Technical Symposium of the China-Australia CO_2 Geological Storage (CAGS) Project

Overview of CCUS Technology Development in China: Current Status and Future Goals

The Administrative Centre for China's Agenda 21
Ministry of Science & Technology of China

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Outline

- **Why CCUS/CCS?**
- **Part I: CCUS Technical Policies and Activities in China**
- **Part II: Summary of CCUS technology Roadmap Study in China**

Why CCUS/CCS attracts attentions?

- **Climate Change and its adverse impacts have been threatening the living of human kind.**

- **Fossil fuel will continue play very important role in the foreseeable future. (IEA, share drop to 75% in 2035 from current 81%, but overall demand raise 40%)**

- **CCUS is an emerging technology with potential for large-scale emission reduction, so it's considered one of the most important technologies to control green house gas emissions.**

Develop and Reserve CCUS is important for China

in the context of Addressing Climate Change

- **CCUS may contributes to middle-long term emission reduction:**

- **safeguard energy security.**

Overview of CCUS Policy and Activities in China

CCUS S&T policies in China (I)

- National Medium- and Long-Term Program for Science and Technology Development (2006-2020), State Council, 2006

  "To develop efficient, clean and near-zero emission fossil energy utilization technologies"---highlighted as an important frontier technology

- China's National Climate Change Programme (2007-2010), State Council, 2007

  CCUS technology was included as one of the key GHG mitigation technologies that shall be developed.

- China's Scientific and Technological Actions on Climate Change (2007-2020), 14 Ministries including MOST, 2007

  CCUS technology was identified as one of the key tasks in the development of GHG control technologies in China.

CCUS S&T policies in China (II)

- National 12th Five-year Plan on S&T Development, July, 2011
  - Technology to mitigate Climate Change
  - Clean Coal Technology for Power generation
- National 12th Five year workplan on GHG emission Control, Dec. 2011
  - Capture pilot in power, coal chemical, cement, steel sectors
  - Establish integrated CO_2 CCS-EOR domonstration

Total funding support for CCUS

- Chinese government has scaled up its funding in the R&D and demonstration of CCUS technology.

- During the 11th Five-Year Plan period, more than 20 CCUS-related R&D projects, over RMB 200 million from government budget, attracted an additional RMB 1 billion Yuan from the corporate and other private sectors.

- In the current 12th Five-Year Plan period, the Chinese government has already dedicated more than RMB 400 million, generating an additional RMB 2.3 billion Yuan from the private sector

CCUS S&T activities and pilot Projects in China

- Main Government Supported S&T activities
  - Themes and areas Supported by National High-tech R&D Program (863)
    - Post-combustion + CCS research and demonstration
    - IGCC+CCS research and demonstration
    - CO2-Microalgea-bio diesel conversion key technology research
    - CO2 mineralization research
  - Themes and areas Supported by National Key Technology R&D Programme
    - Industrial CCS (iron and steel sector)
    - Oxy-fuel + CCS research and demonstration
    - Full-chain dome (Coal chemical capture + Saline water storage) demonstration
  - Themes and areas Supported by National Basic Research Programme (973)
    - Theoretical research and pilot study on enhanced oil recovery (EOR)

CCUS S&T activities and pilot Projects in China

CHINA HUANENG GROUP'S 3,000 T/A PILOT

Huaneng Beijing Gaobeidian Thermal Power Plant, start operation in 2008, CO2 used in food industry

China Power Investment Co. 10,000t/a capture pilot

Location: Hechuan Power station, Chongqing
Technology: Post-combustion capture
CO_2 Capture Rate: >95%
CO_2 Purity: >99.5%

10,000 t/a carbon capture device

Start operation since January, 2010

Huaneng 120kt/a CO_2 capture demonstration in Shanghai Shidongkou Power Plant

Project Entity: Huaneng Shanghai Shidongkou No.2 Power Plant
Location: Baoshan district, Shanghai
Technology: Post-combustion capture + reuse in the beverage industry
CO_2 purity: >99.5%
Start operation since early 2010

Huazhong University of S&T (HUST) 35MWt Oxy-fuel pilot, Hubei

Existing 400kWt Oxy-fuel recycle combustion facility

Features of the 35MWt oxy-fuel pilot

Project Entity: HUST and others

Goal: To set up a full demonstration plant combining carbon capture, storage and utilization

Scale: 35 MWt oxy-fuel combustion boiler with 100,000 t/a CO_2 storage

Location: Yingcheng, Hubei Province

Technology: Oxy-fuel combustion + storage in salt mines

Status: under preparation

CO_2 capture rate: > 90%

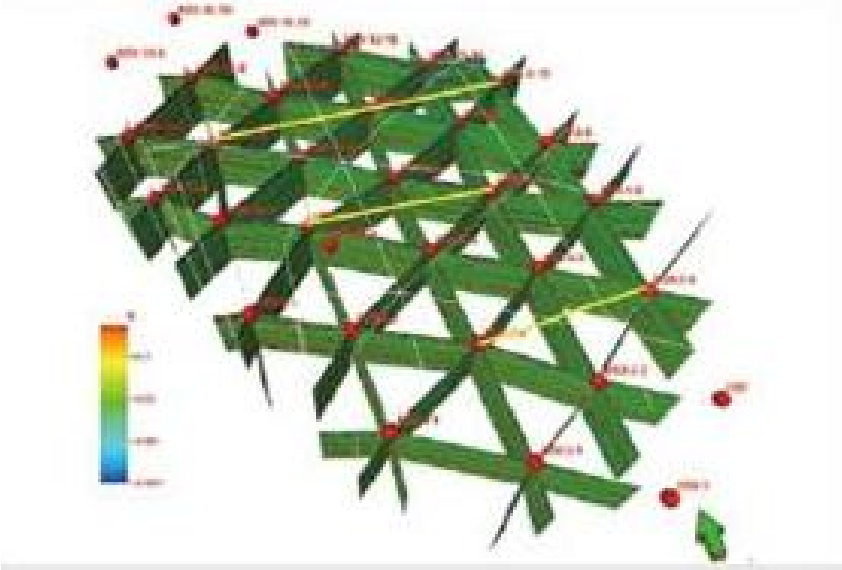
Shenhua 100,000 t/a CCS demonstration, Inner Mongolia

Features:

Technologies: CO_2 chemical source capture + saline aquifer storage
Injection scale: 10,000-100,000 tons per year
Expected Depth: 1000-2500 m
Number of wells: 1 injection well, 2 monitoring well
CO_2 Source: Captured from coal liquefaction plant

PetroChina's CO_2 EOR Research and pilot Injection, Jilin Oilfield

PetroChina EOR Project



Jilin Oil Field CCS-EOR pilot test block well network design

Goal: 0.8-1.0 million tons storage of CO_2 annually (Phase II)

Site: Jilin Oil Field

Technologies: Separation of CO_2 from natural gas + EOR

Status: Phase I has been completed and phase II is in progress

China United Coalbed Methane Co. ECBM Pilot Project

CUCBM CO_2-ECBM Well Site

CUCBM CO_2-ECBM Well Site

Project Entity: China United Coalbed Methane Company (CUCBM)

Goal: Studying and developing ECBM and CO_2 storage technology, testing safety and permanence of CO_2 sequestration.

Location: Shizhuang, Qinshui County, Shanxi Province

Technique: CO_2 Storage for ECBM

Current Status: Ongoing, injection test started since April 2010

ENN Group’s Micro algae Bio-fuel Pilot

Sinopec's 30,000 t/a CCS-EOR Pilot and plan for 0.5-1 M t/a in the coming years

recycling power plant flue gas

absorbing and purifying

inject CO_2 into oil fields

Capture of CO_2 from associated gas

Capture associated gas

- Technologies: Post-combustion+MEA+EOR
- CO_2 Source: Flue gas from the Shengli Power Plant
- CO_2 Purity: 99.5%

International S&T Collaboration on CCS

- **Bilateral scientific exchanges and cooperation conducted with European Union, Australia, Italy, Japan, the United States, etc.**
  - **China-Australia CO_2 Geological Storage Project (CAGS)**
  - **China-EU NZEC Cooperation**
  - **Sino-Italy CCS Technology Cooperation Project (SICCS)**
  - **Etc.**

- **Exchange and cooperation under CSLF, MEF and other international framework**

- **Promote the development of CCUS technology in some extend:**
  - **Info of Newest technology advancement and trends**
  - **Building capacity**
  - **Support preliminary researches, incl. techno-economic evaluation, preliminary assessment of storage potentials, etc.**

Roadmap:
CCUS Technology Development in China

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Why put forward CCUS technology roadmap in China?

- CCUS development in China starts relatively late.
- Unbalanced development in technology chain.
- CCUS technology is complex, and need coordination and planning.
- R&D and pilot project cost a lot.

Roadmap Research Method

- **Questionnaire: Send out 121 questionnaires, ranges from colleges to corporations**
- **Experts brainstorming**
- **Leading Sub-expert group: Set capture, transportation, utilization, storage technology expert teams and each team leader takes responsibility for their work**
- **Set a core expert panel and coordinate the sub-expert groups**

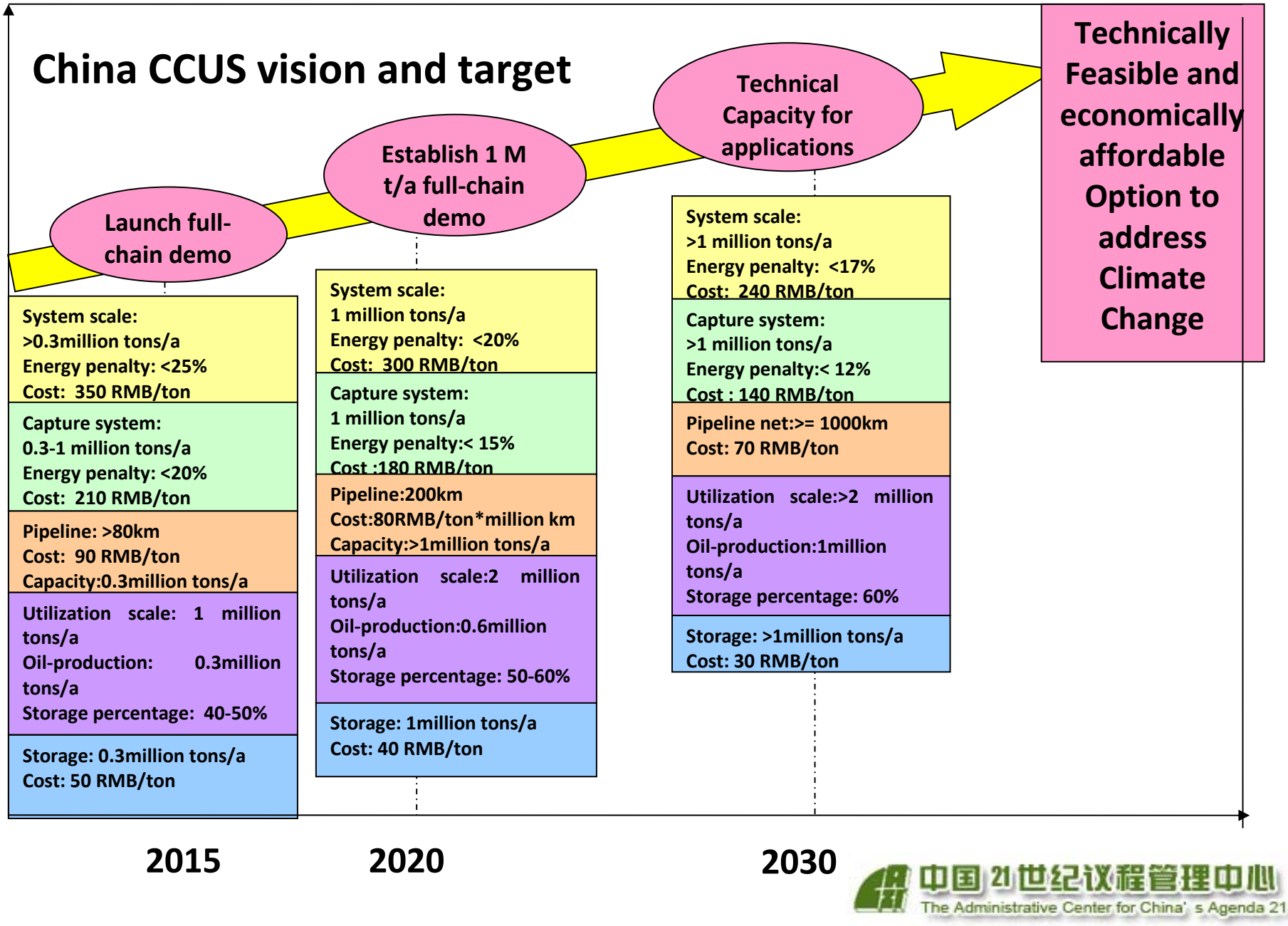
The underlying conditions to develop CCUS in China

Conditions

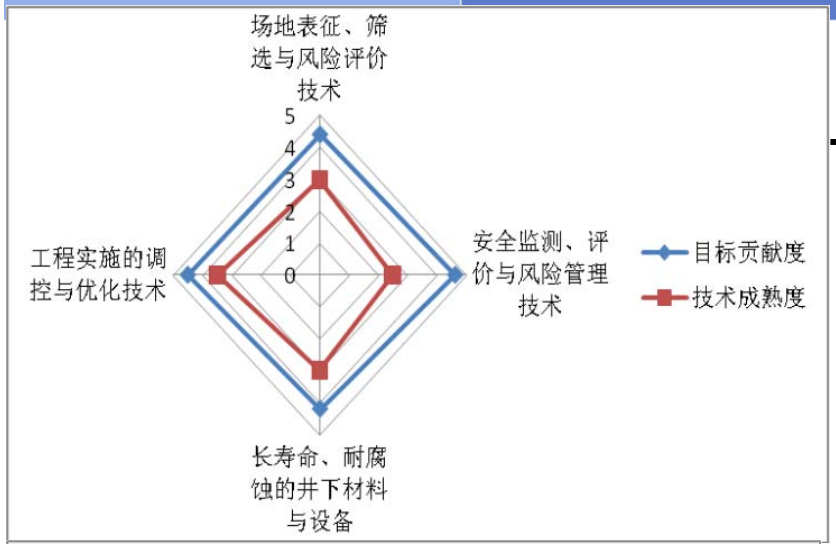
- Large # of concentrated CO_2 emission sources
- considerable theoretical CO_2 storage potential
- multiple promising CO_2 utilization options

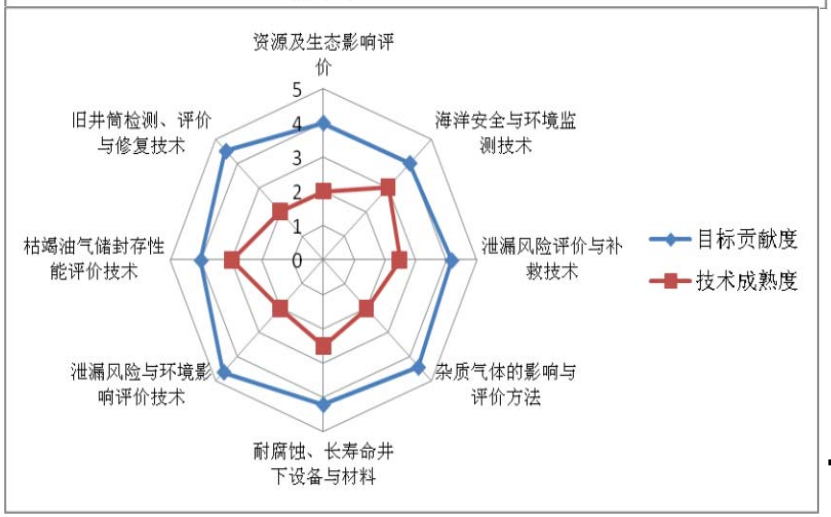
Challenges

- High cost
- High Energy penalty
- complex geological conditions
- Sink and source doesn't match
- dense population


China CCUS vision and target
Launch full-chain demo
Establish 1 M t/a full-chain demo
Technical Capacity for applications
Technically Feasible and economically affordable Option to address Climate Change
System scale:
>0.3million tons/a
Energy penalty: <25%
Cost: 350 RMB/ton
Capture system:
0.3-1 million tons/a
Energy penalty: <20%
Cost: 210 RMB/ton
Pipeline: >80km
Cost: 90 RMB/ton
Capacity:0.3million tons/a
Utilization scale: 1 million tons/a
Oil-production: 0.3million tons/a
Storage percentage: 40-50%
Storage: 0.3million tons/a
Cost: 50 RMB/ton
System scale:
1 million tons/a
Energy penalty: <20%
Cost: 300 RMB/ton
Capture system:
1 million tons/a
Energy penalty:< 15%
Cost :180 RMB/ton
Pipeline:200km
Cost:80RMB/ton*million km
Capacity:>1million tons/a
Utilization scale:2 million tons/a
Oil-production:0.6million tons/a
Storage percentage: 50-60%
Storage: 1million tons/a
Cost: 40 RMB/ton
System scale:
>1 million tons/a
Energy penalty: <17%
Cost: 240 RMB/ton
Capture system:
>1 million tons/a
Energy penalty:< 12%
Cost : 140 RMB/ton
Pipeline net:>= 1000km
Cost: 70 RMB/ton
Utilization scale:>2 million tons/a
Oil-production:1million tons/a
Storage percentage: 60%
Storage: >1million tons/a
Cost: 30 RMB/ton
2015
2020
2030

Priority Actions for Storage





Basic research: enhance basic research on geological storage mechanism.

R&D: launch nationwide storage capacity assessment; to develop assessment techniques and standard on site selection and safety, and monitoring and remediation techniques.

Pilot project: establish the storage security system with a focus on site selection, project implementation guidelines and safety environment assessment standard.

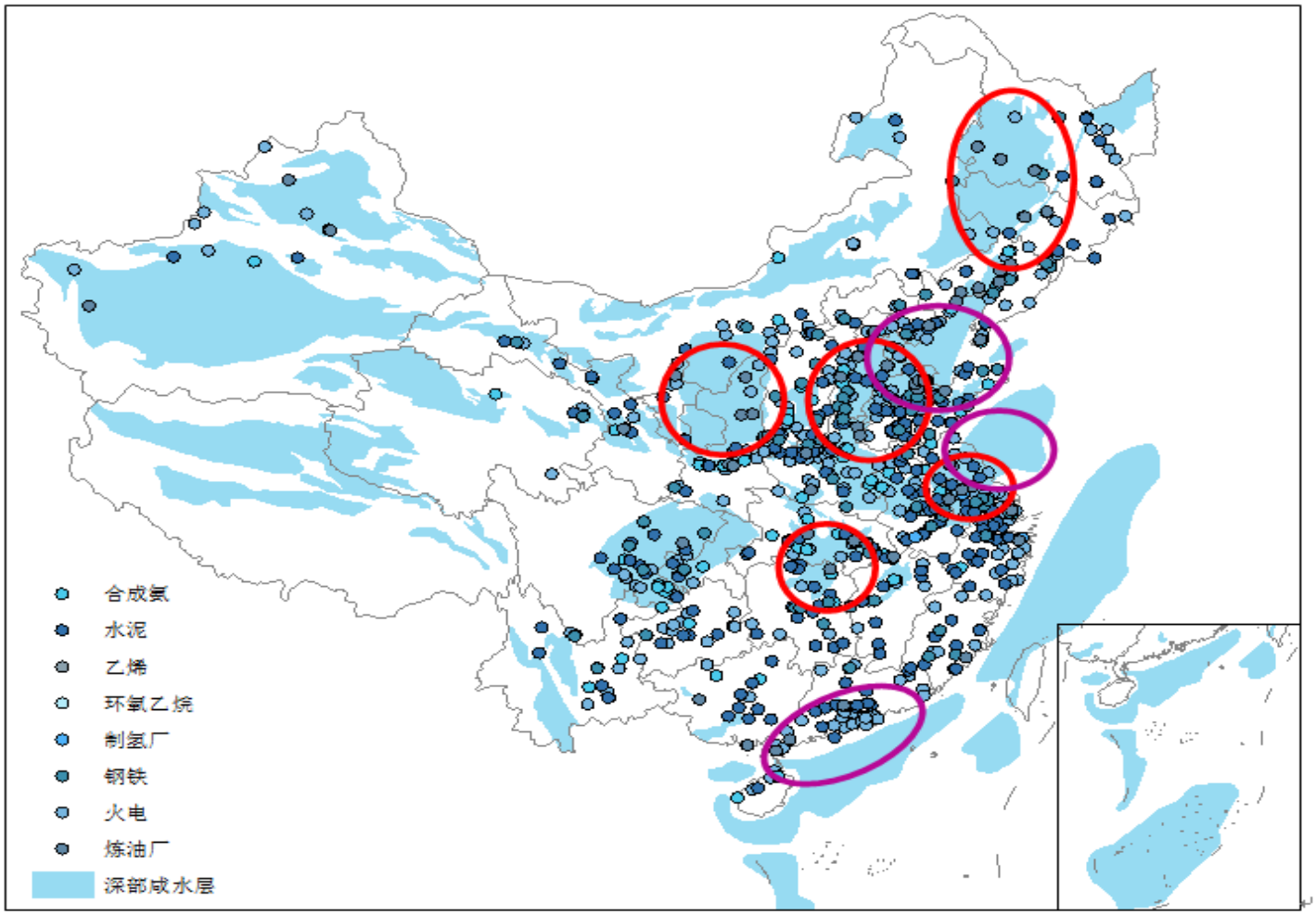
Target

2015
Scale: 0.3 M tons/a
Cost: 50 RMB/t

2020
Scale: 1M tons/a
Cost: 40 RMB/t

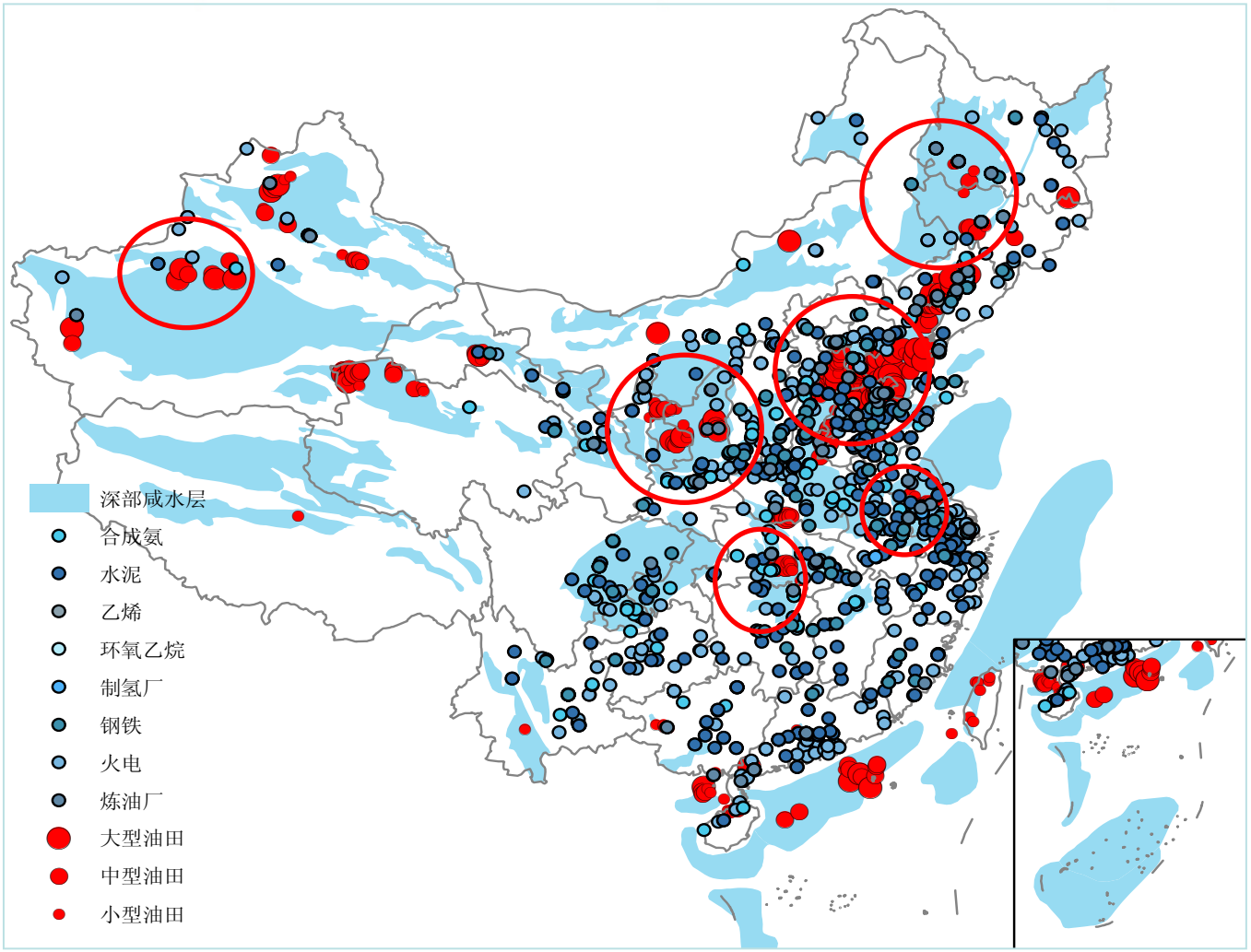
2030
Scale: >1 M tons/a
Cost: 30 RMB/t

Source Matching 1



On-land and off-shore Saline Aquifer Storage Opportunities

Source Matching 2



EOR and Depleted Oil reservoir Storage Opportunities

Conclusion on Source Matching Analysis

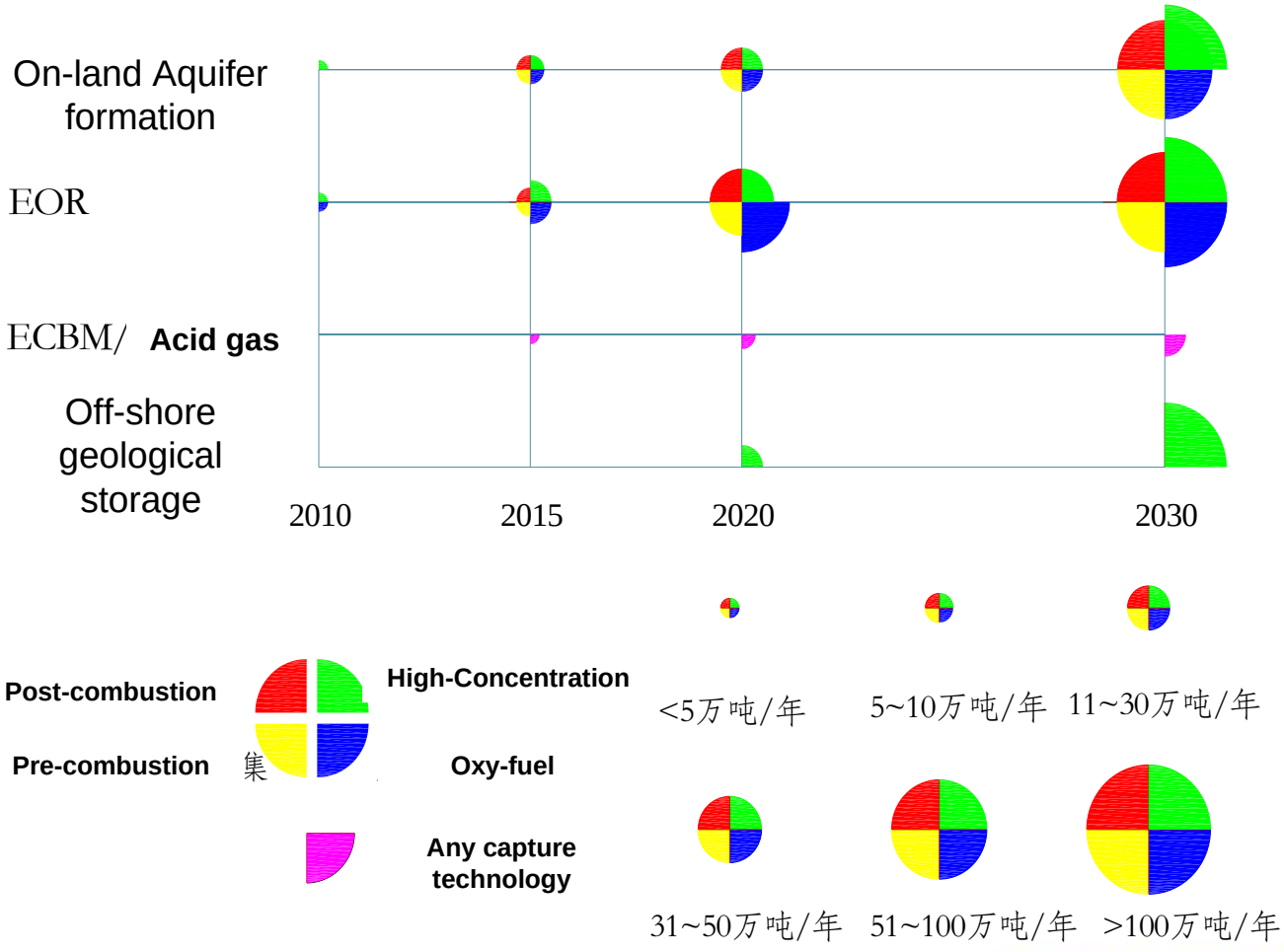
- Erdos Basin, Sichuan Basin, Songliao Basin etc. are potentially good site for geological storage.

- East China has a better chance in demonstrating full chain CCUS projects for now. But in the future, it may be a better option to demonstrate CCUS projects in west China.

Suggestions on CCUS R&D in China

- Nationwide utilization and storage capacity assessment
- Early Opportunities (high-concentration emission sources) and demo large application potentials (power sector) be prioritized
- No winner solution for CO2 capture technology at current stage
- the full-chain technology demonstration for CO2-EOR and land saline aquifer storage shall be prioritized
- Scale of integrated demo steadily take forward with an aim to operate demonstration project at 1 million tons/a and above by 2030
- R&D on innovative and cost-effective CO2 utilization technologies shall be enhanced, and initial demonstration can be launched jointly with other integrated systems.

Suggestions on Full Chain Demo



Support Policy and Suggestion

- Strength R&D and demo
  - Funding; coordination; regulatory framework; financing; platform; public acceptance
- Promote policy research for future
  - Policy and Regulatory system; collaborate among sectors; financing mechanism; infrastructure; IPR
- Strength international corporations on science and technology
  - CBDR
  - Technical and financial support from developed countries

Q & A

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Links for downloading CCUS Technology Progress in China report:
http://www.acca21.org.cn/gest/etc/CCUS_en.pdf

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