



The Capacity Building on Carbon Dioxide Capture, Utilization and Storage in China

Li JIA

The Administrative Centre for China's Agenda 21

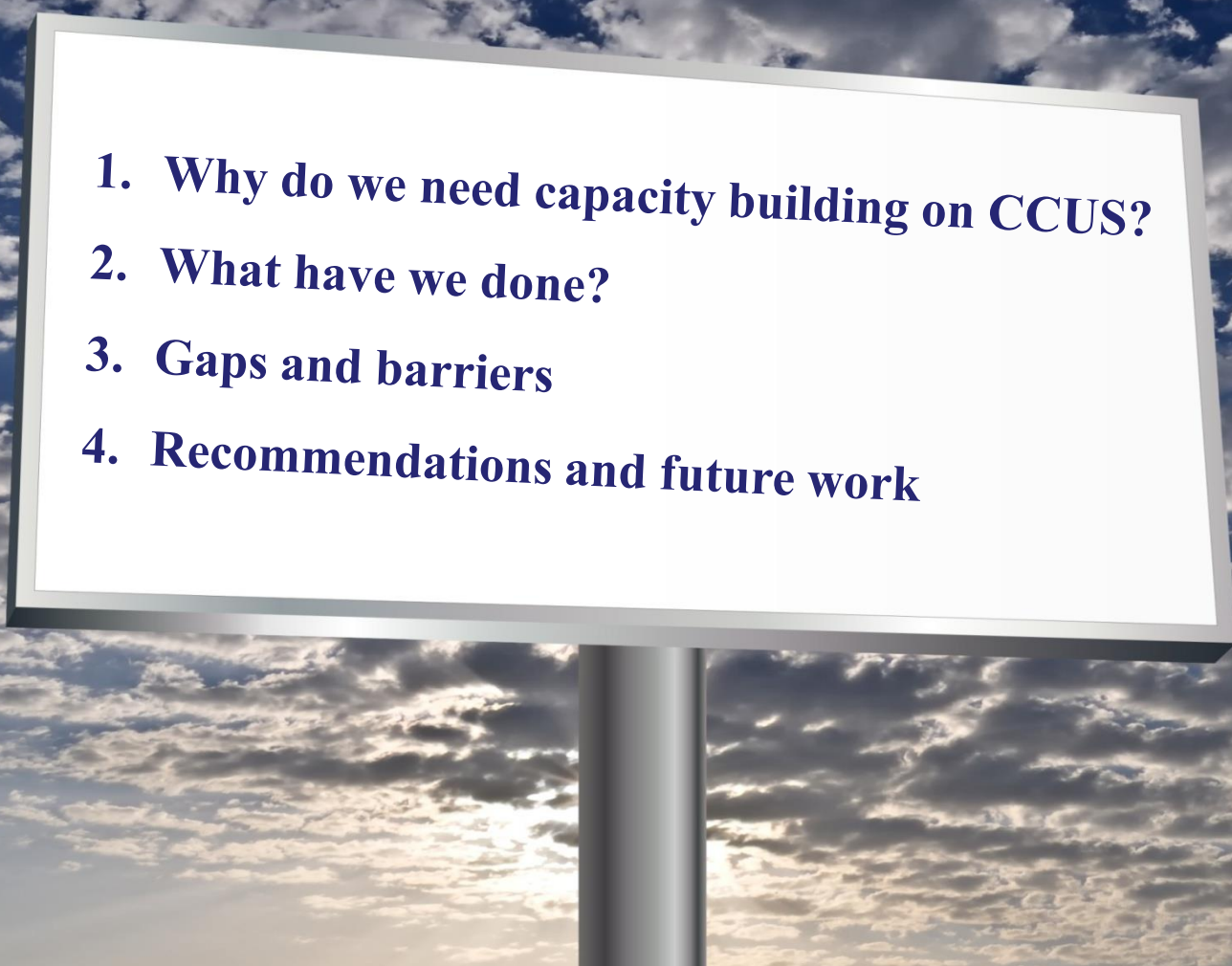
16 May, 2014



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- 
1. Why do we need capacity building on CCUS?
 2. What have we done?
 3. Gaps and barriers
 4. Recommendations and future work





Why do we need capacity building on CCUS?

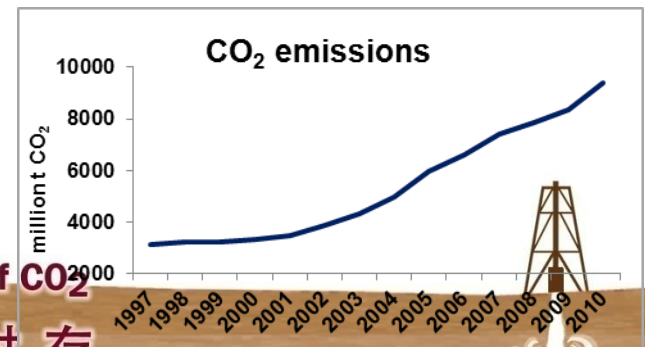
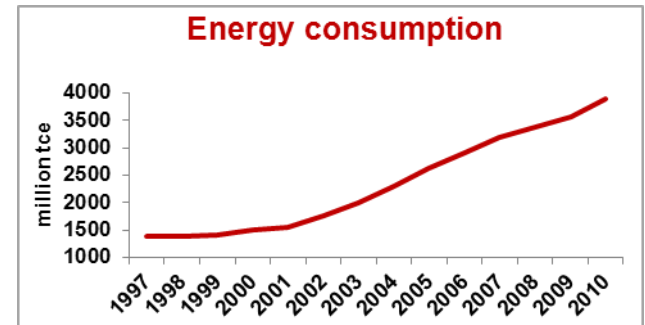
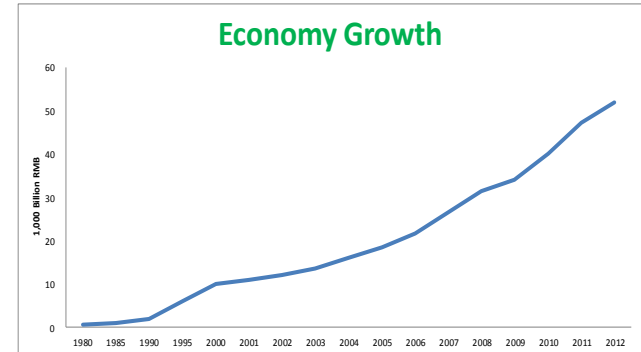


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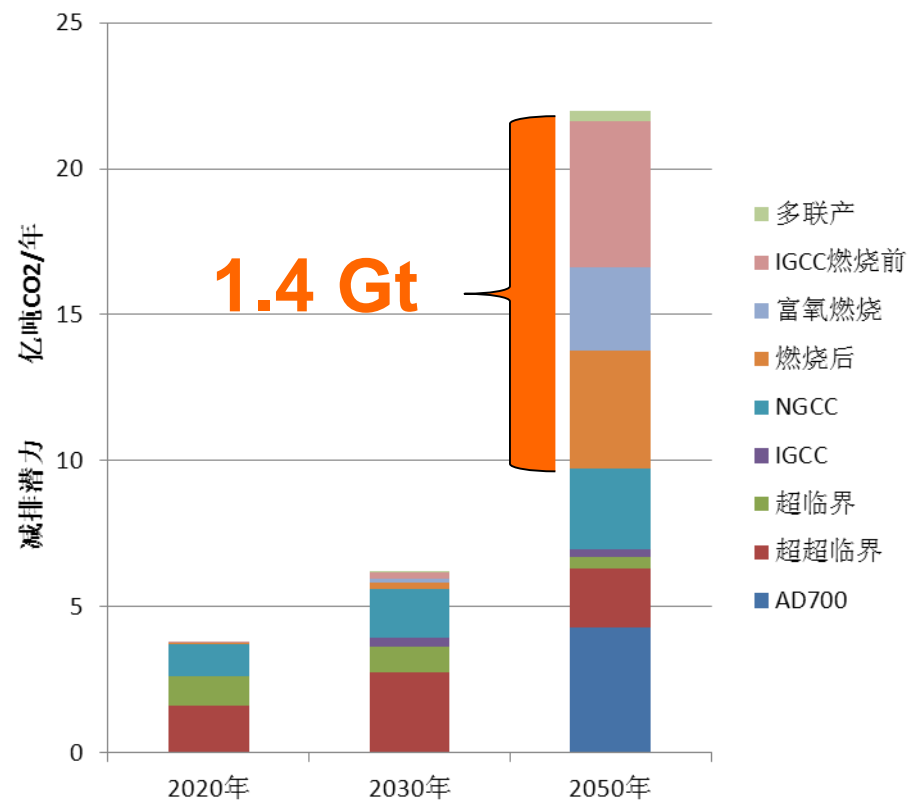
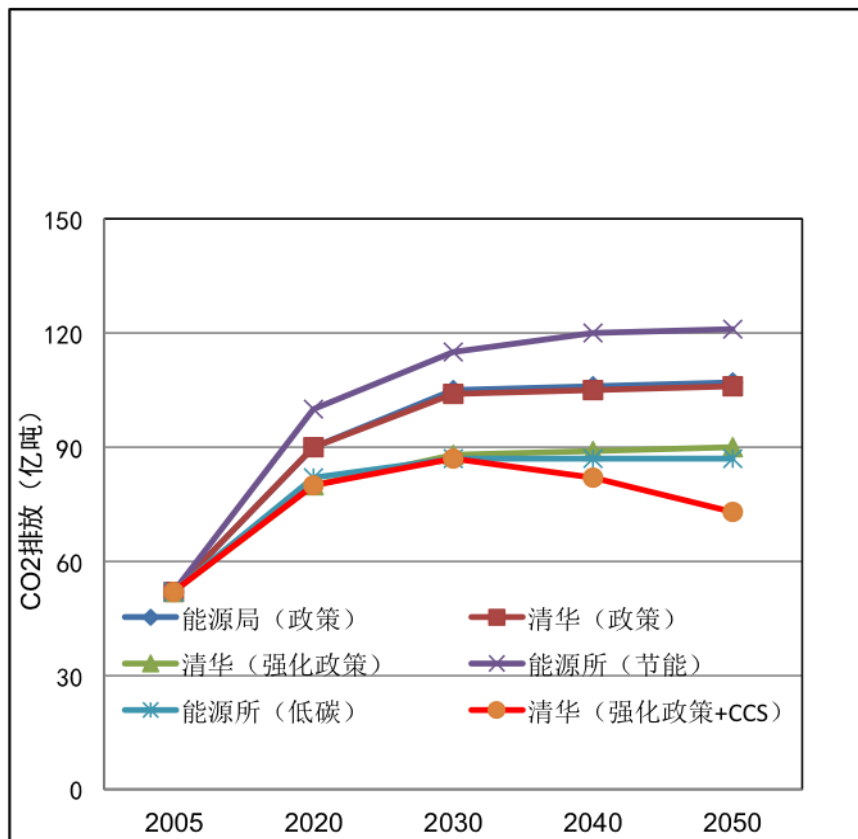
Economy, Energy and Emissions in China

- During the period of rapid industrialization and urbanization, the GDP from high energy-intensive industries accounted for a big proportion in China.
- The energy demand increases by 200 million tce annually in the recent years.
- From 1990 to 2010, CO₂ intensity declined by 57%, that is rare all over the world.
- From 1990 to 2010, the GDP grew by 7.3 times, while energy consumption and CO₂ emission increased by 3.3 and 3.0 times.
- CO₂ emission intensity to drop 40-45% by 2020 according to the 2005 level.



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Scenario analysis suggests CCUS will play important role in mid- and long-term



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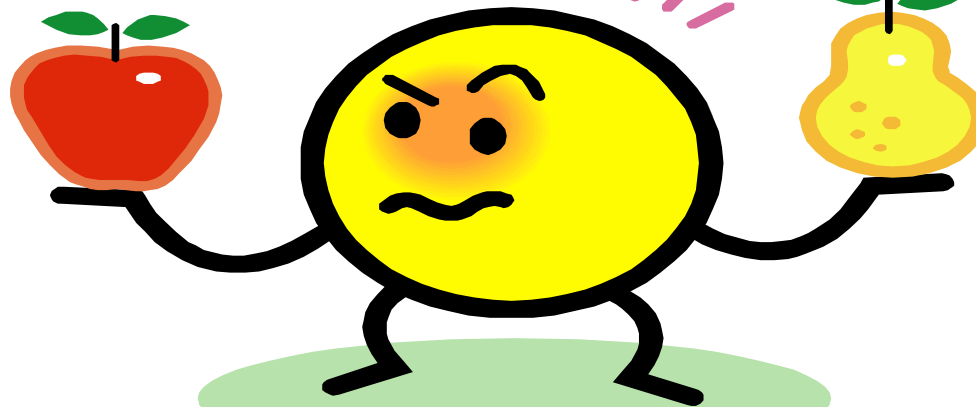
CCUS Status in China

Conditions

- Large # of concentrated CO₂ emission sources
- Considerable theoretical CO₂ storage potential
- Multiple promising CO₂ utilization options

Challenges

- High cost
- High energy penalty
- Complex geological conditions
- Sink and source doesn't match
- Dense population



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WHO

- Experts
- Young Researchers & Students

WHAT

- Knowledge Sharing
- International work experience
- Networking
- Professional Studying
- English Skills

HOW

- Technical Workshops
- Site Study
- Exchange Program
- Publications
- Website
- Technical Training Schools
- Exchange Program
- Site Study
- Publications
- Website



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WHO

WHAT

HOW

- Decision Maker
 - Capacity Building
 - Experiences Sharing
 - Legal & Regulatory Issues
- Publics
 - Public Awareness
 - Public Support
- Stakeholder
 - Business model
 - CO2 capture ready for the power plant
 - Economic returns
 - Coordination of the power company and oil company

- Round-table Meeting
- Study Tour
- Demonstration & Pilot Projects
- Website
- Lectures in the School
- CCUS Brochure
- Poster
- Website
- Technical Workshops
- Site Study
- Round-table Meeting
- Pilot Projects



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What have we done?



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- 院士专家进学校科普活动
- 武汉岩土力学所科技周-湖北襄阳
Institute of Rock and Soil Mechanics,
Chinese Academy of Sciences



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CAGS I: Visiting scholar program

Home institution (China)	Host institution (Australia)	Project	Duration
Administrative Centre for China's Agenda 21	Geoscience Australia	Policy and regulation for CO ₂ storage	1 month
China Geological Survey	Cooperative Research Centre for Greenhouse Gas Technologies (CO ₂ CRC) / University of Adelaide	Hydrogeological characterisation of the subsurface at the Otway Basin project site	3 months
Institute of Rock and Soil Mechanics, Chinese Academy of Sciences	University of Queensland	Experimental and numerical investigations on CO ₂ storage and ECBM	1 month
Institute of Geology and Geophysics, Chinese Academy of Sciences	CO ₂ CRC / University of Adelaide	Rock fracture mechanics and cap rock stability	4 months
Chinese Academy of Environmental Planning	Geoscience Australia	Environmental monitoring systems and CO ₂ storage	3 months
Tsinghua University	Geoscience Australia	Integrated numerical simulation and performance of CO ₂ plumes in saline aquifers	6 months
China University of Petroleum	Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Effects of CO ₂ injection, supercritical CO ₂ and water on reservoir rock characteristics	3 months
Institute of Rock and Soil Mechanics, Chinese Academy of Sciences	CO ₂ CRC / University of Adelaide	Effects of CO ₂ -water-rock interactions on mechanical properties of rocks	2.5 months
China University of Mining and Technology	Geoscience Australia / CSIRO	Investigation of methods for tracing CO ₂ in the subsurface	12 months

- **Workshops**

200 participants attended at least 1 workshop

- **CCS summer schools**

130 students from China and Australia

- **Networking and linking: Gov, institute, enterprise, NGOs**

51 Chinese organisations and
21 Australian / Int'l organisations

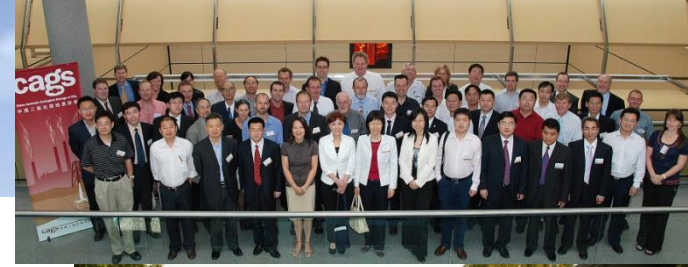
- **Visiting scholar program**

5 Chinese researchers
4 Chinese doctoral students

- **CCS international conference**



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International Conference

Seminars

- The Fourth CSLF Ministerial Conference
- Workshop on CCUS Legal and Regulation Framework in China

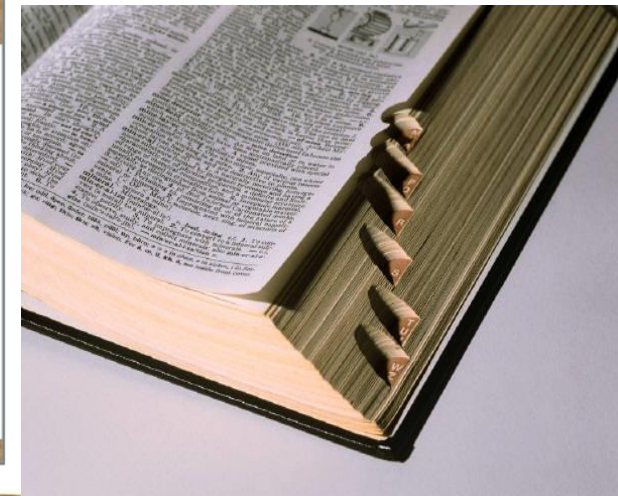


CAGS: Publications

- Brochure
- Dictionary
- Website
- Newsletter



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CCUS Brochure for the public

- Is CO₂ harmful?
- What is the Greenhouse Effect and Global Warming?
- What are the adverse/negative effects of Global Warming?
- What are the key measures to reduce carbon dioxide emissions?
- What is CO₂ Capture, Utilization and Storage (CCUS)?
- What are the strengths/advantage of CCUS?
- Where can CO₂ be captured?
- How to capture CO₂?
- How is the captured carbon dioxide transported?
- Where CO₂ can be stored?
- What's the form of sequestrated CO₂ underground?
- What are the ways for CO₂ utilization?
- Is CCUS safe and reliable?
- What are the major CCUS challenges?
- How the public do contribution to mitigation of climate change?

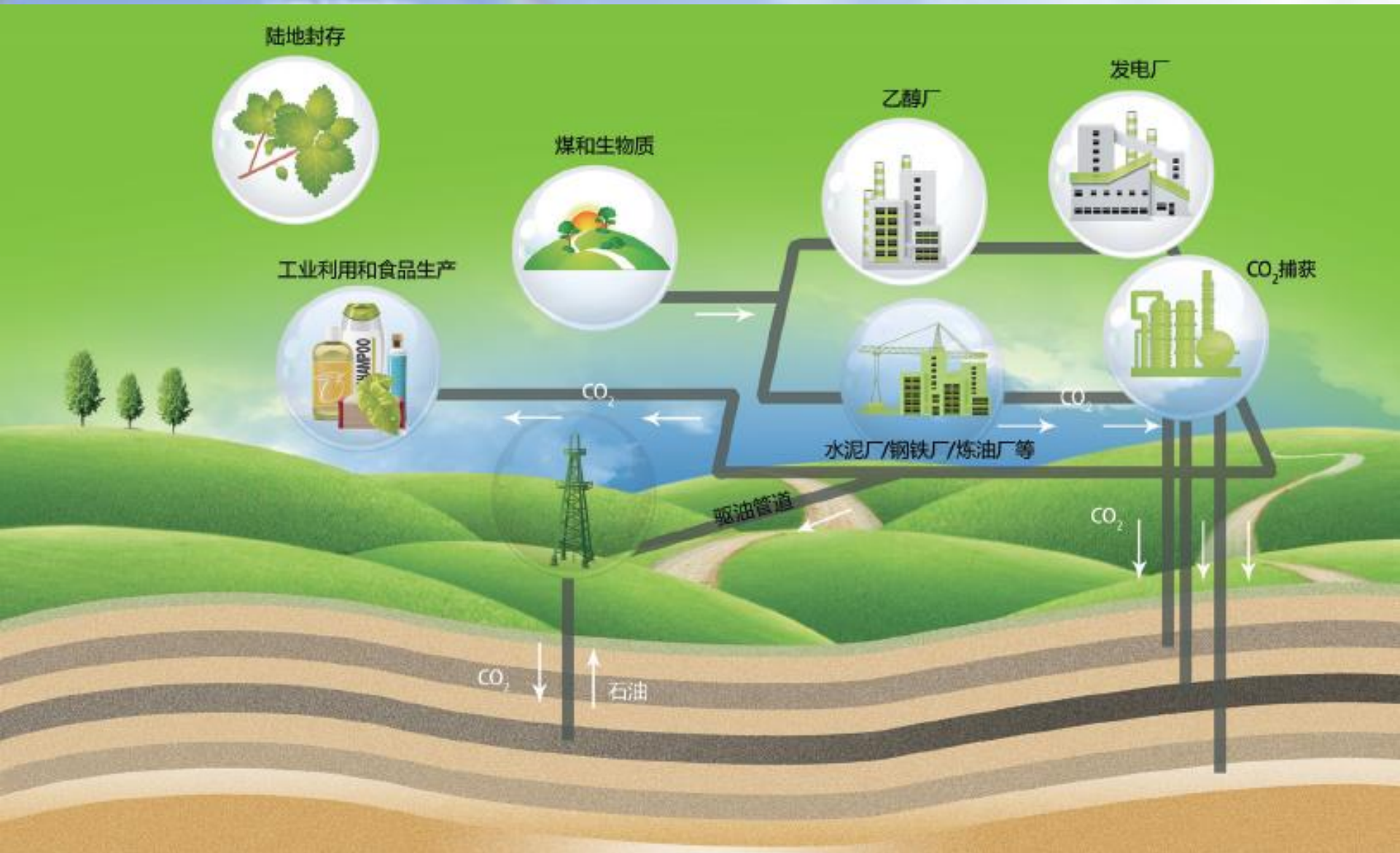


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What is CCUS?



To separate CO₂ from industrial or other sources of emissions, and transport it to the specific locations for utilization or geological storage. By doing so, to keep the captured CO₂ long-term isolated from the



希望中国科学院不断出创新成果、出创新人才、出创新思想，率先实现科学技术跨越发展，率先建成国家创新人才高地，率先建成国家高水平科技智库，率先建设国际一流科研机构。
——习近平总书记2013年7月17日在中国科学院考察工作时的讲话

高级

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国内首部二氧化碳捕集利用与封存(CCUS)词典出版

文章来源：武汉岩土力学研究所

发布时间：2014-01-07

【字号： 小 中 大 】



- 
- To further international cooperation on CCUS, and speed up tech transfer and knowledge sharing
 - To build a skilled and experienced Chinese workforce
 - To make good opportunities for postgraduate students and early career researchers to involve in CCS
 - To enhance public awareness on CCUS
 - To support Chinese government policy and decision maker



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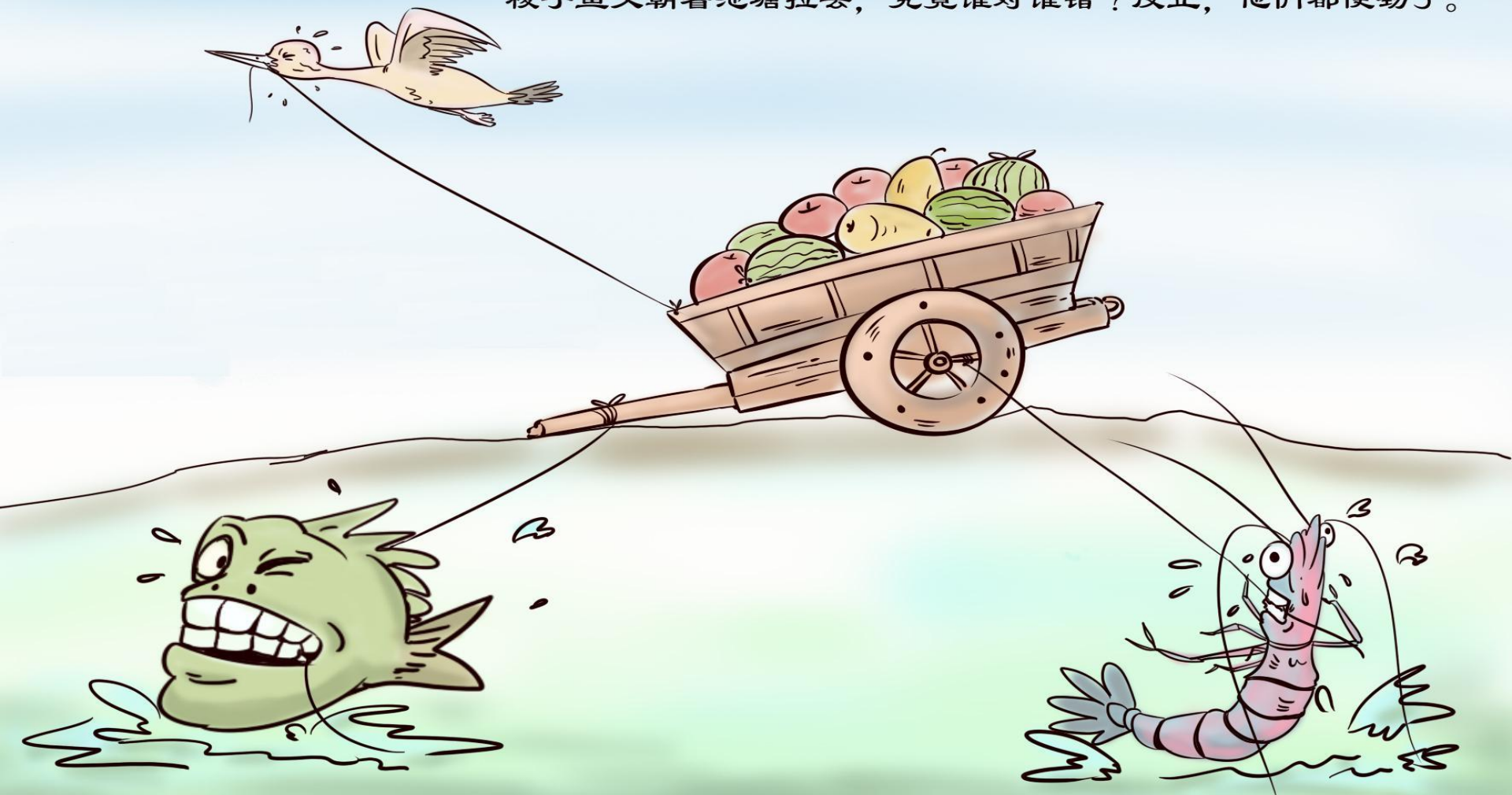
- Public capacity building on CCUS was enhanced since CCUS has been developed in China, 2005.
- Still lack of research works.
- Have done the exploratory work.
However, in generally, they are partial, small scale and pilot projects, and lack of CCUS guideline for the coming future.



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可是，无论他们怎样拖呀、拉呀、推呀，小车还是老地方，一步也动不了。原来，天鹅使劲往天上提，虾一步步向后倒拖，梭子鱼又朝着池塘拉去，究竟谁对谁错？反正，他们都使劲了。



一个团队有不同才能的人，如果这些才能不能用到一块，
最终，大家的努力将无济于事！

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To become a force

- CCUS Technology Development in China
- CCUS Technology Development Roadmap in China
- China Assessment Report on CO₂ Utilization
- CCUS Progress

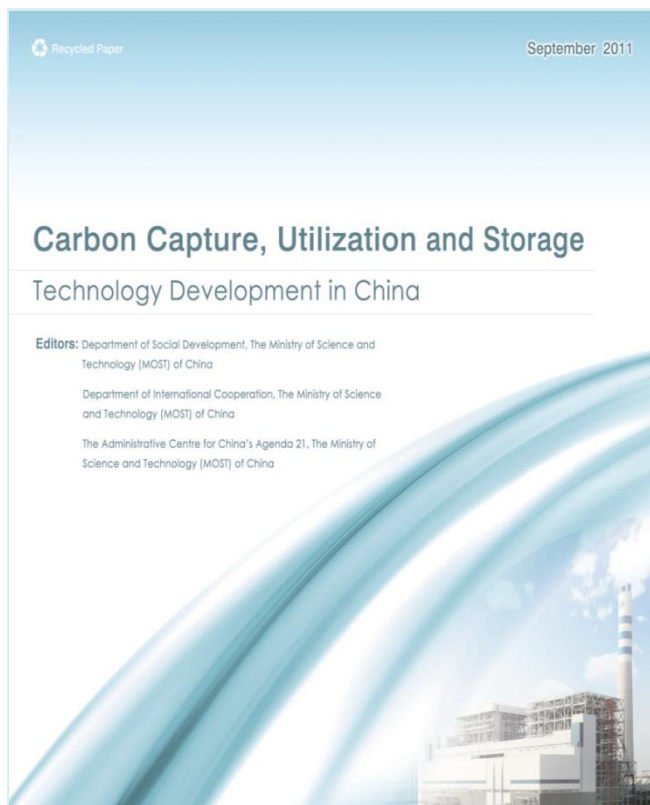


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CCUS Technology Development in China



<http://www.acca21.org.cn/gest/etc/20110928.html>

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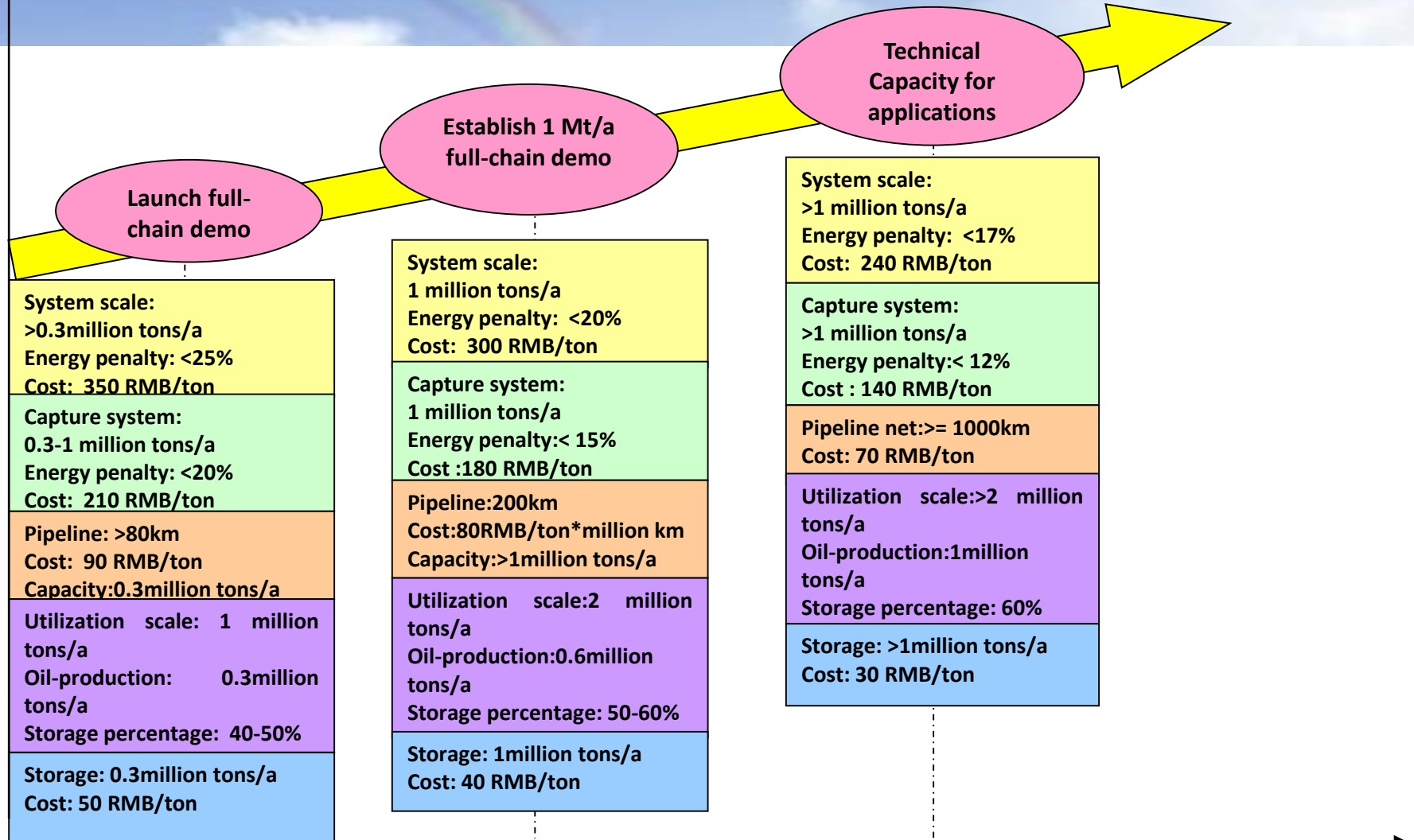
- Technology Roadmap Study on Carbon Capture, Utilization and Storage (CCUS) in China
 - Led by MOST and ACCA21
 - Released in September 2011 during the 4th CSLF Ministerial Conference in Beijing
 - Describes the technology aim and prioritized actions to develop CCUS in China



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Vision and Target Technically Feasible & economically affordable



2015
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2020

2030

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China Assessment Report on CO₂ Utilization

Three Categories:

Geological Use

1. CO₂强化采油 (EOR)
2. CO₂驱替煤层气 (ECBM)
3. CO₂增强产气 (EGR)
4. CO₂增强页岩气开采 (ESGR)
5. CO₂增强地热系统 (EGS)
6. CO₂铀矿浸出增采 (EUL)
7. CO₂强化深部咸水 (EWR)

Chemical Use

1. CO₂合成可降解聚合物材料
2. CO₂间接非光气合成异氰酸
3. CO₂间接制备聚碳酸酯/聚酯材料
4. CO₂间接制备乙烯基聚酯
5. CO₂间接制备聚丁二酸乙二醇酯
6. CO₂与甲烷重整制备合成气
7. CO₂经一氧化碳制备液体燃料
8. CO₂直接加氢合成甲醇
9. CO₂合成碳酸二甲酯
10. CO₂合成甲酸技术
11. 钢渣直接矿化利用CO₂
12. 钢渣间接矿化利用CO₂
13. 磷石膏矿化利用CO₂
14. 钾长石加工联合CO₂矿化

Biological Use

1. 微藻固定CO₂转化为生物燃料和化学品
2. 微藻固定CO₂转化为生物肥料
3. 微藻固定CO₂转化为食品和饲料添加剂
4. CO₂气肥利用

Applied in Five Areas:

能源增采与合成

矿产资源增采

化学品转化合成

生物农产品增产

消费品生产

CCUS Progress

Policies are getting into details gradually

- National Medium- and Long-Term Program for Science and Technology Development (2006-2020)
by State Council, 2006
- China's scientific actions on climate change,
by MOST, 2007
- 12th National Scientific and Technological Plan on Climate Change
by MOST, May 2012
- Work plan for 12th 5-year National GHG Control
by State Council, 2012
- S&T roadmap of China's CCUS development
by MOST/ACCA21, 2011
- Special Plan for CCUS technology development
by MOST, 2013

General statement

“to develop CO₂ near zero emission technology”



Detailed development



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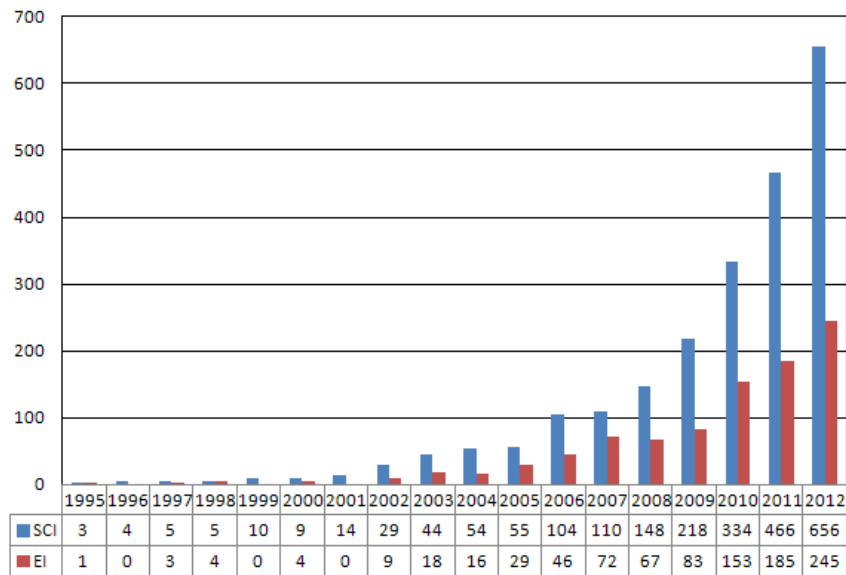
Targets, actions in capture, storage, utilization and storage, full-chain demo, etc



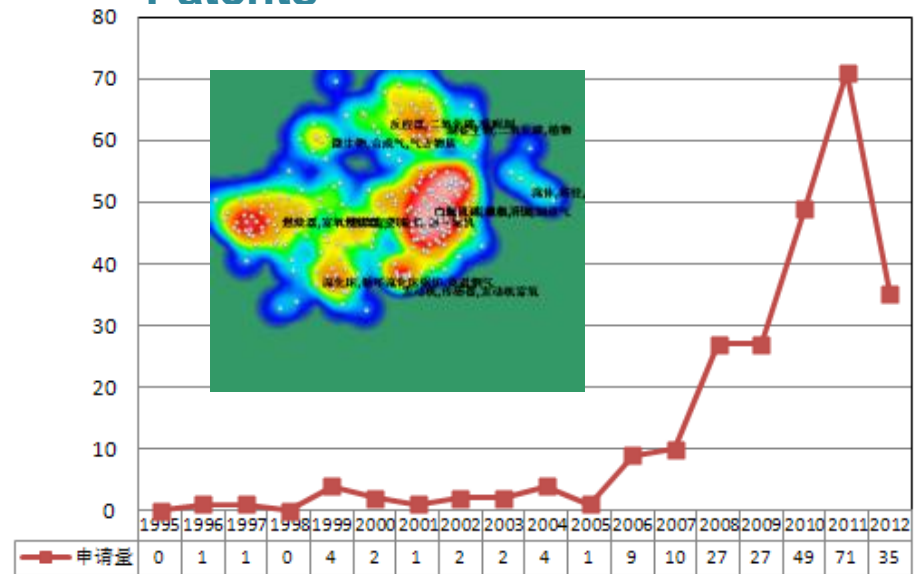
CCUS Progress

Trends of Paper & Patent on CCUS (1995-2012)

SCI & EI Papers



Domestic Patents



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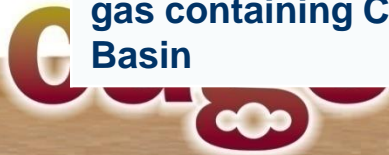
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CCUS Progress

- R&D Activities in the 11th FYP

Project Title	Funding by	Duration	Type of projects
The Project of CCS–EOR, Utilization and Storage	973	2006-2010	Basic Research
Program of CO2 Capture and Storage technology	863	2008-2010	Technology R&D
The Key Tech Research Program on CCS-EOR and Storage	863	2009-2011	
The Key Tech Research Program on CO2-Algae-Biodiesel	863	2009-2011	
CO2- Safety Mining with CO2 Gas Reservoirs and CO2 Utilization Tech	National Major Special Project	2008-2010	R& D
Demonstration Project of Mining and Utilization Tech of Volcanic gas containing CO2 in Songliao Basin	National Major Special Project	2008-2010	



CCUS Progress

- R&D Activities in the 12th FYP**

Name of Projects	Funding by	Duration	Type of projects
Demonstration Project of CO2 capture and geological storage in Coal Liquification Plant, China Shenhua Group	National Key Technology R&D Programme	2011-2014	Technology R&D
The Key Tech Research Project of CO2 Emission Reducing on Iron-Steel Sector	National Key Technology R&D Programme	2011-2014	Technology R&D
Research and Demonstration Program of IGCC +CO2 Caputere, Utilization and Storage	National Key Technology R&D Programme	2011-2013	
CO2 Storage Capacity Assessment and Demonstration in China	China Geological Survey	2011-2014	
The Program of CCS –EOR, Utilization and Storage	973	2011-2015	Basic Research



CCUS Progress

Project Title	Scale	Capture Tech	Storage/ Utilization	Status
The pilot project of CO2 Capture, Huaneng Beijing Gaobeidian Thermal Power Plant	Capture Capacity:3,000 T/Y	Post-Combustion	Food Use	Operated in 2008
Demonstration Project of CO2 capture and storage in Coal Liquification Plant, China Shenhua Group	Capture Capacity:100,000 T/Y Storage Capacity: 100,000 T/Y	Coal liquefaction	Saline Aquifer	operated in 2011
Demonstration Project of CO2 capture, Storage and Utilization in IGCC Plant Greengen of Huaneng	Capture Capacity:60,000--100,000 T/Year	Pre-Combustion	EOR	Launched in 2011
Small Scale Demonstration Project on CO2 Capture and EOR in Shengli Oil Field, Sinopec	Capture/Utilization:40,000T/Y	Post-Combustion	EOR	Operated in 2010
Demonstration Project of CO2 capture, Shanghai Shidongkou Power Plant, Huaneng	Capture Capacity:120,000 T/Y	Post-Combustion	Food/ Industrial	Operated since 2010
Demonstration project of Carbon Capture, Shuanghuai Power Plant, China Power Investment	Capture Capacity:10,000 T/Y	Post-Combustion	Food/ Manufacture	Operated in 2010
Pilot Plant of CO2 capture in Lianyungang City, CAS	Capture Capacity:30,000 T/Y	Pre-Combustion	N/A	Operated in 2011





Gaps and barriers



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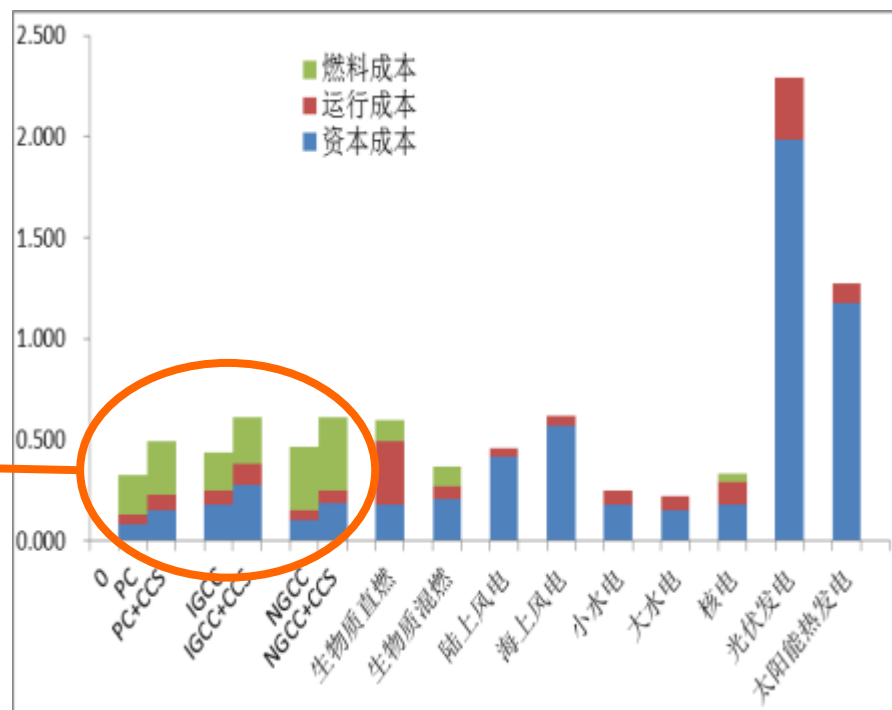


Gaps and barriers

CCUS is not mature and is expensive

- High costs
- High energy penalty
- High risk

A big portion of fuel costs in total cost.



Gaps and barriers


- Technical barriers
- Economic barriers
- Legal & regulatory barriers
- Social barriers



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- Requirement from publics
 - Barriers between the researcher and publics
 - Challenge of communication



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Recommendations and future work



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Recommendations and Future Work

- To develop technology R&D platform
 - Lab
 - Research Center
- To build CCUS educational system
 - Talent team
 - Training



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Recommendations and Future Work

- To establish positive strategy
 - Investment
 - Early opportunities
- To disseminate knowledge
 - CCUS Special Issue
 - Manual
- International Cooperation



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Recommendations and Future Work

- Build networks for publics and researchers
- Preparing teams for engagement and communication
- Break down language barriers



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jiali@acca21.org.cn

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