

携手应对全球挑战！

Joint hands to cope with global challenge!

——中国应对气候变化的政策和项目进展

China's Policies to mitigate climate change and projects progress

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中国的能源背景 China's Primary Energy Background

- 中国已成为世界最大的能源消费国之一。

China has become one of the biggest energy consumers in the world.

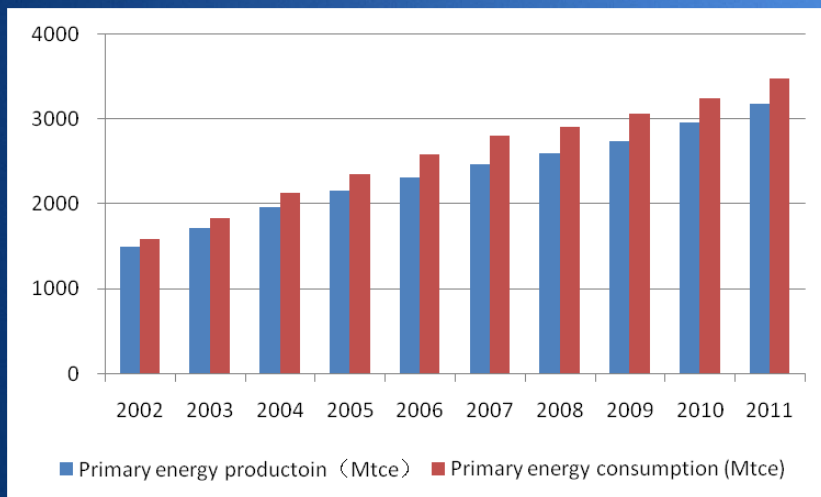
- 2012年一次能源消费总量达到27.4亿吨标准油。

Primary energy consumption was 2.74 btoe in 2012.

- 受资源限制，煤炭在中国一次能源中长期占主导地位。

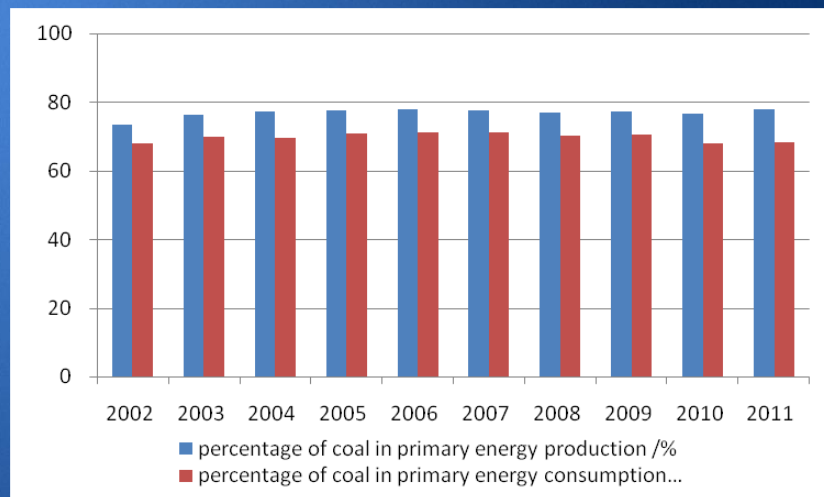
Constraint by resource, coal has always been dominating China's primary energy consumption.

中国近年来一次能源消费增长迅速



China's primary energy prod./cons. in 2011

煤炭在一次能源生产/消费中的比重



Coal's dominance in China's primary energy prod./cons.

中国的能源背景 China's Primary Energy Background

• 煤炭的大规模集中利用产生了巨大的碳排放

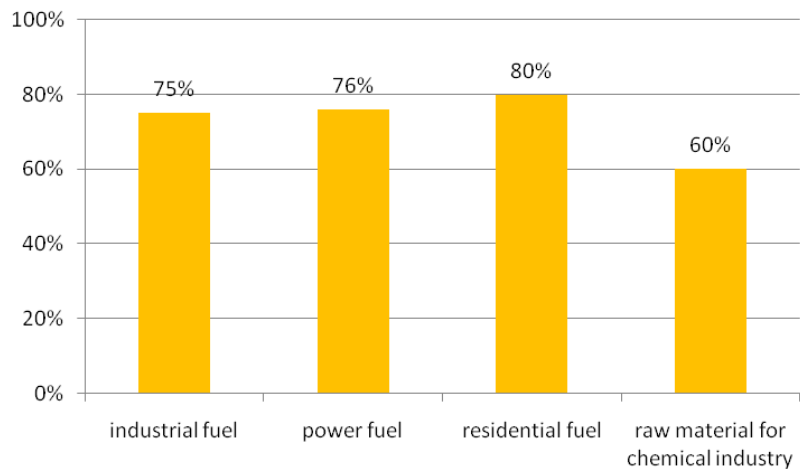
Large scale and centralized consumption of coal caused huge CO₂ emissions.

- 煤炭是很多重要工业行业最主要的燃料、原料来源

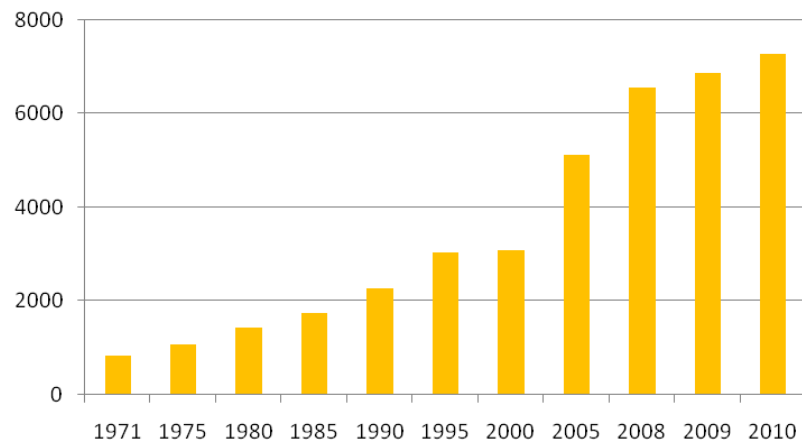
Coal is the most important fuel or raw material resource for many important industrial sectors.

- 吨标煤燃烧的碳排放达2.67吨CO₂，显著高于石油、天然气

CO₂ emissions per tce consumption is 2.67tCO₂ , much higher than oil and gas.



Coal's critical role in many important sectors



CO₂ emissions of China rises fast in recent years (MtCO₂)

此表数据来自IEA2012报告，中国国内无官方统计数据，但中国政府对此数据存在异议。

中国政府高度重视气候变化和CCUS

China attaches great importance to climate change mitigation and CCUS

- CCS受到中国政府重视，且结合中国特点提出CCUS概念

China sees CCS as an important technology to reduce CO₂ emissions in China, and proposed the concept “CCUS” considering China’s development stage.

- CCS适用于大规模集中碳排放源减排，因此拥有大量集中大规模煤炭利用工业装置的中国尤其适用。

CCS is capable to effectively reduce CO₂ emissions from large and centralized CO₂ sources, so that is especially suitable for China which owns many industrial facilities consuming large amount of coal intensely.

- CCS实施成本高，中国结合自身发展中国家的发展阶段，不仅关注CCS中的“封存”，更加重视寻找对捕集到的CO₂进行有效利用的途径，即CCUS概念。

CCS is expensive. Considering its current development stage, China not only pays attention to CO₂ storage, but also attaches more importance to approaches to make good use of the captured CO₂, or “CCUS”.

- CCUS概念为中国在世界上首创，提出后引起世界反响并被各国迅速接受，成为未来过渡到大规模推广CCS项目的桥梁。

The concept “CCUS” was firstly proposed by China, and attracts great attention and is quickly accepted by many other countries of the world. CCUS will become the transiting bridge to large scale implementation of CCS projects in the future.

中国政府高度重视气候变化和CCUS

China attaches great importance to climate change mitigation and CCUS

- 近年来中国出台一系列应对气候变化、支持CCUS发展的政策

In recent years China promulgated a series of policies to mitigate climate change and also support CCUS development.



政府资助了大量CCUS 相关技术研发项目

Chinese government sponsors many CCUS related R&D programs

• 以科技部为主导，各政府部门设立了大量CCUS研发项目

Leading by MOST, the government departments sets a large number of CCUS R&D programs

— 研发项目大多由企业、高校和科研院所合作开展

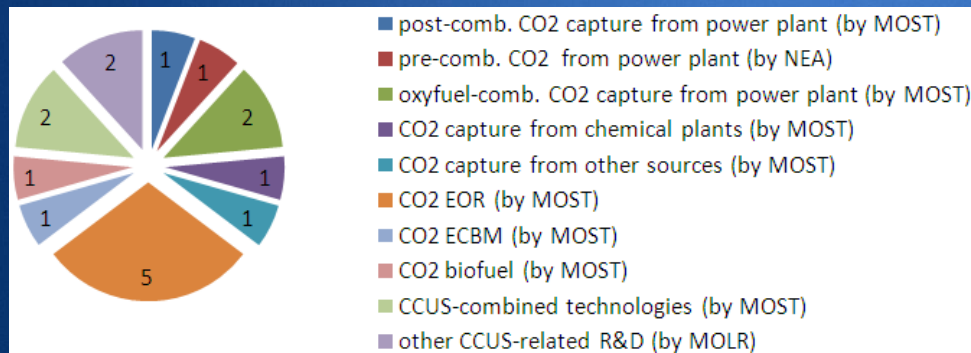
The R&D programs are mainly carried out by joint-body of enterprises, universities and institutes through collaboration.

— 项目涵盖CO₂ 捕集、封存、利用等所有CCUS相关环节的多种技术路径

Covering a wide range of technology approaches for all sections of CCUS including CO₂ capture, storage and utilization.

— 资助时间大多为3~5年，但根据项目进展情况可能会有后续项目支持。

The sponsoring programs mostly last for 3~5 years, but there might be new programs that will continue to provide support according to the progress made by each program.



中国政府资助的主要CCUS 研发项目分布情况
Distribution by type of the major CCUS R&D programs sponsored by Chinese government

MOST: The Ministry of Science & Technology of China.
NEA: The National Energy Administration of China.
MOLR: The Ministry of Land & Resources of China.

中国还积极参与CCUS有关国际合作项目

China also actively participates in CCUS related international cooperation programs

- 使中国能获得CCUS技术最新发展成果，加速技术进步和推广

International cooperation enables China to get the latest achievements in CCUS technology development globally, and fasten technology advancement and industrialization.

- 同时也让世界了解中国发展CCUS和应对气候变化的努力，加强彼此相互信任

This also enables the world to understand China's effort to mitigate climate change and promote CCUS development, and also enhances mutual trust between China and other countries.

Project name	Sources of financial support	Execution time	Major participants
The China Australia Geological Storage of CO ₂ (CAGS) Project	Ministry of Science and Technology (China) and Department of Resources, Energy and Tourism (Australia)	2009–2011	<i>China side:</i> The Administrative Centre for China's Agenda 21, China Geological Survey, Tsinghua University, etc. <i>Australia side:</i> GeoScience Australia;
Joint research on the lower emission technology for IGCC between China and U.S	Ministry of Science and Technology of China and U.S. Department of Energy	2010–2012	<i>China side:</i> Chinese Academy of Sciences; <i>U.S. side:</i> National Energy Technology Laboratory, Pacific Northwest National Laboratory;
Sino-Italian CCS technology cooperation project	Cooperation Action within CCS China-EU, COACH, Italian Ministry for the Environment, Land and Sea	2010–2012	<i>China Side:</i> The Administrative Centre for China's Agenda 21, Huaneng, Tsinghua University, Chinese Academy of Sciences, etc. <i>Italian Side:</i> Ministry for the Environment, Land and Sea, Enel, etc.
Cooperation Action within CCS China-EU, COACH	Ministry of Science and Technology of China and EU	2006–2009	<i>China side:</i> The Administrative Centre for China's Agenda 21, Huaneng, Tsinghua University, Zhejiang University, Chinese Academy of Sciences, etc. <i>EU side:</i> Imperial College, Air Products, Alstom, Shell, British Geology Survey, SINTEF, etc.
UK-China Near-Zero Emissions Coal project (NZE)	Ministry of Science and Technology of China, Department of Environment, Food and Rural Affairs of UK	2007–2009 (Phase I) 2010–2012 (Phase II)	<i>China side:</i> Administrative Centre for China's Agenda 21, Xi'an Thermal Power Research Institute, Tsinghua University, Zhejiang University, CAS, etc. <i>UK side:</i> Alstom, British Geological Survey, BP, Shell, Schlumberger, Doosan Babcock, Cambridge University, etc.
U.S.-China Clean Energy Research Center	Ministry of Science and Technology of China and U.S. Department of Energy	2010–2015	<i>China side:</i> Huazhong University of S&T, S&T and Industrialization Center of Ministry of Housing and Urban-Rural Development, Tsinghua University, etc. <i>U.S. Side:</i> West Virginia University, Lawrence Berkeley National Laboratory, Michigan University, etc.

CCUS工业示范项目已经中国四处开花

CCUS industrial demonstrations are in operation in China

- 中国目前实施的CCUS 工业示范项目的数量为全球最多

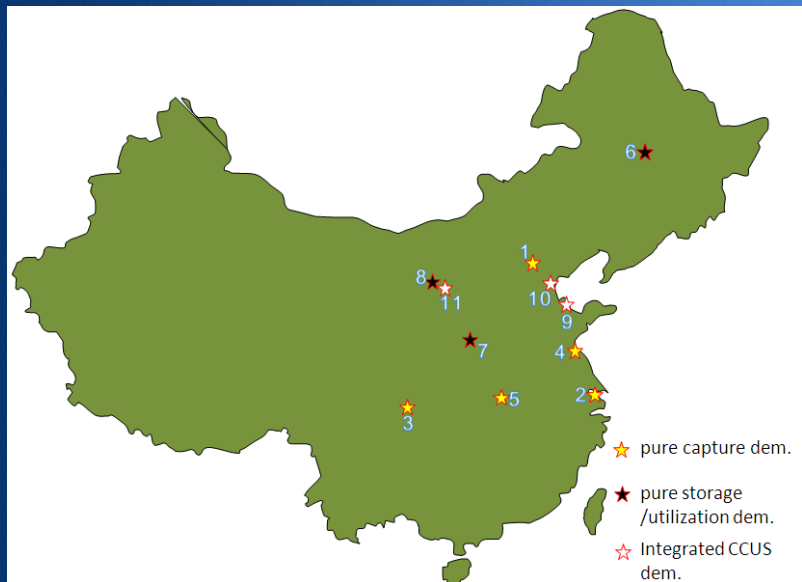
China is now implementing the largest number of CCUS industrial demonstrations around the world.

- 目前已经走在了全世界发展和推广CCUS技术的最前沿

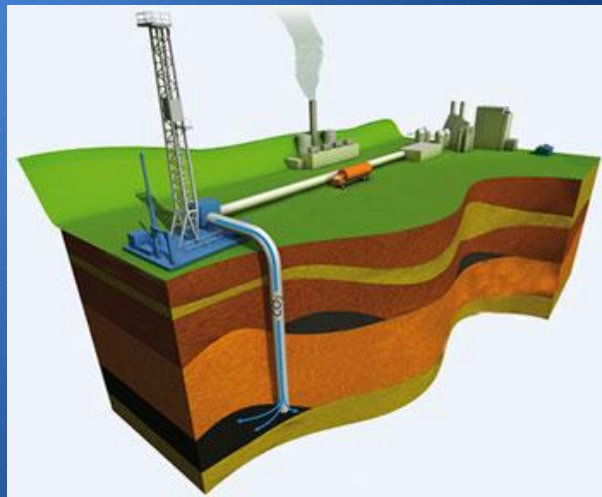
China has marched to the forefront in the world to develop and promote CCUS technology.

- 中国发展CCUS的努力将为世界应对气候变化发挥巨大作用

China's effort in CCUS development will do great contribution to the world in climate change mitigation.



CCUS industrial demonstration projects in China



CCUS工业示范项目已经中国四处开花

CCUS industrial demonstrations are in operation in China

CO₂ 捕集示范项目 Pure CO₂ capture demonstration projects in China

No.	Project Name	Type	Site	Scale (tonnes CO ₂ /yr)	Year Begun
1	Huaneng Gaobeidian CO ₂ Capture Project 华能高碑店后捕碳项目	Post-combustion capture (PCC) from power plant flue gas 电厂烟气捕碳	Choayang, Beijing	3000	2008
2	Huaneng Shidongkou CO ₂ Capture Project 华能石洞口后捕碳项目	PCC from power plant flue gas 电厂烟气捕碳	Baoshan, Shanghai	100,000	2010
3	China Power Investment Co. Shuanghuai CO ₂ Capture Project 中电投双槐后捕碳项目	PCC from power plant flue gas 电厂烟气捕碳	Hechuan, Chongqing	10,000	2010
4	CO ₂ Capture Project by Institute of Advanced Energy & Power, CAS 中科院先进能源动力中心前捕碳项目	Pre-combustion capture from IGCC fuel gas 燃烧前 煤气捕碳	Lianyungan g, Jiangsu	~10,000	2013
5	HUST CO ₂ Capture Project 华中科技大学富氧捕碳项目	CO ₂ capture from oxy-fuel combustion 富氧燃烧过程 捕碳	Yingcheng, Hubei	100,000	2013

CCUS工业示范项目已经中国四处开花

CCUS industrial demonstrations are in operation in China

CO₂ 封存/利用示范项目 CO₂ storage /utilization demonstration projects in China

No.	Project Name	Type	Site	Scale (tonnes CO ₂ /yr)	Year Begun
6	Jilin Oilfield Project, PetroChina Co. 中石油吉林油田驱油示范项目	CO ₂ EOR / storage CO ₂ 驱油+油层封存	Songyuan, Jilin	300,000– 1,000,000	1997
7	CUCBM Project, ChinaCoal Co. 中联煤层气公司驱煤层气示范项目	CO ₂ ECBM / storage CO ₂ 驱煤层气+煤层封存	Jincheng, Shanxi	~1900	2005
8	ENN Project, ENN Co. 新奥集团CO ₂ 利用示范项目	CO ₂ utilized for microalgae cultivation and biodiesel production 用含CO ₂ 废气培养微藻并生 产生物柴油	Dalate, Inner Mongolia	20,000	2010

CCUS工业示范项目已经中国四处开花

CCUS industrial demonstrations are in operation in China

CCUS集成示范项目 Integrated CCUS demonstration projects

No.	Project Name	Type	Site	Scale (tonnes CO ₂ /yr)	Year Begun
9	Integrated CCUS Project by Shengli Oilfield Power Plant 胜利油田自备电厂捕碳+驱油集成示范	PCC from power plant flue gas + CO ₂ -EOR with storage 电厂烟气捕碳+驱油	Dongying, Shandong	30,000	2010
10	Integrated CCUS Project by GreenGen, Huaneng 华能绿色煤电IGCC捕碳+驱油/封存集成示范	pre-combustion capture from coal-based fuel gas of IGCC plant + CO ₂ EOR / storage 煤基燃料气燃烧前捕碳+驱油	Binhai, Tianjin	60,000–100,000	2012
11	Integrated CCUS Project by Shenhua Coal-to-Liquid Co., Ltd. 神华煤制油捕碳+封存集成示范	pre-combustion capture from coal-based fuel gas of chemical plant + saline aquifer storage 化工厂高含碳废气捕碳+盐水层封存	Ordos, Inner Mongolia	100,000	2011

典型示范项目的基本情况

Basic information for key demonstration projects

- 华能石洞口捕碳示范项目

Huaneng Shidongkou CO₂ capture demonstration

- 采用与高碑店3000吨示范相同的技术流程，年捕集10~12万吨CO₂。
Adopting the same technology and process as Gaobeidian Dem. at a much larger scale, capturing 100,000~120,000 tCO₂/year.
- 迄今世界上已建成的规模最大的电厂烟气后捕碳项目
The largest post-combustion CO₂ capturing project in power plant in the world till now.
- CO₂被售往化工厂作为原料，但市场较有限，售价不太理想。
CO₂ is sold to chemical plants as raw material at a normal price constrained by a limited market.

典型示范项目的基本情况

Basic information for key demonstration projects

- 华中科技大学富氧燃烧示范

The Oxyfuel combustion CO₂ capturing dem. by Huazhong Univ of S&T

- 2009年在武汉建成国内第1、世界第3套3MW_{th}级富氧燃烧捕碳示范装置，年捕碳7000吨。

Establishing China's 1st, the world's 3rd 3MW_{th} oxyfuel combustion CO₂ capturing dem. in Wuhan in 2009, capturing 7000 tCO₂/year.

- 目前在应城建设世界最大的35MW_{th}级富氧燃烧捕碳示范装置，年捕碳10万吨，预计年底建成。

Now a 35MW_{th} oxyfuel combustion CO₂ capturing dem. with capturing capability of 100,000 tCO₂/year, which is the world's largest, is under construction in Yingcheng. This project is to be completed before 2014.

- 该项目标志中国已走在世界富氧燃烧捕碳技术发展最前沿。

This dem. marks China has marched to the forefront of development of oxyfuel combustion CO₂ capture technology in the world.

典型示范项目的基本情况

Basic information for key demonstration projects

- 吉林油田EOR示范 CO₂ EOR dem. in Jilin Oilfield of PetroChina
 - 吉林油田自1997年开始进行CO₂ EOR示范。
Jilin Oilfield has been working on CO₂ EOR since 1997.
 - 目前CO₂年注入量达15万吨，原油产量增幅达80%，且大部分CO₂被有效封存于油层中。
Now 150,000 tCO₂ is injected annually, and crude oil production rises by 80%, with most of the injected CO₂ effectively stored in the oilfield.
 - 计划未来将CO₂注入量提高到30-100万吨/年。
It is planned that annual CO₂ injection rate into the oilfield will be increased to 300,000-1,000,000 tCO₂.
 - 属中国首次，对了解中国复杂油田地质下EOR技术经济性、建立工程能力有重大意义。
It is the first demonstration of this kind in China, although not the first in the world. This dem. has great significance to understand the technical and economical performance of EOR, and also set up an engineering capability to establish EOR under China's complicated oilfield geology.

典型示范项目的基本情况

Basic information for key demonstration projects

- 神华CCUS集成示范 The integrated CCUS dem. by Shenhua Coal-to-Liquid
 - 神华于2009年建成了世界上第一座100万吨直接煤液化工厂。
Shenhua established the world's first 1Mt/year direct coal-to-liquid (DCTL) facility in 2009.
 - 在2011年神华对煤化工生产过程的高含碳废气实施了捕集示范，年捕碳量10万吨
In 2010, Shenhua established a CO₂ capturing dem. facility for the high CO₂ content waste gas, which can capture 10,000 tCO₂ per year.
 - 捕得的CO₂ 被用运往17公里外的地点，随后被注入并封存于3km深的盐水层中。
The captured CO₂ is transported to a site 17km away, and then injected into and effectively stored in the saline aquifer 3km deep.
 - 中国第一个盐水层封存项目，也是第一个全流程的集成CCUS示范项目，为中国未来大规模开展CO₂盐水层封存提供了大量重要的地质数据和工程实施经验。
China's first CO₂ saline aquifer storage dem. project, and also the first whole-process integrated CCUS dem. project, providing lots of important geological data and engineering experience for China to establish more CO₂ saline aquifer storage projects.

典型示范项目的基本情况

Basic information for key demonstration projects

- 华能绿煤IGCC+CCUS示范 The IGCC+CCUS integrated dem. by GreenGen
 - 2012年绿色煤电在天津建成了中国第一套26.5MW IGCC发电示范装置
GreenGen Co. established China's first 26.5MW IGCC demonstration facility in 2009 in Tianjin.
 - 华能计划对该装置进行部分煤气的燃烧前捕碳示范，应用Selexol工艺，已经开始相关准备工作。
GreenGen plans to carry out an pre-combustion CO₂ capture dem. project on part of the flue gas applying the Selexol CO₂ capture technology. Some preparation work is now in process.
 - 华能计划在2015年对该装置进行部分煤气的燃烧前捕碳示范，应用Selexol工艺，已经开始准备工作。年捕碳量可达6~10万吨。
GreenGen plans to carry out an pre-combustion CO₂ capture dem. project on part of the flue gas applying the Selexol CO₂ capture technology in 2015. Some preparation work is now in process. Annual capturing capability is 60,000-100,000 tCO₂ /year.
 - 如部分捕碳成功，将实施全部燃料气捕碳改造。
If the partial capturing dem. is successful, a full-scale fuel gas CO₂ capturing retrofit will be performed.
 - 捕得的CO₂ 计划用于驱油或盐水层封存，初步选定大港油田附近区域。
The captured CO₂ is planned to be used for EOR or stored in saline aquifer. The area around Dagang Oilfield is preliminarily selected.

CCUS技术国际合作存在巨大潜力

Great potentials exist for international technical cooperation

- 中国排放源数量大、种类多、增长快，且地质封存潜力巨大，为CCUS研发和示范提供广阔舞台

China has a large number CO₂ sources of great varieties, which are increasing fast, providing a perfect platform for CCUS R&D and demonstration.

- 各种技术类型、容量的化石燃料电厂，总容量世界第二

Fossil energy power plants of different technical categories and capacities, with total capacity 2nd in the world.

- 世界上规模最大的煤化工产业，大量的大规模高浓度碳排放源

The largest coal chemical industry in the world, with many large and high-concentration CO₂ sources.

- 随生活水平提高快速增长的汽车保有量和燃油消耗量

Vehicles holdings and the corresponding gasoline/diesel consumption increases fast along with people's living standard.

- 适于CO₂地质封存的地质构造多，且地理分布广泛，封存潜力巨大

China owns many geological formations that are suitable for CO₂ storage, which are widely distributed in all major regions, providing China with a huge potential for CO₂ storage.

CCUS技术国际合作存在巨大潜力

Great potentials exist for international technical cooperation

- 中国对减碳高度重视，对减碳技术研发示范在配套政策方面和其他领域给予大力支持

Chinese government attaches great importance to CO₂ reduction, providing material support in many related policies and other aspects to R&D and demonstration of CO₂ reduction technologies.

- 大量有技术背景的官员，对CCUS技术理解更深，也更容易产生共鸣

Many Chinese officials have technical background, so they can better understand and provide resonance to CCUS technologies.

- 有专门政策支持CCUS 技术发展，提供专项资金支持

Special policies to support development of CCUS technologies, with special funds provided.

- 政府决策和执行效率高，研发和示范项目获得支持后推进迅速

Efficient government for decision making and execution; CCUS R&D and demonstration projects can be promoted quickly if getting support from the government.

CCUS技术国际合作存在巨大潜力

Great potentials exist for international technical cooperation

- 中国企业和科研机构已在CCUS研发示范和国际合作方面建立良好的基础

Chinese companies and research institutes have set a sound foundation for CCUS R&D and development.

- 很多能源企业在发展CCUS方面态度积极，行动迅速

Many energy companies are very active in developing CCUS and moving forward fast.

- 在很多技术领域中国已经和发达国家站在同一起跑线上，甚至部分已走在世界最前沿

In many technical aspects, China is now standing at that same line with the developed countries, or even has marched to the forefront of the world in some single technologies.

- 但发达国家在很多CCUS技术上仍有独到优势，值得中国学习借鉴

Meanwhile, the developed countries still owns special advantage in many CCUS-related technologies, which China can learn to fasten CCUS advancement.

- 中国和他国的CCUS技术合作开端良好，且取得良性循环

China's cooperation with other countries in CCUS technologies have made a perfect start, and is now moving forward with great expectations.

中国与发达国家就CCUS技术合作的潜在领域

Potential aspects for international cooperation on CCUS

- 在以下技术领域发达国家和中国或可以加强合作，优势互补

The developed countries might enhance cooperation with China in these aspects to make fully use of their own advantages.

- 新型低能耗烟气/煤气碳捕集技术

Novel low energy consumption flue gas / syngas CO₂ capture technologies

- CO₂ 高效循环利用技术，如合成可再生塑料、人工光合作用等

High efficiency CO₂ recycling utilization technologies, e.g. CO₂-based renewable plastics, artificial photosynthesis, etc.

- 高含油微藻藻株培育、高效生产技术

High oil-content microalgae cultivation and high-efficiency production technology

- CO₂封存适宜地质构造高效判别评估技术

High-efficiency judgement and evaluation technology for potential CO₂ geological storage formations

- 高精度CO₂ 地下扩散情况监测技术

High precision monitoring technologies for CO₂ diffusion in geological formations

- 高灵敏度、低成本CO₂泄漏立体监测网技术

High-sensitivity and low cost integrated CO₂ leakage monitoring network related technologies

- 其他相关技术

Others.

结论 Conclusions

- 中国政府高度重视应对气候变化和发展CCUS工作，并为之做出了积极而卓有成效的努力。

China attaches great importance to climate change mitigation and CCUS development, and has made active and fruitful effort.

- 中国已成为世界上CCUS技术发展最快、示范项目最多的国家，已经站在了世界CCUS技术和产业发展的最前沿。

China is the country where CCUS technology is developing the fastest and number of CCUS demonstration is the largest, and has marched to the forefront of CCUS technology and industry development.

- 中国CCUS技术和产业的快速发展将为全世界减碳事业做出重要贡献。

The fast development of CCUS technology and industry will make great contributions to the world's climate change mitigation campaign.

- 国际社会应加强与中国就CCUS展开的合作，帮助加快CCUS的发展和推广，并提供技术和资金上的必要支持。

The other countries should enhance cooperation with China on CCUS and help promote the development and industrialization of CCUS in China. Providing some necessary technical and financial support would also be of great help to fasten this process.

The End!

