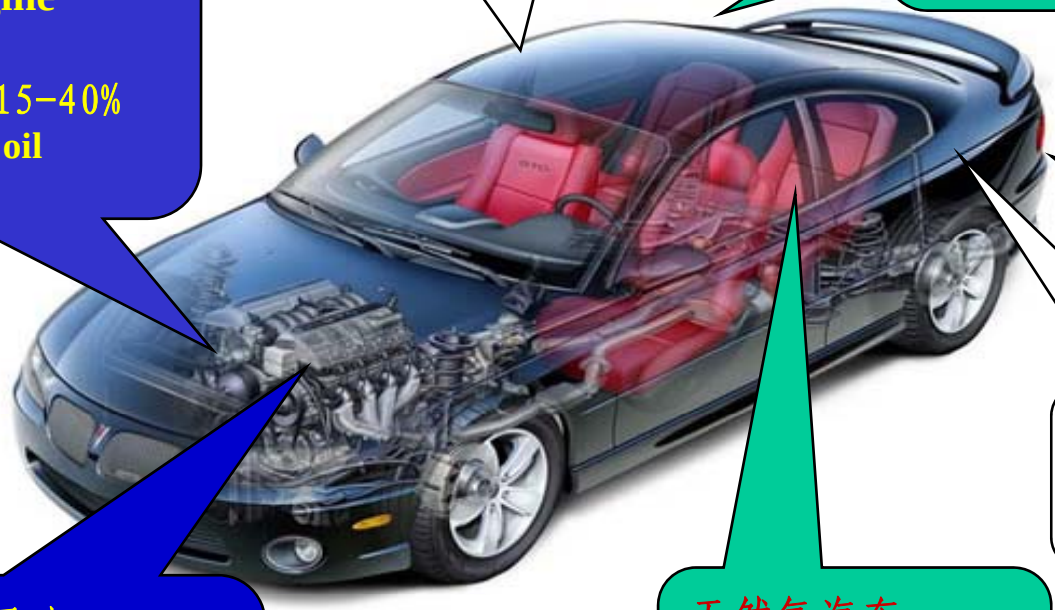
✓The total quantity of cars must be limited.

战略之一：
Strategy 1：

先进柴油车
Diesel-engine vehicle

轻量化：铝，复合材料可减重15-30% **Lightweight vehicle: auminium, multiple material, save weight 15-30%**

高效发动机：可提高效率10-15%
High-efficiency engine (enhance 10-15%);
混合动力：可节油15-40%
Commix engine: Save oil 15-40%



太阳能汽车
Solar-engine Vehicle

电动汽车
Electro-motion Vehicle

天然气汽车
Natural-gas engine vehicle

燃料电池：115.6公里时，1.048kg/100km 代用燃料：醇醚，燃气可替代燃料5-15%
Fuel Cell: 115.6km/h, 1.048kg/100km Substitute fuel: alcoholic aether, save oil 5-15%

战略之一：
Strategy 1：

照明节能 Energy saving in lighting

推广节能灯、LED等。加快LED外延、芯片、封装技术的国产化市场化。半导体照明工程将为节能做出革命性的贡献。

Promote energy-saving lights and LED. Pace up the localization and marketization of LED extension, Microchip and packaging technologies. Semiconductor lighting Program will make a revolutionary contribution to energy saving.

全国每年照明用电约：3千亿度/年 **Total lighting consumption is app. 300 bi kW/h per year**

改用节能照明可节约：1千亿度/年 **Apply energy-saving lights saves app：100 bi kWh per year**

（三峡电站发电800亿度/年）（**The Three Gorges Project provides 80 bi kWh per year**）

战略之一：
Strategy 1：

社会节能 Energy saving in community

政府机构带头节能，具有重要的示范、表率作用。要突出抓好节电、节油、节水，抓好能源计量，强化目标责任，接受社会监督。

Government should take the leading role in energy-saving and act as an active and important model. Targets should accentuate energy-saving on electricity, oil and water, energy measurement should be attended, together with strengthened target accountability and accepted community supervision.

市政工程导光板节能超薄灯箱

City Demonstration Project: light pipe, energy-efficient ultra-thin lamp.

战略之一：
Strategy 1：

对中国特色消费方式、生活方式的思考，构建节约型消费体系

Consumption styles and lifestyles with Chinese characteristics should be deliberated for building a conservative consumption system.

✓在全社会倡导“适度的物质消费、丰富的精神追求”的生活方式，反对“攀比奢华”的不良风气，中国的人均能耗、人均轿车数、人均排污量、单位建筑面积能耗等必须控制到显著低于国际水平，提倡“节约而健康的富裕”，这是“节约型社会”的必然内涵，也是创新中国经济增长模式的必然要求。

✓ A lifestyle of appropriate material consumption and abundant spiritual pursuit should be advocate. Energy consumption per capita, number of private cars, amount of pollutant emission and energy-consumption per unit construction area in China should be well-controlled below the international average level, and the concept of Economical-Healthy Wealth should be proposed, which is the essential component of an economized-society and an inevitable requirement for the innovation of China’s economic growth pattern.

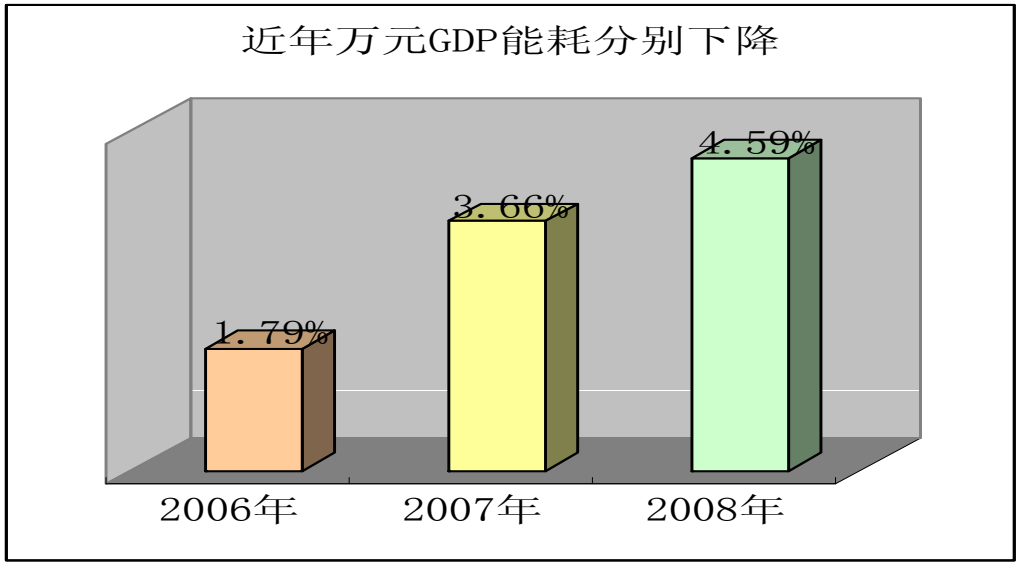
战略之一：
Strategy 1：

近年节能减排初见成效，仍任重而道远。

Energy saving and emission reduction have gained preliminary effects over recent years, a long path lying ahead though.

2010年全国万元GDP能耗要比2005年下降20%，主要污染物排放总量要比2005年减少10%

National 11th Five-Year Plan stipulates: Energy consumed per 10,000 Yuan GDP must be reduced by 20% and total emission of major pollutants by 10% by 2010 compared with 2005.



二氧化硫和化学需氧量在2007年首次实现排放总量双下降，分别下降4.66%和3.14%。

Both SO_2 and COD emission began to drop for the first time in 2007 by 4.66% and 3.14%, respectively.

战略之二：煤的洁净化利用，使煤这个传统黑色能源“绿色化”

Strategy 2: Clean and sustainable use of coal, turning the black energy source “green”.

在目前的火电站，大力推广脱硫、脱氮技术、污染排放控制技术；

* Desulfurization, denitrification and pollution control technologies are strongly promoted currently at thermal power plants;

* 提高燃煤效率，加强超临界和超超临界火力发电技术应用，淘汰落后的发电机组；

* Improve coal burning efficiency, strengthen the applications of super-critical and super-super-critical thermal power generation technologies and remove the outdated units;

* 我国百万千瓦超超临界发电机组已成功运行，锅炉效率、机组热效率、节煤减排均达到先进水平，值得大力推广；

* China has successfully put our own million-kW super-super-critical generation units in operation, our boiler efficiency, power unit thermal efficiency, coal emission reduction have reached leading level in the world, which are worth spreading;

战略之二：煤的洁净化
Strategy 2：Green use of coal

◇富氧燃烧技术；

◇O_2/ CO_2 Combustion Technology;

◇加强循环床煤燃烧技术的研发和推广；

◇R &D R of cyclic bed coal burning technology are intensively conducted;

◇研发碳捕捉及封存和整体煤气化联合循环技术（CCUS -IGCC）及二者的结合；

◇Combination of CCUS and IGCC technologies;

◇基于煤气化的IGCC发电比粉煤发电可减排：50%的Hg；90%的SO_2；并有利于CO_2的捕捉。

◇IGCC power generation based on coal gasification may cut down emissions of NOx and particles by 60%, Hg by 50%, SO_2 by 90%, helpful for CO_2 capturing.

战略之三：加快可再生能源和核能的发展，使其成为中国能源的绿色支柱。

Strategy 3:

Speed up the development of renewable energies and nuclear energy, constructing them as the green backbone of China's energy sources.

战略之三：加快发展可再生能源和核能

Strategy 3: Develop Renewable Energy and Unclear Energy

a. 水电有发展潜力，可利用资源量约5亿kW，估计2020年可达2.6亿kW。

a. Hydropower is potential for development, which is estimated to be app. 500 mil kW for attainable usage and reach 260 mil kW by 2020.

b. 风能 Wind Power

中国风能资源丰富，开发潜力大 **Wind power resources are abundant with great potentiality for exploration:**

※ 陆上风电资源约为6－10亿kW,海上约2亿kW，

※ Wind power resources mount to app. 0.6-1 bil kW on land, app. 0.2 bil kW on sea

※ 高空（50～60米以上）风电资源更多

※ Even greater resource at height (over 50-60m)

※ 如果能开发其中1/2，将能提供约5亿千瓦的电力，再加上约5亿千瓦的水电，可大幅度补充2050年所需电力的缺额。

※ App. 0.5 bil kW will be added if 1/2 is exploited. Together with app. 0.5 bil kW of hydropower, it may significantly compensate the gap in 2050 power demand.

风能发展现状Situation of wind energy development

国际上风能发电发展迅速

Wind power generation is advancing rapidly across the world

- 2002年世界风电装机容量达到3200万kW，平均年增长30%以上，近10年成本下降一倍。
- **The total installation capacity of world's wind turbines reached 320 mil kW by 2002 with an annual growth above 30% and the cost had been halved over the last decade.**
- 至2020年风力发电可提供世界电力需求的12%，创造180万个就业机会，并减少100多亿吨纯CO_2排放。
- **By 2020 wind power generation may supply 12% of the world's electricity demand, create 1.8 million employments, and reduce over 10 bil tons of CO_2 emission.**

风能发展现状Situation of wind energy development

- 中国风力发电十几年来迅速发展
- Wind power generation has been developing rapidly in China over the last 10 years or so
  - 2004年并网风电装机容量达到57万kW
  - 2004: total installation capacity of on-grid wind turbine reached 570 thousand kW
  - 2005年达到120万kW
  - 2005: 1.2 mil kW
  - 2007年达400万kW
  - 2007: 4 mil kW
  - 2008年已达1000万k
  - 2008: 10 mil kW

战略之三：加快发展可再生能源和核能

Strategy 3: Develop Renewable Energy and Unclear Energy

- 风力发电是目前中国最具有大规模产业化前景的可再生能源
- Wind power is the renewable energy that bears the greatest potentiality for massive industrialization in China today.
  - ✓目前，国家正在推进大型风电设备的国产化，以大幅降低风电成本，提升产业竞争力。
  - ✓Presently, China is promoting localization of large wind power equipment to lower the cost of wind energy tremendously for enhancing industrial competence.
  - ✓2020年装机容量有望超过3000万千瓦－8000万千瓦。
  - ✓The installation capacity is expected to exceed 30-80 mil kW by 2020.

c. 太阳能 Solar Energy

资源丰富 **Abundant resources**

* 中国2/3以上国土的年日照大于2200h
* **2/3 of Chinese soil receives annual solar radiation over 2200h**
* 年辐射总量平均大于60亿J/m^2
* **The average annual total radiation is over 6 bil J/m^2**
* 可用太阳能发电资源20亿kW
* **Solar resource usable for power generation is 2 bil kW**

洁净, 有利于环境保护 **Clean and good for environmental protection**

中国的太阳能光电利用， 还处于初级阶段：

Photovoltaic exploitation of solar energy is still in its initial stage in China:

- 高成本是制约光伏发电大规模应用的主要因素（高纯度硅的制备）
- **High cost is the major factor that limits wide application of photovoltaic power generation (high-purity waste silicon preparation)**
  - ✓上网电价约为常规发电的10倍
  - ✓**Price of on-grid electricity is 10 times the price of regular power generation**
  - ✓缺乏市场竞争力，需要政策支持和技术进步推动
  - ✓**Lack of market competence calls for policy support and technical advances**
  - ✓预计到2010年有望下降至每度0.8元，接近常规发电的2倍
  - ✓**The price is expected to drop to 0.8 Yuan/kWh by 2010, which is close to twice.**

战略之三：加快发展可再生能源和核能

Strategy 3: Develop Renewable Energy and Unclear Energy

◆太阳能的能量密度低，集能面积大。需要在科学技术上取得重大突破，大幅提高光电转换效率，降低成本。

◆ Solar energy has a low energy density and hence a large collection area. Major scientific and technological breakthroughs are needed to enhance the efficiency of photoelectric conversion and lower the cost tremendously.

✓如薄膜太阳能电池是一个出路，用纳米材料（硒化铅晶体）取代半导体光电效率将提高一倍。

✓film solar battery is a potential solution, which uses a nano-material (lead selenide crystal) to replace the conventional semi-conductor and the conversion efficiency is doubled.

预计2020年： It is predicted that by 2020:

◇太阳能发电可达500万kW

◇ Solar power generation reaches 5 mil kW

◇太阳能集热面积达3亿m^2，年替代化石能源约4000万吨标煤

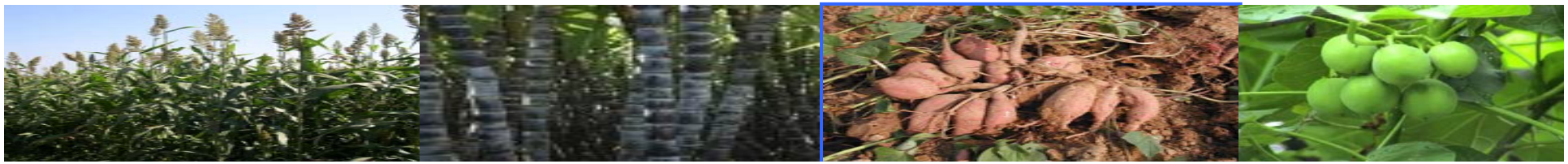
◇ Heat collection area totals 300 mil m^2, replacing fossil energies equivalent to app. 40 mil tons of standard coal.

d. 生物质能 Biomass energy

生物质能资源丰富，以非粮的农、林废弃物和荒地种植作物及垃圾为主。

Abundant biomass energy resources are represented by non-grain agricultural and forestry wastes, wasteland plants and garbage.

- ✓主要发展方向是：沼气、生物乙醇、生物柴油、生物质颗粒燃料等；
- ✓Main directions of development: methane, bio-ethanol, bio-diesel, pellets;
- ✓垃圾燃烧发电或以其它方式资源化也是一个重要的方向，是我国的一件大事。
- ✓Provide electricity and heat with garbage or other approaches from biomass, which is an important direction and a big issue for China.



各种形态的生物质能利用

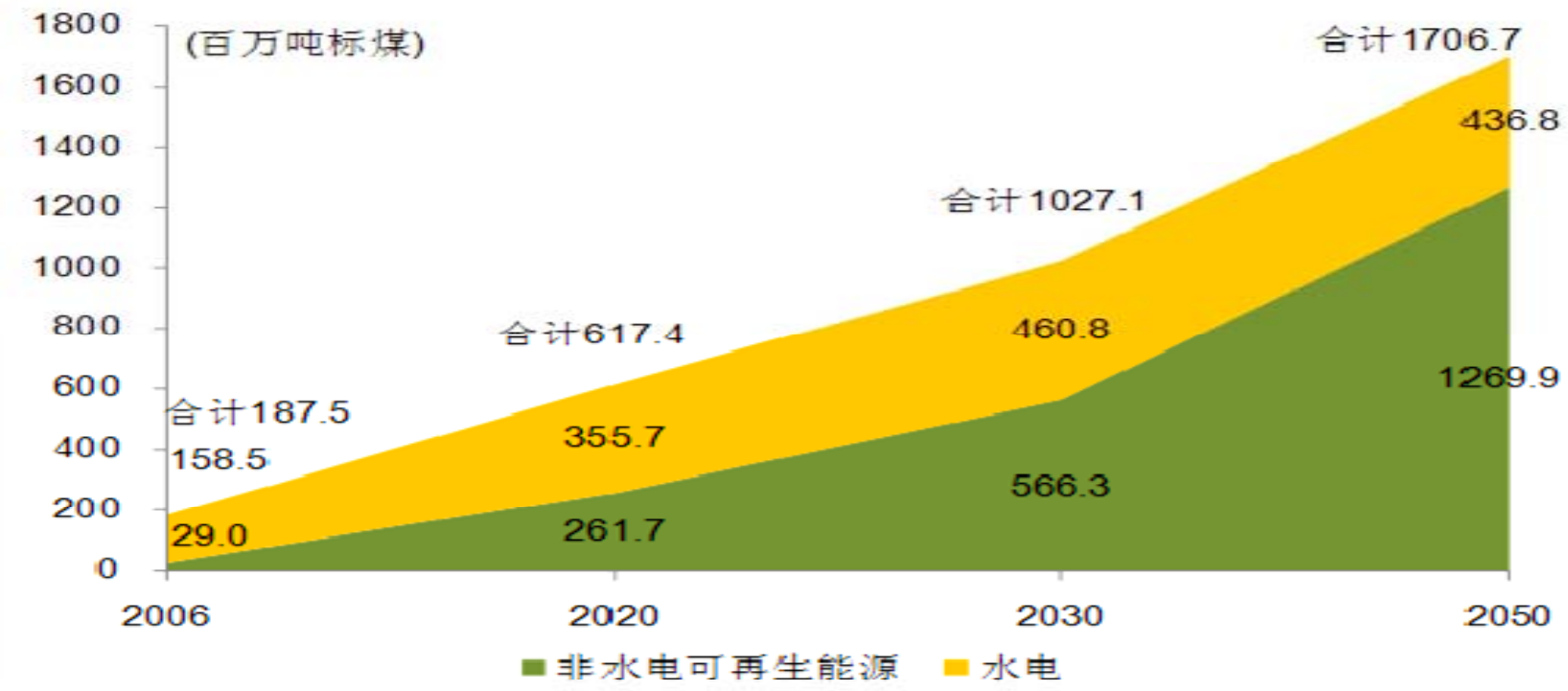
Forms of biomass exploitation

生物质 BIOMASS

- 固化成型 颗粒燃料 Briquette & Pellet → 供热 Heating / 发电 Electricity
- 生物柴油 Bio-diesel / 生物乙醇 Bio-ethanol → 替代石油 alternative oil
- 沼 气 Methane → 替代天然气 alternative natural gas
- 生物质直接燃烧发电或供热 Power generation or heating by direct combustion of biomass

中国可再生能源中长期发展估计

Medium /Long-term Estimation of China's Renewable Energy Development



Trend in Development of Hydro- and Non-hydro Energies in China
(Calculated by the intermediate prediction, Unit: Mil tce)

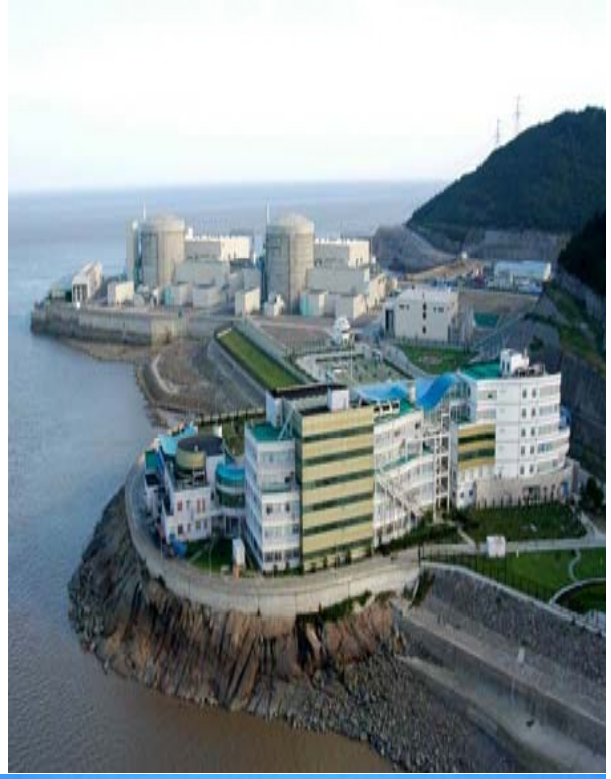
可再生能源发展的减排贡献

Renewable Energy's Contributions to Emission Reduction

Table Reduction emission from 2020-2050

year	2010	2020	2030	2050
Reduce emission (BIL Ton)	0.7	1.2	2.0	4.0

e. 核能　Nuclear Energy



国家已明确了积极发展核能的方针，目前主要发展基于核裂变的PWR电站。我国核能发展将是由三部曲组成的乐章。

The state has identified an active guideline to develop nuclear energy, which is currently focused on fission-based PWR power plant. China's nuclear energy development will be a movement of trilogy.

秦山核电站全景

Qinshan Nuclear Plant

战略之三：加快发展可再生能源和核能

Strategy 3: Develop Renewable Energy and Unclear Energy

✓预计到2020年，核电装机容量可达7000万kW

It is predicted that by 2020 the installation capacity of nuclear power may reach 70 mil kW.

✓也起动了快堆的研究

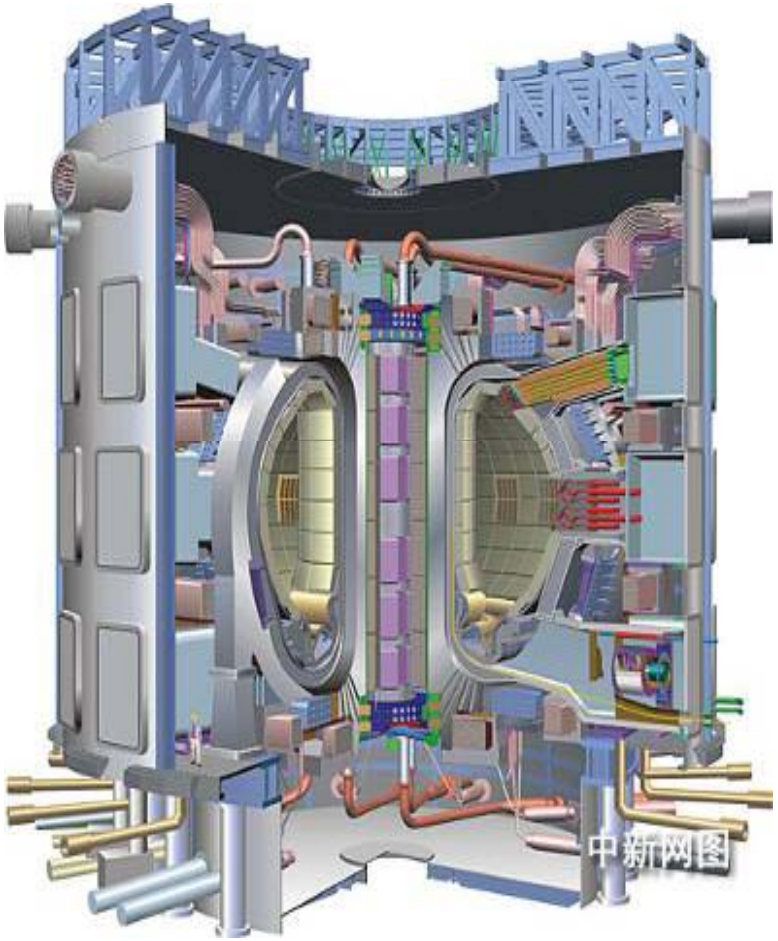
Research into fast reactor has started.

✓至2050年，核能可占全国总电力10％以上

Nuclear power may make up over 10% of China's total electricity supply by the middle of the 21st century.

✓同时，对未来的受控核聚变的前期研究给予了应有的重视。

Meanwhile, significant attention has been paid to the preliminary study of future controlled fusion reactor.



ITER装置示意图

ITER Instrument

主要内容
Main Contents

一、环境与能源密切相关

Ⅰ. Environment is closely linked with Energy

二、对中国低碳能源战略的思考

Ⅱ. Deliberation on China’s Low-Carbon Energy Strategy

三、结语

Ⅲ. Closure

三、结语
Ⅲ. Closure

环境能源学

Environmental-Energetics

催生

midwifery

→

低碳能源战略

Low-Carbon Energy Strategy

其基本内涵是发展三种概念的绿色能源

Basic idea is to develop green energies of three concepts

三、结语
Ⅲ. Closure

节能、提效、减排＋煤的洁净化＋发展核能和可再生能源

Energy saving, efficiency enhancement, emission reduction + coal cleaning + development of nuclear and renewable energies

↓

碳汇

Carbon Sink

＋

低碳能源

Low-Carbon Energy

＋

碳的捕获存储

CCUS

↓

低碳经济

Low-Carbon Economy

三、结语
Ⅲ. Closure

人类经历了渔猎文明、农业文明、工业文明，现在需要自觉地由工业文明走向生态文明时代。

The humanity has gone through the fishing and hunting, agricultural and industrial civilizations, and is now spontaneously transforming from the industrial civilization into an ecologic era.

低碳能源战略正是生态文明呼唤的能源战略。

The low-carbon energy strategy is the very response to the calling of ecologic civilization.

低碳能源战略是由工业文明步入生态文明的绿色通道！

The low-carbon energy strategy will be the green channel to realize ecologic civilization via industrial civilization!

三、结语
Ⅲ. Closure

中国古代的哲人充满智慧，但却不可能告诉我们：十几亿人口的中国如何持续发展；世界上的许多先进的发达国家各有所长，却不可能创造十几亿人口的国家可持续发展的经验。

Ancient wisdom of China shines but fails to offer us experiences on how a nation with a population over 1 billion may develop sustainable; some developed countries in the world have their own ways to develop, but they could not innovate sustainable development experiences for such a big country like China.

中国人必须创新一条可持续发展的道路。低碳能源战略是这条道路的重要组成部分。这条发展道路的创新，将是中国对人类做出的最重要的贡献。

Chinese people have to build a new way for sustainable development, of which the low-carbon energy strategy is a crucial part. Innovation on this path will be the most important contribution China makes to human being.

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衷心感谢！

Thanks for your attention!