



绿色、低碳能源战略：中国能源的可持续发展之路
**Green and Low-carbon Energy Strategy:
Path to China's Sustainable Energy Development**

杜祥琬
DU Xiangwan

中国·北京
Beijing · China



主要内容:

Main Contents:



China needs a green and low-carbon energy strategy

中国需要绿色、低碳能源战略

Being low-carbon coincides with being green

低碳与绿色并行

Main contents of green and low-carbon energy strategy

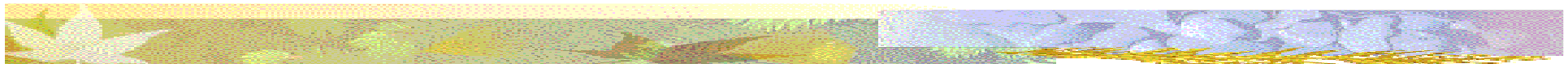
绿色、低碳能源战略的主要内涵

Forecasting China's energy development in the first half of the century

本世纪上半叶中国能源发展预估

Conclusion

结束语



中国需要绿色、低碳能源战略

China needs a green and low-carbon energy strategy

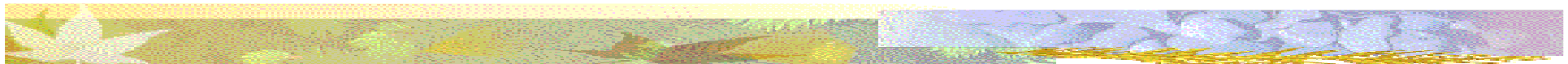


Global climate change and world financial crisis have given us a warning once again: humanity shares an urge for solution to the sustainable development problem. Countries all over the world are looking to new forms of energy, hoping to create a foundation for sustainable development, and at the same time, by taking strategic heights in new energy technologies, to transform human society into the stage of innovation-driven development and eco-civilization

China has a huge population where per capita resources are scarce. The transformation seems even more imperative and important. As a result, China has to pursue an energy strategy that is win-win economically and environmentally: a green and low-carbon energy strategy

全球气候变化和世界金融危机再次警示人们：人类面临着共同的可持续发展问题。世界各国不约而同地把眼光投向新能源，以期为人类创造一个永续发展的基础，同时，通过占领新能源技术这个战略制高点，把人类社会转型到创新驱动的发展方式和生态文明阶段

对于中国这个人口众多、人均资源短缺的国度，这个转型更为紧迫和意义重大。为此，中国需要制定经济-环境双赢的能源战略：绿色、低碳能源战略



中国是人口大国，又是人均资源小国、穷国

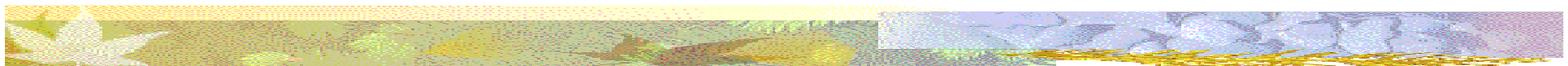
China is a large country in population, but a small and poor country in per capita resources



percentage of world

人口	population	22%
耕地	cropland	7%
淡水	fresh water	7%
石油	oil	4%
天然气	natural gas	2%

中国必须创新自己的发展方式：由粗放的发展，转向创新驱动的发展，注重发展的质量、效率，实现经济-环境双赢。



低碳与绿色并行

Being low-carbon coincides with being green



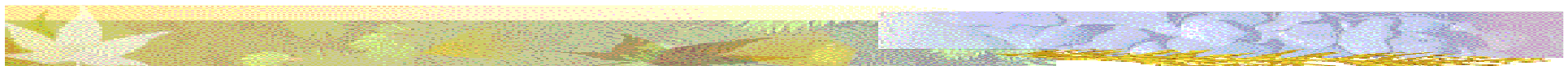
The low-carbon energy strategy is intended to reduce greenhouse gas emissions (mostly CO₂), through low-carbon technologies and policies.

It is a call for a new development path of industrialization on the basis of a low-carbon economy, and also a national strategy in response to climate change

低碳能源战略是减少温室气体（主要是CO₂）排放的能源战略，是以低碳技术和政策为支撑的战略，是走新型工业化道路的要求，是低碳经济的基础，也是应对气候变化的国家战略

Greenhouse gas emission and pollution emission are two different concepts. Hence, the concepts of being low-carbon and green (low in pollution) are also different. But given China's energy reality, the two concepts are unified to a great extent: being low-carbon coincides with being green

GHG 排放和污染排放是两个有差异的概念，因而，低碳与绿色（低污染）也是两个有差异的概念，但就中国能源的具体情况而言，这是两个方向上高度一致的概念：走向低碳和走向绿色并行不悖



中国绿色、低碳能源战略的主要内涵

Main contents of green and low-carbon energy strategy



中国绿色、低碳能源战略由以下几个子战略为支撑:

China's green and low-carbon energy strategy is built on the following sub-strategies:

Make great efforts to save energy, enhance energy efficiency and control total energy consumption

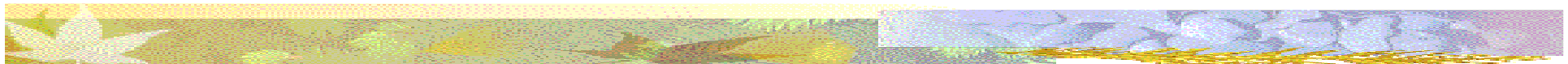
大力节能，提高能效，控制总量

Clean and efficient use of fossil energy, turning the black energy source "green"

高效、洁净化利用化石能源，使这一黑色能源逐步“绿色化”；

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

加快核能和可再生能源的发展，使其逐步成为中国能源的绿色支柱



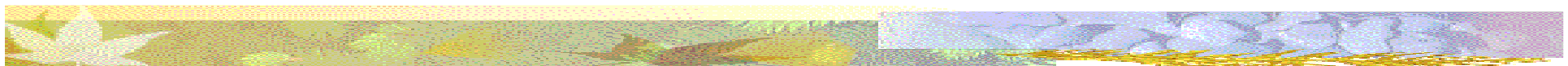
大力节能，提高能效，控制总量。

Make great efforts to save energy, enhance energy efficiency and control total energy consumption



美国的人口占世界总人口的5%，却消耗着25%的能源。中国的人口是美国的4.3倍，人均能耗现约为美国的1/6，如果中国的人均能耗提高到美国的水平，则全世界的能源也不够中国用。因此，中国决不能攀比发达国家的人均能耗，必须走节能的发展道路。

The population of the US is about 5% of the total world population, but it consumes 25% of the world's energy. China's per capita energy consumption is about 1/6 of that in the US, but if China's per capita energy consumption reached the level of the US, the total world energy would not meet China's demand. So, China has to pursue the energy-saving mode while not catching up to the level of developed countries.



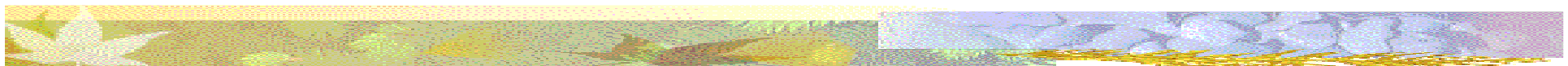
大力节能，提高能效，控制总量。

Make great efforts to save energy, enhance energy efficiency and control total energy consumption



节能包括从生产到生活的各个环节，需要创造节约的生产方式和生活方式，树立节约的消费观。中国节能潜力巨大，节能应该被看做是一种低碳能源，绿色能源。

Energy saving includes all aspects from production to living style. We have to create an energy-saving production mode and an energy-saving consuming outlook. China has great potential to save energy and energy-saving could be regarded as a low-carbon energy and green energy.



大力节能，提高能效，控制总量。

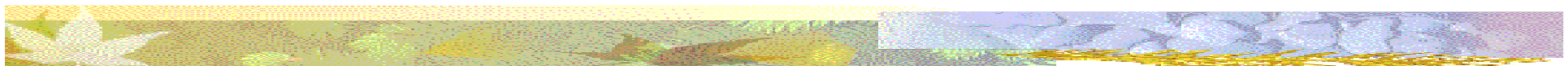
Make great efforts to save energy, enhance energy efficiency and control total energy consumption



使实现我国第三步战略目标所消耗的能源总量，尤其是煤炭、石油等化石能源总量最小化。中国的经济与社会发展必须走向节约的形态。研究表明，强化节能，可将年能耗 $E_{\text{总}}$ 控制到：

The aim is to minimize China's total energy consumption (third strategic objective) by the middle of the century, in particular minimizing the total consumption of coal, oil and other fossil energies. Research findings indicate that by strengthening energy saving, we may keep the annual total consumption of energy low:

	2020	2030	2050
$E_{\text{总}}$ /Billion Tce	<4.0	~4.6	~5.6

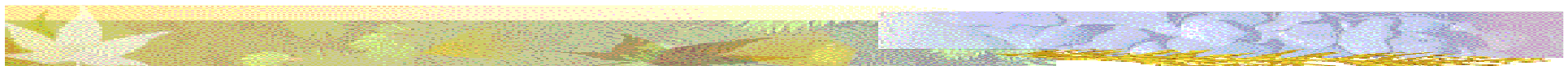


高效、洁净化利用化石能源，使这一黑色能源逐步“绿色化”
Clean and efficient use of fossil energy, turning black energy "green"



煤炭目前是我国压倒性主导能源，贡献大，但较粗放（低效、污染、欠安全）。煤炭在总能源中的比重应逐步下降。2050年可压至40%以下。煤炭年消耗的绝对量，近一、二十年内仍会有所增加，经努力，约在2030年达到峰值。以后，总能源的增量将由清洁新能源补充。煤炭的洁净化、安全性和利用效率将逐步提高。煤炭的战略地位将调整为重要的基础能源。

Coal is currently China's dominant primary energy source and it is consumed in an extensive manner (low efficiency, high pollution, low safety). The proportion of coal should be gradually brought down to 40% of the total or lower by 2050. The absolute coal consumption will continue to increase, peaking by 2030 given appropriate efforts. Subsequent increases in energy consumption will be supplemented with clean energies. The cleanliness, safety and utilization efficiency of coal will be gradually elevated and it will shift from dominant adjusted to be a major basic energy source.

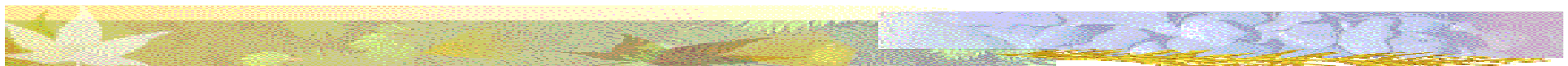


高效、洁净化利用化石能源，使这一黑色能源逐步“绿色化”
Clean and efficient use of fossil energy, turning black energy "green"



石油、天然气是我国第二位的能源，又是对外依存度大的能源。石油的发展战略是：节约、替代、加强勘探、适量引进。天然气是较洁净的化石能源，应作为发展重点之一（含煤层气和天然气水合物）。

Oil and natural gas are the No. 2 energy source of China, and these are also the most dependent on external supplies. The strategy of oil development is: saving, substituting, strengthened survey, and appropriate import. As a relatively clean fossil energy, natural gas should be prioritized in development (including coal-bed gas and natural gas hydrate)



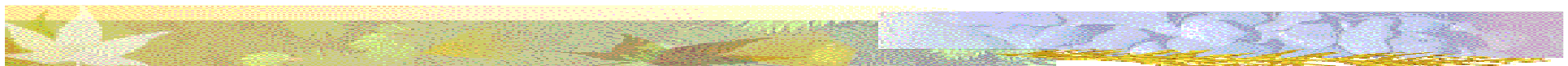
加快核能和可再生能源的发展，使其逐步成为中国能源的绿色支柱



Speed up the development of renewable energies and nuclear energy, making them China's green energy backbone

核电 Nuclear Energy:

- 铀资源不构成对核能发展的根本性约束；
Uranium resource is not a principal restriction for developing nuclear energy
- 核能可以达到安全、洁净；
Nuclear energy can be safe and clean
- 核能必须全产业链和政策配套、协调发展；
Nuclear energy must be supported with full industrial chain and appropriate policies
- 按照热堆——快堆——聚变堆三部曲的技术路线，核能可持续发展。
Coordinated development: following the trilogy technical roadmap of thermal reactor-fast reactor-fusion reactor, nuclear energy can be developed in a sustainable fashion.

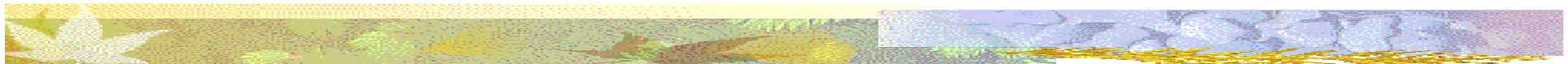


加快核能和可再生能源的发展，使其逐步成为中国能源的绿色支柱



Speed up the development of renewable energies and nuclear energy, making them China's green energy backbone

	2020	2030	2050
电力总装机 total installation of electricity generation	1.5 bi kW	2.0bi kW	2.5bi kW
核电装机 total installation of nuclear power generation	70mil kW	200mil kW	400mil kW
核电装机比重 proportion of nuclear power installation capacity	4.7 %	10 %	16 %
核电发电比重 proportion of nuclear power generation	7 %	15 %	22 %



加快核能和可再生能源的发展，使其逐步成为中国能源的绿色支柱



Speed up the development of renewable energies and nuclear energy, making them China's green energy backbone

可再生能源 Renewable Energy

- 水电:可稳步发展，2020年装机达3亿KW，2050年装机达4.5亿

Hydropower: steady development, installation capacity will reach 300 mil kW by 2020, 450 mil kW by 2050.KW

- 太阳能、风能：资源足够，需要也能够逐步长大；需逐步突破技术、经济瓶颈，发展新的用能方式，积极、扎实、有序发展；从全寿命分析看，可以达到低碳。

Solar & wind power: abundant resources, growing demands; steps have to be taken to break through the technical and economic bottlenecks, and develop new ways of energy use; from the full life-circle perspective, low carbon is possible.



加快核能和可再生能源的发展，使其逐步成为中国能源的绿色支柱



Speed up the development of renewable energies and nuclear energy, making them China's green energy backbone

可再生能源 Renewable Energy

- 生物质能：多种形态，重点应是液体燃料替代和沼气。

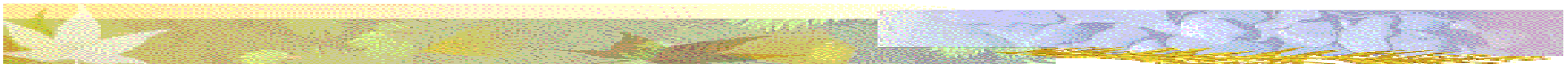
Biomass energy (including turning waste into resource): multiple forms, with priorities in alternative liquid fuels and methane

- 地热、海洋能等，也有相当的发展潜力。

Geothermal and oceanic energies, etc, have great potential for development.

可再生能源的战略地位：补充能源→替代能源→主流能源→主导能源

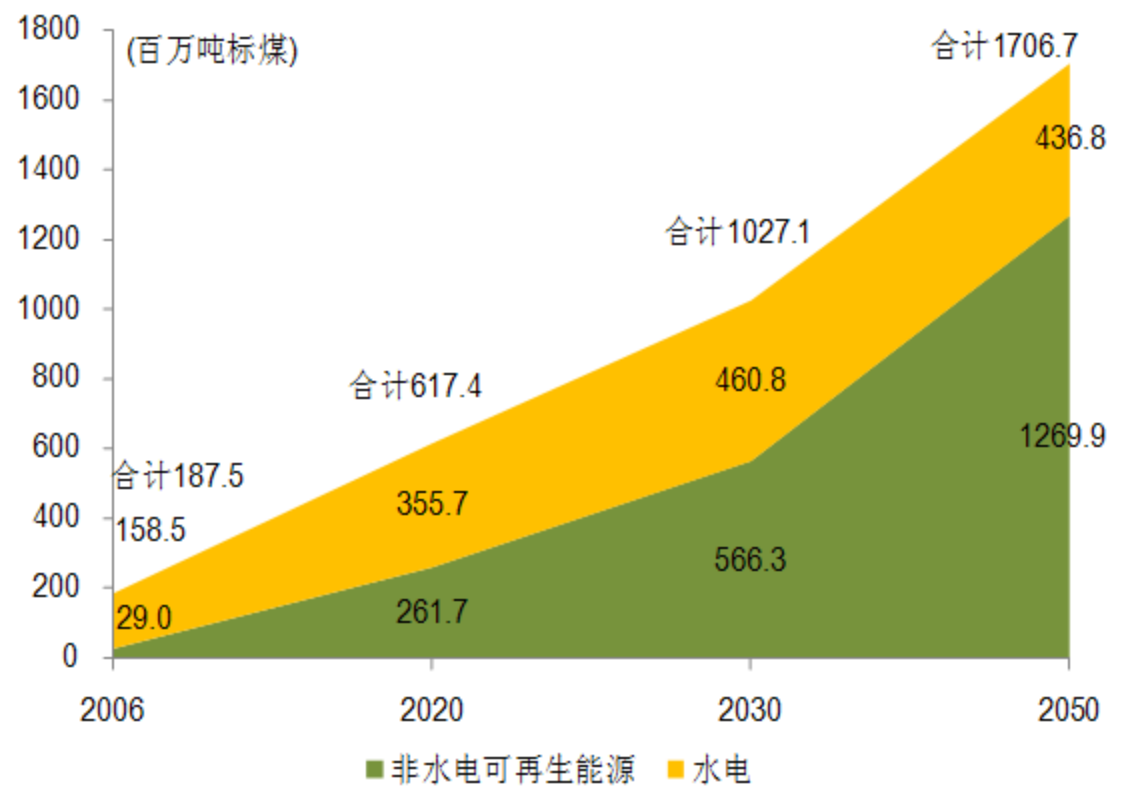
Strategic position of renewable energy: supplementary energy → alternative energy → mainstream energy → one of primary energies





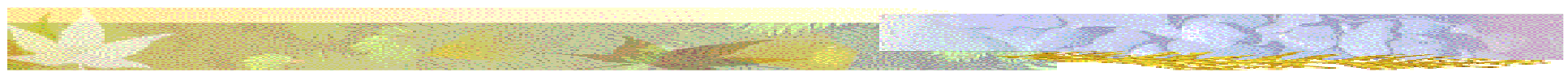
加快核能和可再生能源的发展，使其逐步成为中国能源的绿色支柱

Speed up the development of renewable energies and nuclear energy, making them China's green energy backbone



上图：至2050年中国可再生能源发展曲线

Figure: Estimation of China's Renewable Energy Development



加快核能和可再生能源的发展，使其逐步成为中国能源的绿色支柱

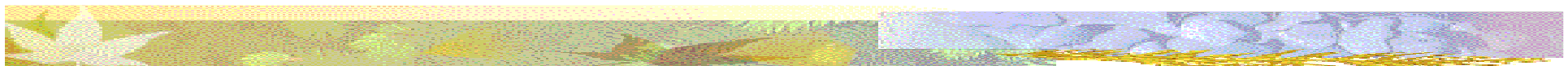


Speed up the development of renewable energies and nuclear energy, making them China's green energy backbone

Table Reduction of CO₂ emission from 2020-2050

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

- 上表：至2050年可再生能源发展的对CO₂减排贡献
The table shows renewable energy development contribution to CO₂ emission reduction
- 为适应可再生能源发展，需构建智能电网和发展储能技术
A smart power grid and energy storage technologies have to be created to the match the development of renewable energy.



本世纪上半叶中国能源发展预估

Forecasting China's energy development in the first half of the century

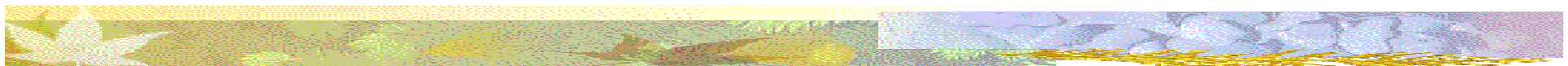


The first half of the century will see the strategic transition and transformation of Chinese energy development, gradually converting the current low-efficiency, extensive and highly polluting system into a clean, efficient, economical and multi-source system. By the second half of the century, energy development can be sustainable in China

The coming 20 years will be the most difficult period. Breakthroughs have to be made in new clean energies; enormous efforts are needed for clean coal utilization; energy saving and efficiency enhancement will take massive efforts; breakthroughs are needed for replacing oil; and a series of key issues have to be addressed in the power system

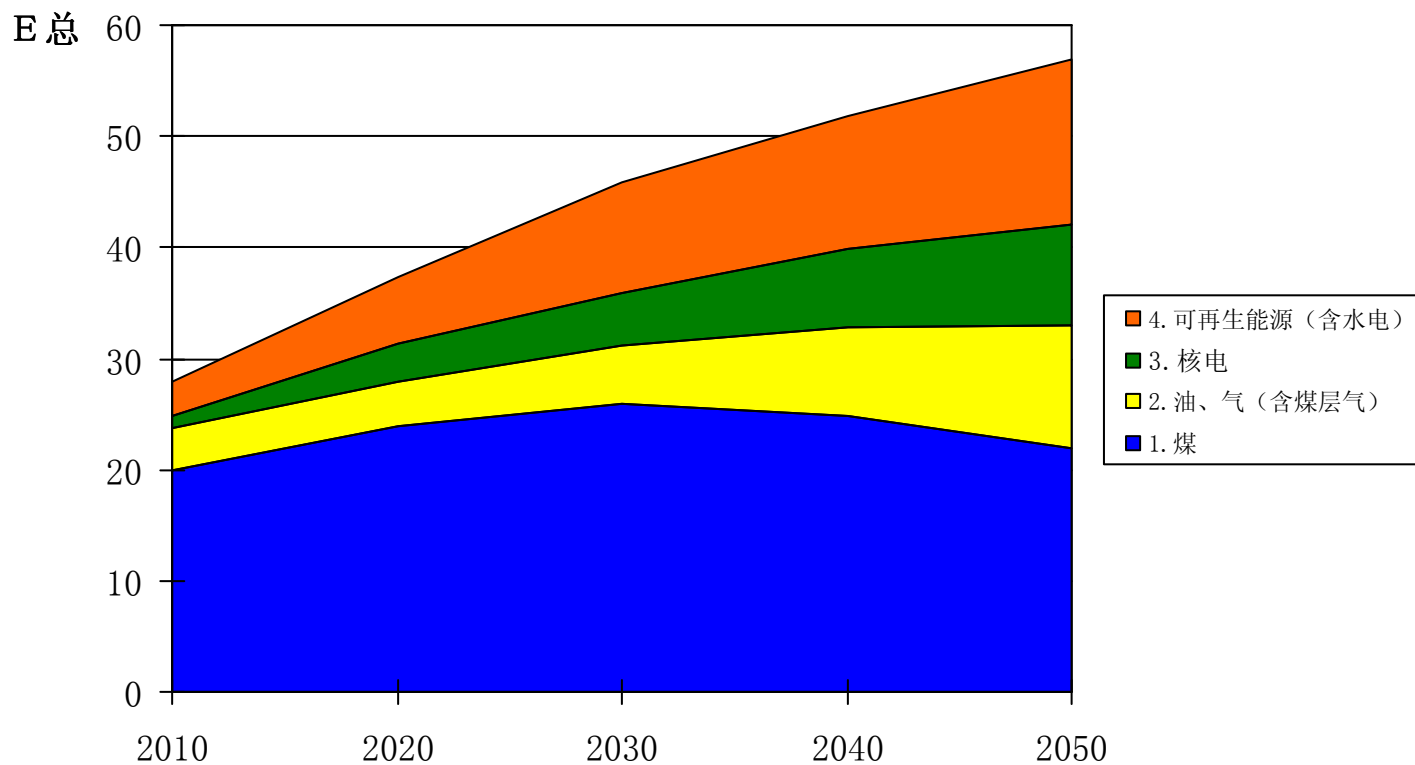
本世纪上半期，是中国能源发展的战略过渡期、转型期：将目前低效、粗放、污染的能源体系，逐步转型为洁净、高效、节约、安全、多元的现代化能源体系，能源结构、颜色和质量将发生革命性变革。从半个世纪后的长远看，中国能源是可持续发展的

今后二十年是这个转型期中的攻坚期（困难期）。新型洁净能源要突破；煤炭洁净化利用需付出巨大努力；节能、提效要花大力气；石油替代需攻关；电力系统要解决一系列重大问题



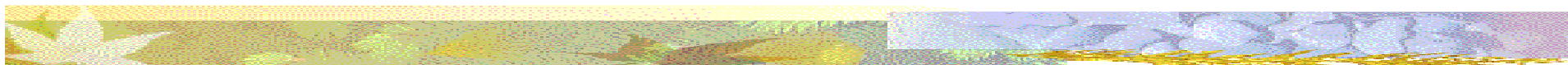
综上所述，对中国能源中长期发展的预测如下：

Summing up: China's medium to long-term energy development



单位：亿Tce
Unit: 10⁸ Tce

能源结构示意图
Energy Structure Sketch Map



我国主动承诺的降低碳排放强度靠什么来实现？

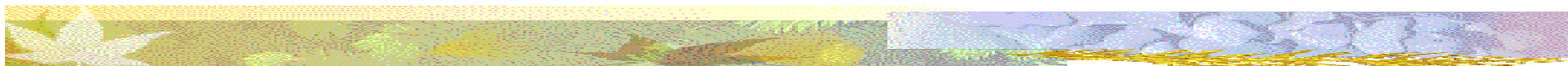
How to realize the goal of reduction in carbon- emission intensity we actively promised?



- ① 节能、提效，降低能耗强度： 降26-30%
saving energy, enhancing energy efficiency to reduce energy consumption intensity: reduce 26-30%
- ② 发展非化石能源（核、可再生）： 降8-10%
development of non-fossil energy (nuclear, renewable): reduce 8-10%
- ③ 化石能源洁净化： 降6-7%
clean use of fossil energy: reduce 6-7%

合计下降(**total reduction**) **40-47%**，这三个要素也说明：
“绿色”和“低碳”方向一致

（中国的几项主动承诺，都是经过科学论证的）

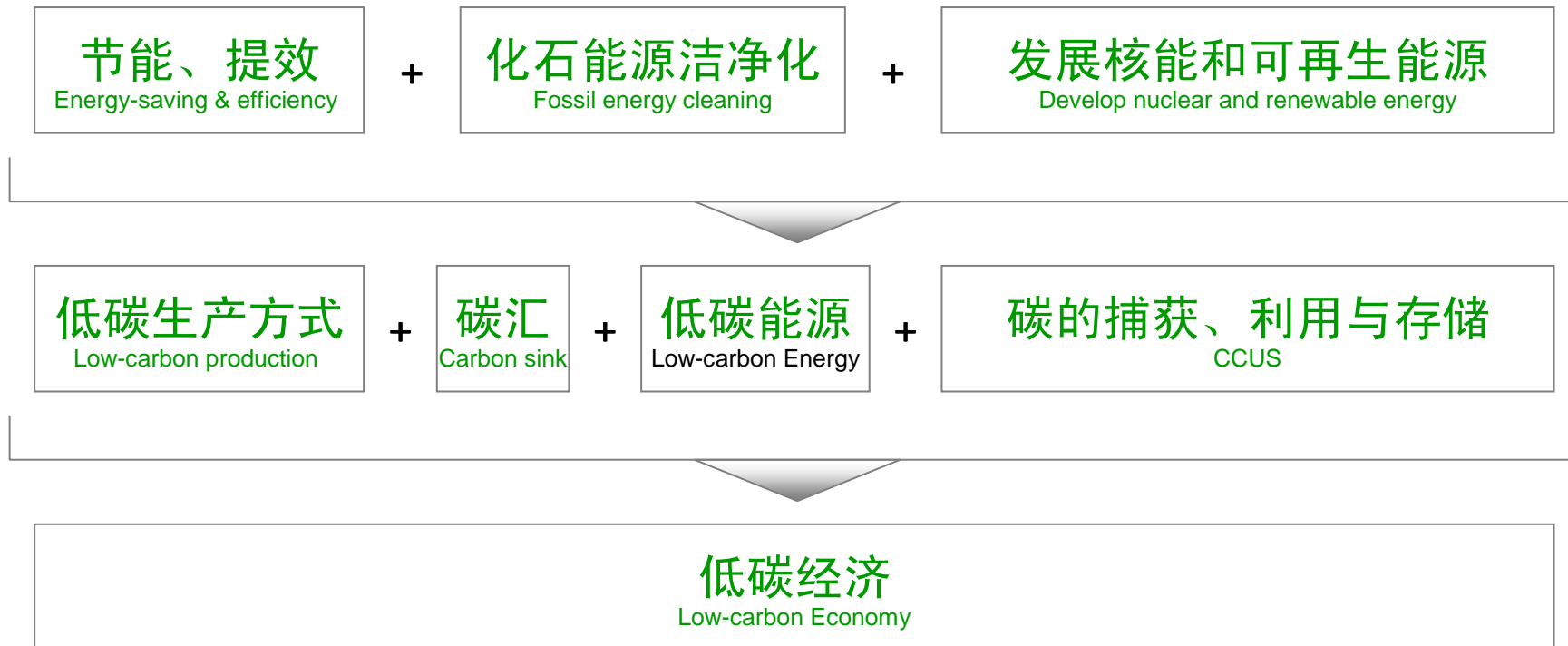


结语
Conclusion



■ 绿色、低碳能源战略组成:

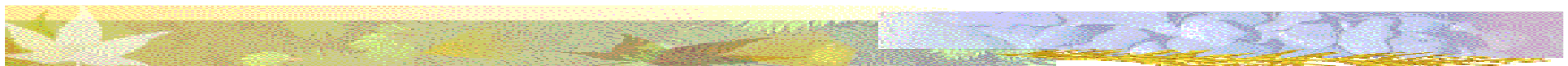
An Approach of Green and Low-carbon Energy strategy





■ “中国模式”在探索中。中国人必须创造一条可持续发展的新型道路。绿色、低碳能源战略是这条道路的要素。这条道路的创新，将是中国对人类做出的最重要的贡献。

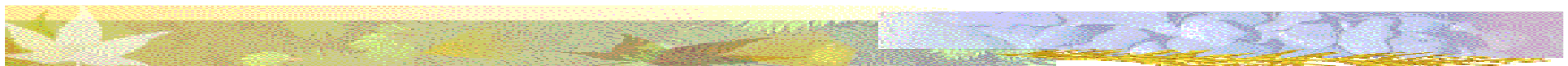
The "Chinese Development Model" is being worked out. Chinese people have to build a new way for sustainable development, of which the green and low-carbon energy strategy is a crucial part. Innovation on this path will be the most important contribution China makes to humanity.





■ 科技合作跨越时空。可持续发展是人类共同目标，支撑可持续发展的技术对各国发展有共用性。这为国际合作开创了新的领域和广阔的空间。

Co-operation in science and technology bridges time and space. Sustainable development is a shared objective of human beings, and the technologies needed to support sustainable development are of common interest to all countries and offer a new realm and broad space for international co-operation.





谢谢！
Thank You!

