CO_2 EOR in China:
An Armchair Tour

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Presented at the 26th Annual CO_2 Conference, 2020

Bush Convention Center, Midland, Texas

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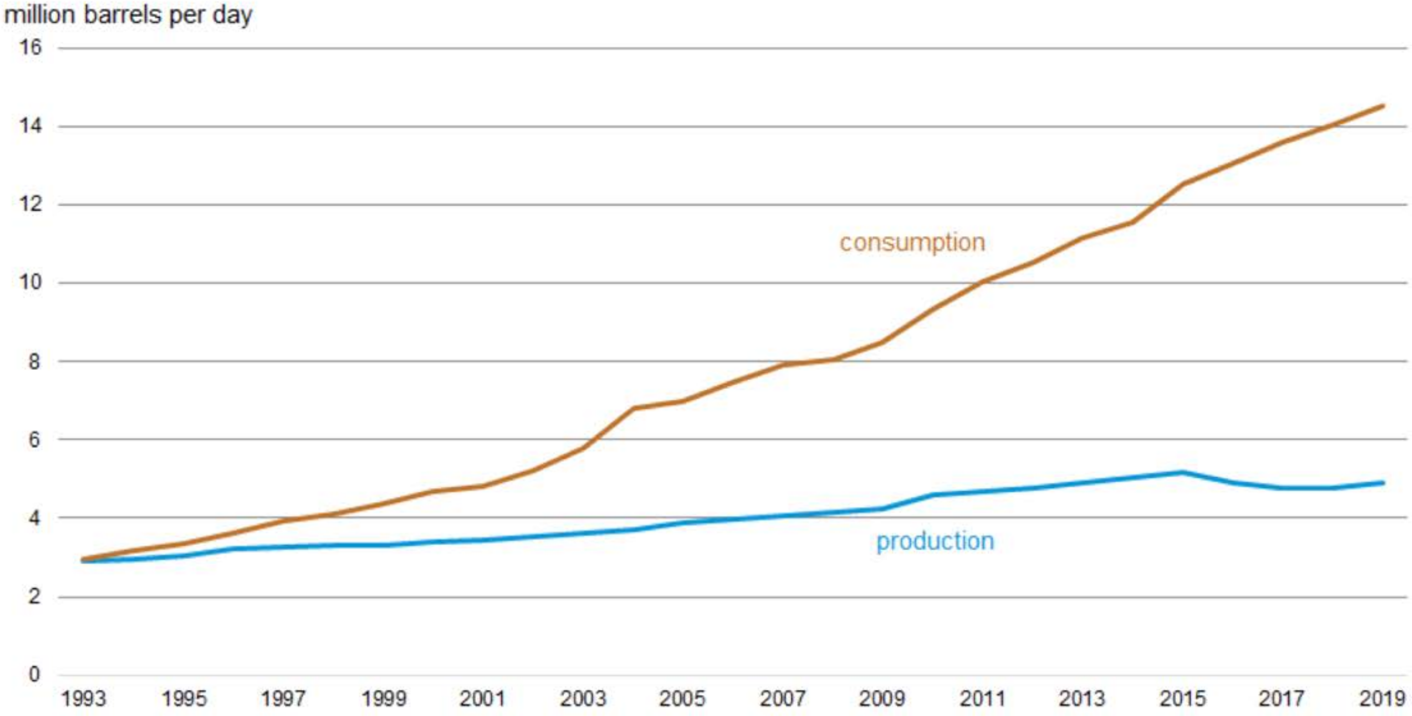
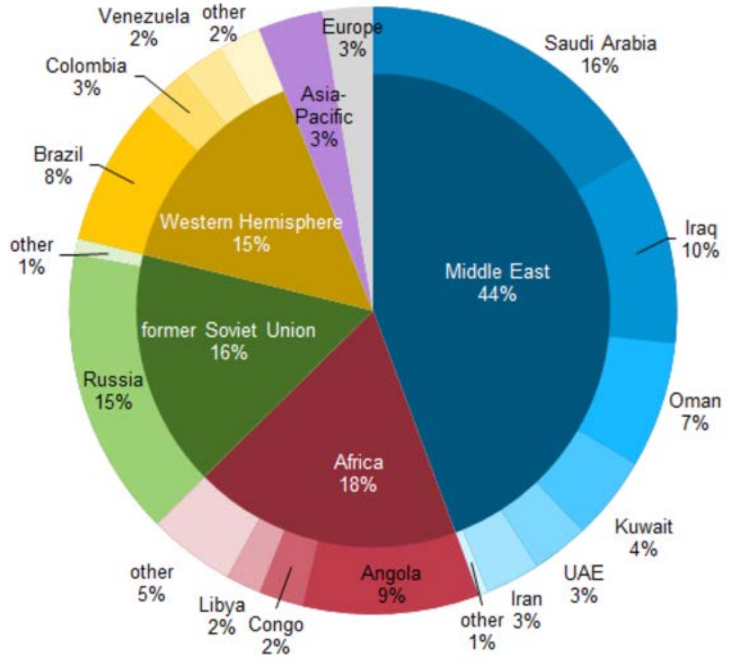
Figure 2. China's petroleum and other liquids production and consumption, 1993-2019



Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, August 2020

Figure 3. China's crude oil imports by source, 2019



Source: FACTS Global Energy Services, *China Oil Monthly*, February 2020
Note: Total may not equal 100% because of independent rounding.

EIA,2020. https://www.eia.gov/international/content/analysis/countries_long/China/china.pdf

China's Consumption–Production Gap and Climate Goals Motivate CO_2 EOR

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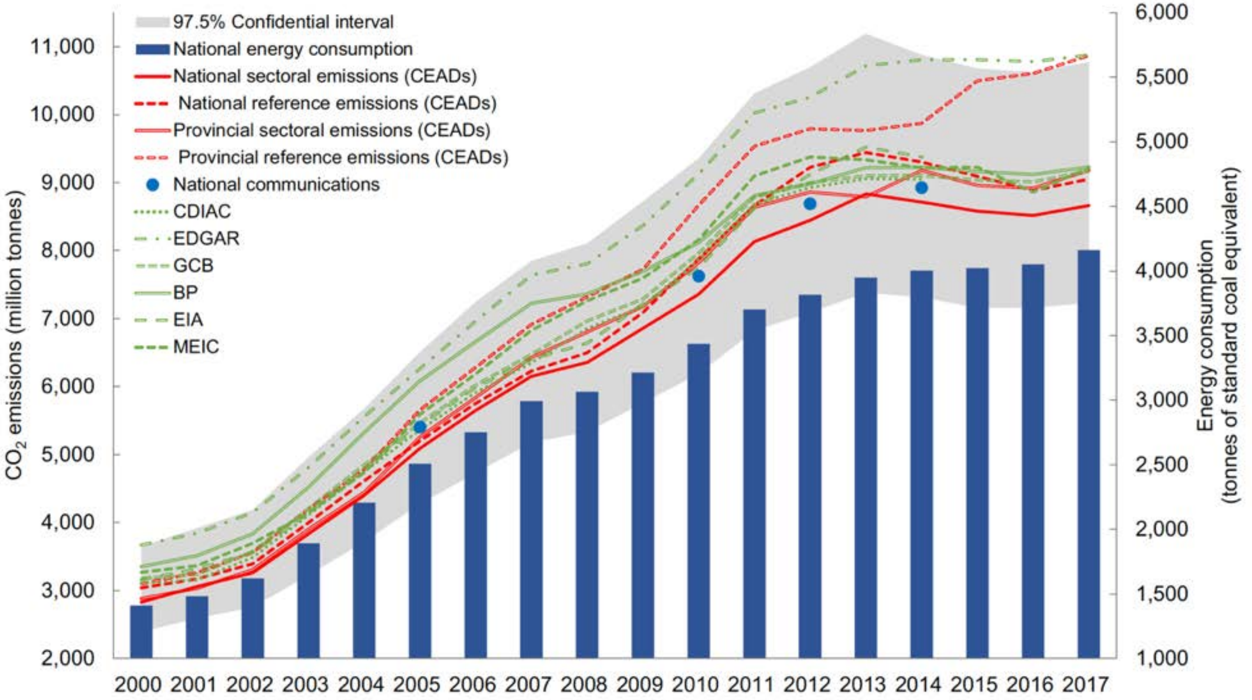
China's Increasing CO_2 Footprint Means CCUS/EOR is a Critical Climate Mitigation Technology



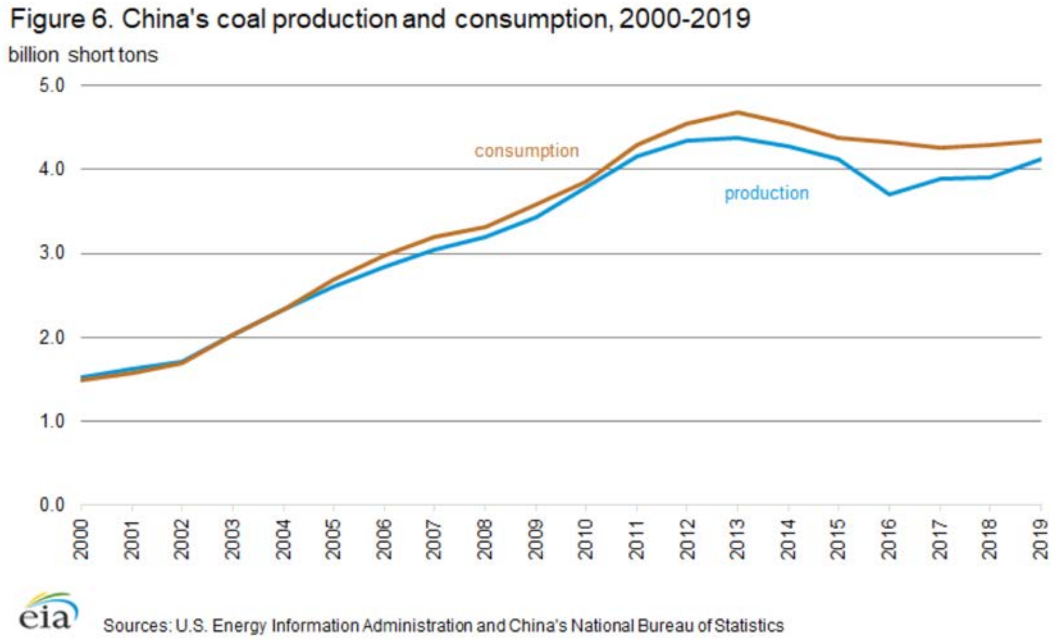
Data Descriptor | Open Access | Published: 13 February 2020

China CO_2 emission accounts 2016–2017

Yuli Shan, Qi Huang, Dabo Guan & Klaus Hubacek

Scientific Data 7, Article number: 54 (2020) | Cite this article

6059 Accesses | 9 Citations | 2 Altmetric | Metrics



Trade

Electric Generation: 6,700 TWhr in 2018. 69% coal (for comparison: 4000 TWh/20% coal in US)

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https://www.nature.com/articles/s41597-020-0393-y

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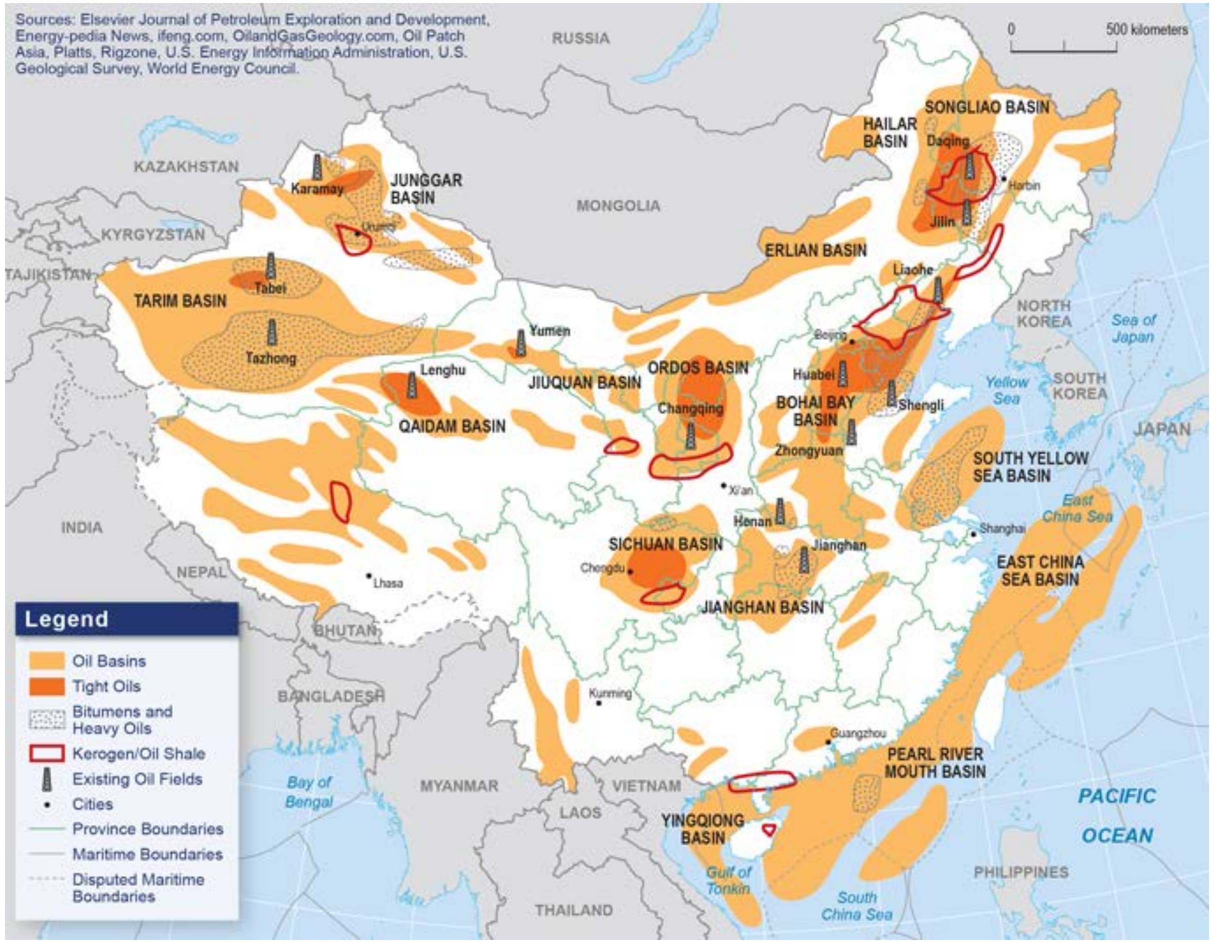
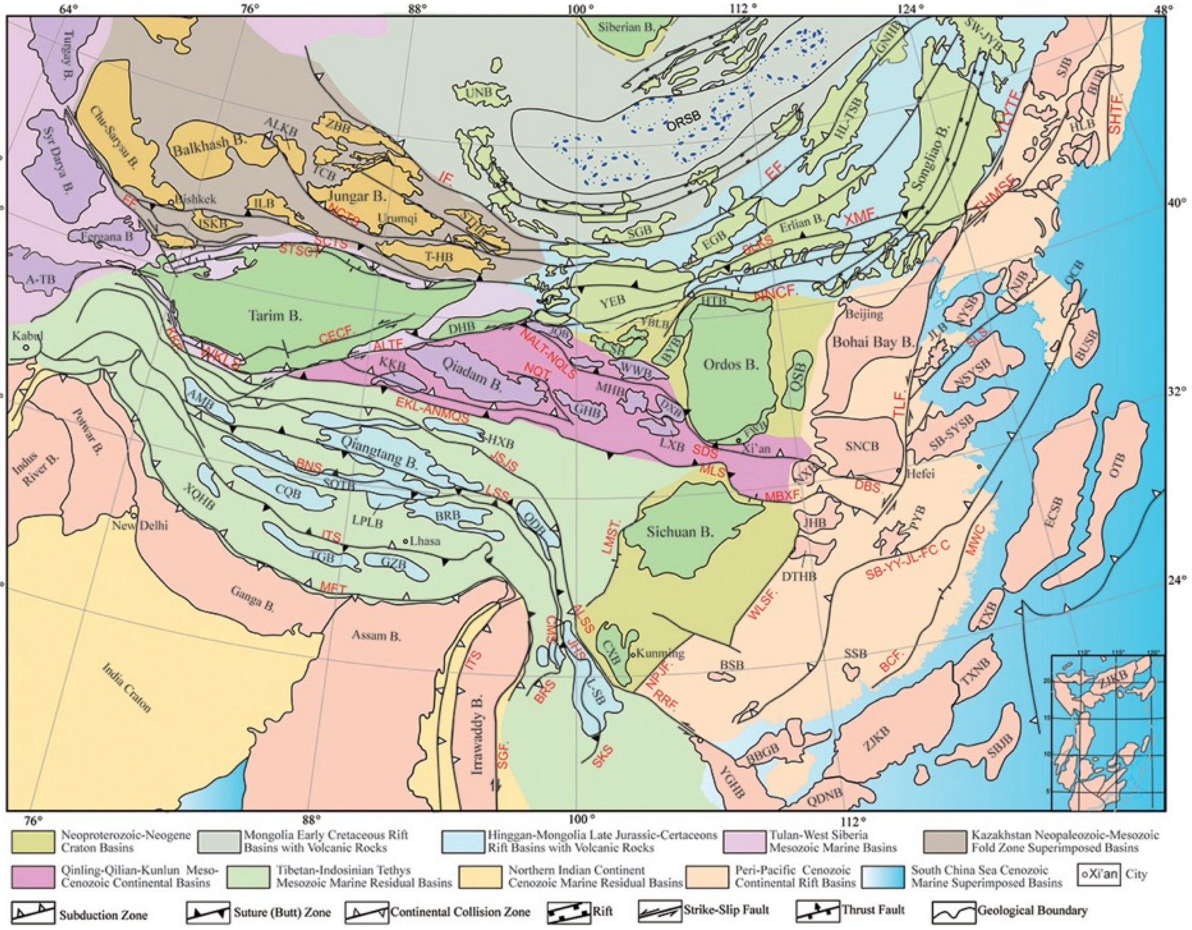
China's Petroleum Basins Are Framed by Complex Continental Geology





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China’s Challenging Petroleum Geology

- Cratonic basins separated by PreCambrian to Holocene tectonic features.
- Continental fluvial, lacustrine facies dominate China’s Sedimentary basins. Much of the petroleum is found in continental Mesozoic – Cenozoic fluvial-deltaic-lacustrine sequences.
- Active tectonics from the Paleozoic up to the present result in indurated tight and fractured formations.
- Permeabilities of 1-10 mD and porosities of <10% not atypical
- Tight, fractured formations, some shallow, difficult to reach miscibility.
- Oil is low API gravity.

What we have learned about China's CO_2 EOR Projects

- No operational supercritical CO_2 pipelines. A few gas phase CO_2 pipelines and liquification facilities.
- No recycle facilities (but there has been some pilot testing)
- Trucked liquid CO_2 from industrial operations and capture facilities limits flooding supply.
- Water is scarce for secondary flooding making CO_2 advantageous.
- A number of projects are economic despite lack of pipelines using trucked CO2 (e.g. Jiyuan, Gao-89, Jilin, Jingbian).
- Target reservoirs are low quality rather than high quality. High CO_2 utilization rates.
- Geologic carbon storage has been claimed for some projects, but storage quantification is not possible without recycle facilities.

Plenty of CO_2 for China's Future EOR Projects

China's is still the world's leading energy consumer and CO_2 emitter, accounting for approximately 30% of global emissions.

https://www.nature.com/articles/s41597-020-0393-y

Petrochemical CO_2
Yanchang Methanol/Acetic Acid
Plant to Jingbian Oilfield

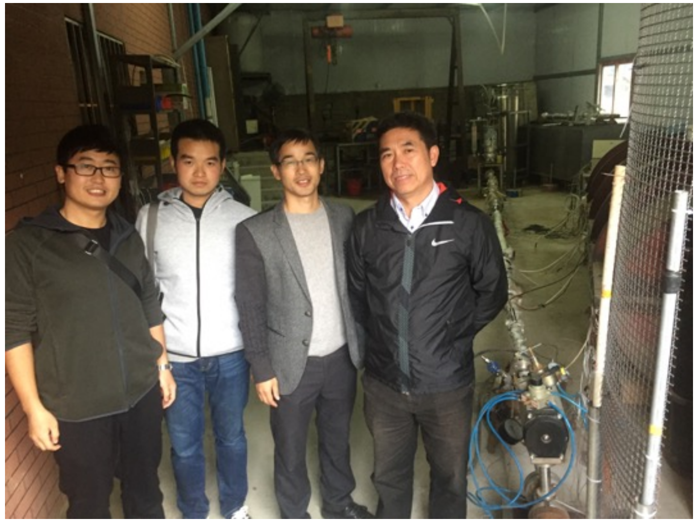
Captured CO_2 from Power Plants.
e.g. Sinopec Shengli Power Plant
25Mtpa CO_2 capture to Gao-89
(future pipeline)

Natural Gas separation
(PetroChina, current Jilin Oilfield)

Lack of confidence in supercritical pipelines

Dalian University of Technology pipeline test site explored accident scenarios.

- International project. Build out of lab scale testing at Dalian University of Technology
- 257 m test pipeline in Anbo, Liaoning Province, NE China.
- Electrical heating wrap boosts pressurized liquid CO_2 to supercritical.
- Accidental release tests in sand and above surface to test plume dispersion.
- Testing crack propagation, decompression waves.



Dalian's Dr. Chen Shaoyun and colleagues.

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Dr. Ning Wei
Institute of Rock and Soils Mechanics
Chinese Academy of Sciences
(audio-only)

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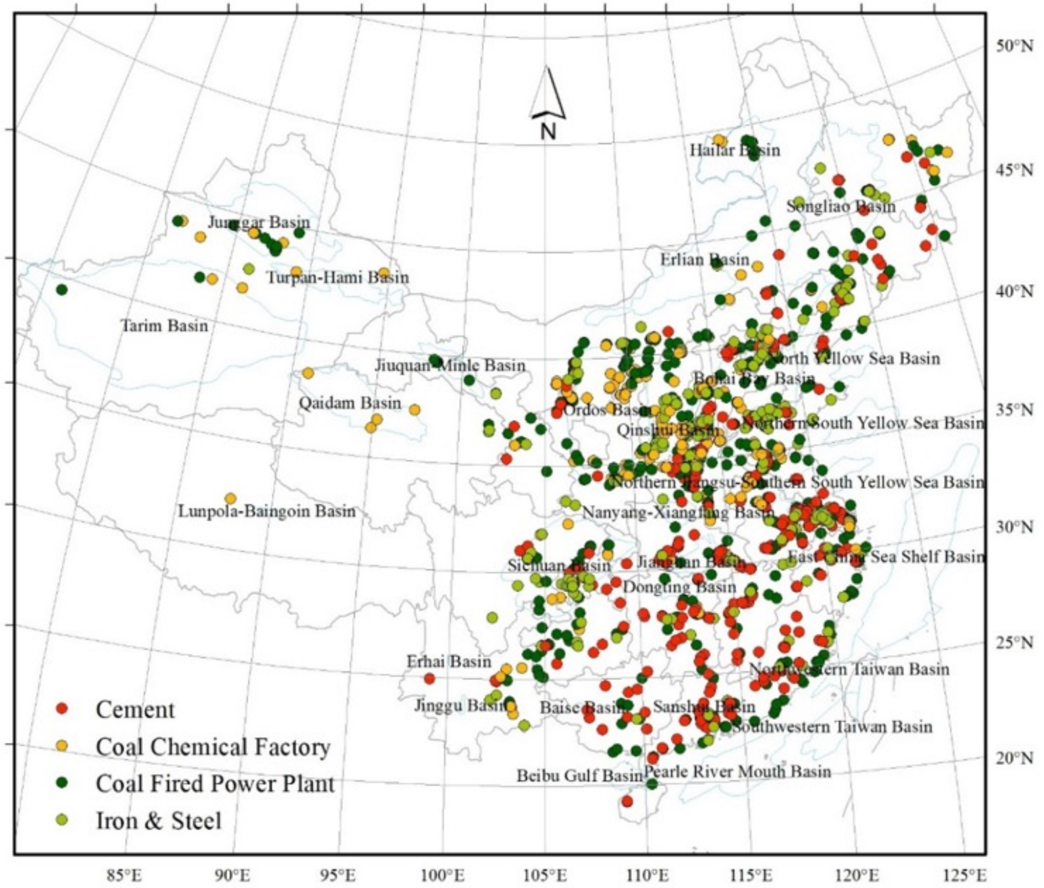
CO_2 Emissions from Major Industries

CO_2 emission from 4 major industries

- About **6.5 Gtpa** CO_2 from the four sectors.
- 4 major industry sectors inventoried: 1769 sources in iron & steel sectors, coal fired power plants, cement in China (data: 2015 and 2012).
- Most locate in North China East China, and coast area with a certain distance to EOR projects.
- High-purity CO_2 streams from coal chemical industries provide potential CO_2 supplies.



Distribution of four major industries in China
Coal fired power plant, Coal conversion (2015), Steel, Cement (2012)

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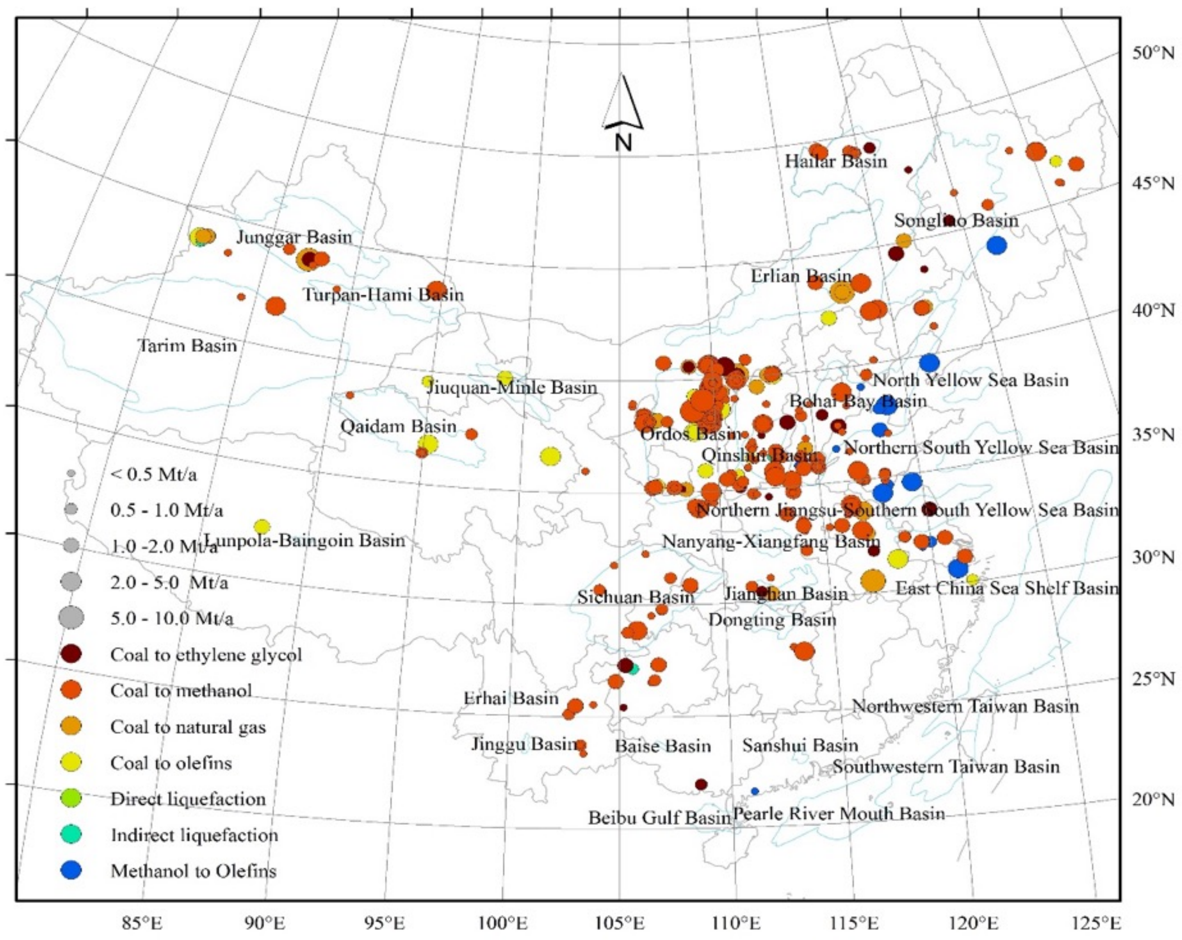
High-Purity CO_2 from Coal-Conversion Industries in China

Distribution of modern coal chemical industries

- 297 coal chemical factories in China (2015)
- Most are in Ordos, Bohai Bay, Songliao and Junggar Basins.
- About **143 Mtpa** high concentration in CCT in 2015 and more high-purity CO_2 emission in 2020.
- The high-purity CO_2 have good proximity with storage sites. This provides low-cost CO_2 at cost less than 20 USD/t (liquid CO_2) for CO_2 utilization.
- However, the CCUS technology is still at R & D stage in China.



Distribution of modern coal-chemical factories in China (2015)

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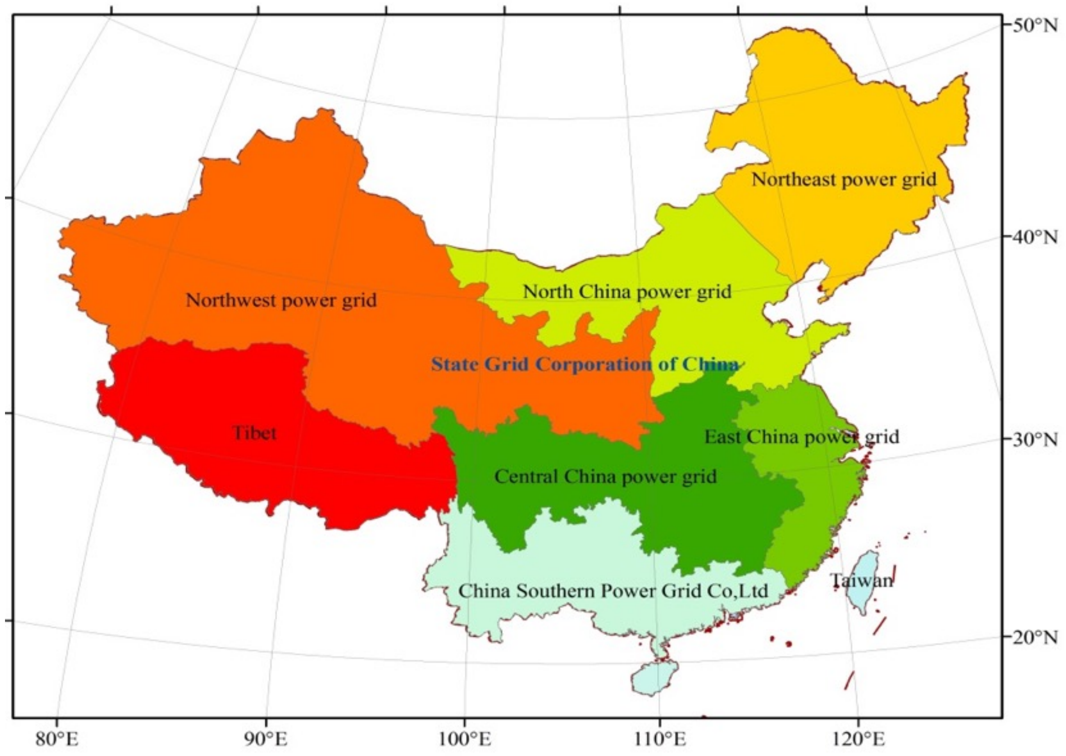
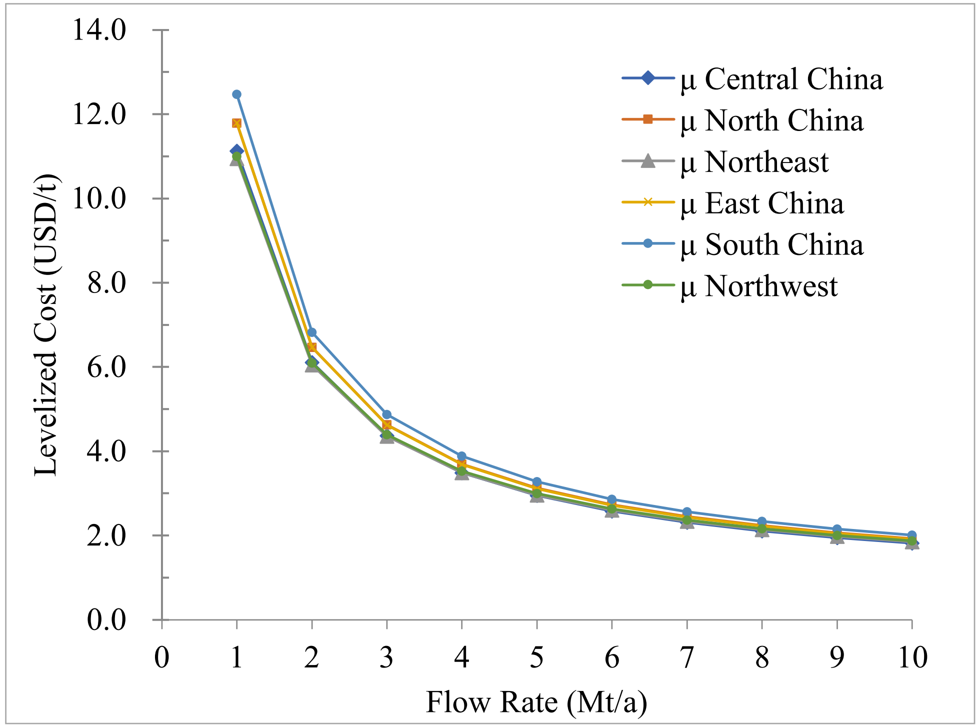
High-Purity CO_2 from Coal-Conversion Industries in China

Cost Evaluation for Sc-CO_2 pipeline



Power grid distribution of China (onshore)

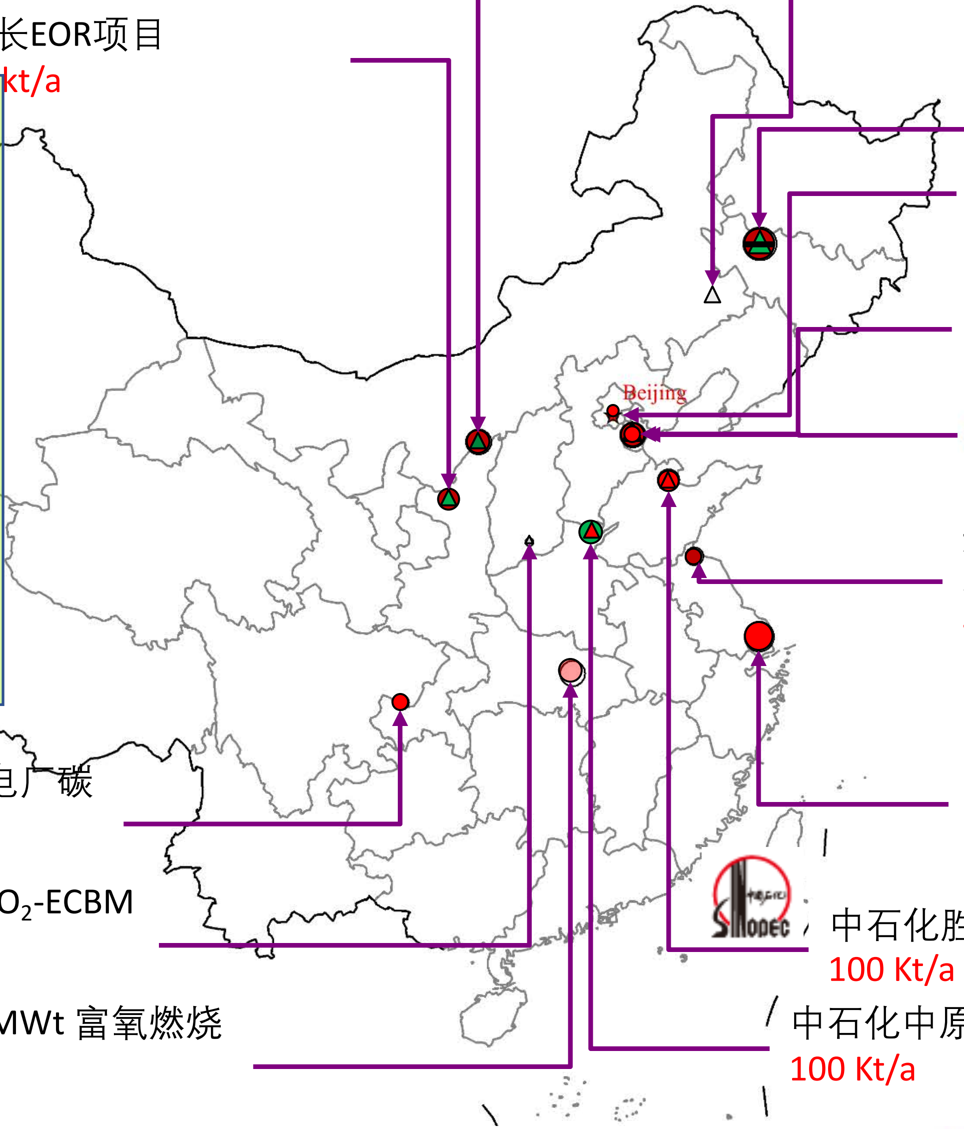


Levelized cost for onshore CO_2 pipeline (100 km)

The levelized cost of SC-CO_2 pipeline transportation is less than that in U.S.

CCUS Projects Underway

- Oxy-fuel: 1 @ 100kt/a
- Post-com: 6 @ 120kt/a
- Pre-com: 2 @ 100kt/a
- Ind Sep: 5 @ 260kt/a
- Pipeline: 2 @ 90km
- DSF: 1 @ 100kt/a
- EOR: 8 @ 260kt/a
- ECBM: 2 @ 1kt/a
- EUL: 1 @ little
- Integrated: 7 @ 260kt/a



神华鄂尔多斯煤制油项目
100 kt/a

延长EOR项目
50 kt/a

中核通辽 EUL项目

中石油吉林油田CO_2-EOR研究与示范
260 Kt/a

中国华能 CHINA HUANENG

华能高碑店电厂
3 Kt/a

华能绿色煤电IGCC电厂捕集利用和封存示范
100 Kt/a

国电集团天津北塘热电厂20 Kt/a

连云港清洁煤能源电力系统研究设施
30 Kt/a

中国华能 CHINA HUANENG

华能石洞口电厂
120 Kt/a

中石化胜利油田EOR项目
100 Kt/a

中石化中原油田EOR项目
100 Kt/a

中电投重庆双槐电厂碳捕集示范项目
10 Kt/a

中联煤层气公司CO_2-ECBM项目
1 Kt/a

华中科技大学 35MWt 富氧燃烧技术研究与示范
100 Kt/a

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Governmental Support for Climate in China Should Include More Support for CCUS

No.	Policy/meeting	Time
1	National key basic research and development plan (973 plan), 11th five-year plan outline	2006
2	China's national climate change plan	2007
3	China's policies and actions on climate change (2011)	2008
4	Decision of the State Council on accelerating the cultivation and development of strategic emerging industries	2010
5	Outline of China's policy on the comprehensive utilization of resources	2011
6	12th five-year plan for scientific and technological development (2011–2015)	2011
7	12th five-year plan for controlling greenhouse gas emissions	2011
8	China's CCUS technology development roadmap	2011
9	National science and technology development plan on climate change during the 12th five-year plan period	2012
10	12th five-year plan for controlling greenhouse gas emissions	2012
11	Industrial action plan on climate change	2012
12	National 12th five-year plan for the development of CCUS technology	2013
13	Medium- and long-term plan for national major scientific and technological infrastructure construction (2012–2030)	2013
14	Guide catalog for key products and services of strategic emerging industries	2013
15	Notice about promoting carbon capture, utilization, and storage experiment, and demonstration	2013
16	Notice on environmental protection work of strengthening carbon capture, utilization, and storage experiment and demonstration projects	2013
17	National climate change program (2014–2020)	2014
18	Opinions of the National Energy Administration, the Ministry of Environmental Protection, and the Ministry of Industry and Information Technology on promoting the safety, green development, and clean and efficient use of coal	2014
19	China–US Joint Announcement on Climate Change	2014
20	Measures for assessing the responsibility for reducing carbon dioxide emissions per unit of GDP	2014
21	Action plan for energy conservation, emission reduction, and low-carbon development in 2014–2015	2014
22	CCUS roadmap (ADB)	2015
23	Action plan of the efficient utilization of clean coal (2015–2020)	2015
24	Second national key promotion directory of low-carbon technologies	2015
25	Pollution control technology policy of the synthetic ammonia industry	2015
26	Control scheme for greenhouse gas emissions	2016
27	13th five-year plan for national science and technology innovation	2016
28	Technical guidelines for the environmental risk assessment of CCUS (trial)	2016
29	Action plan for energy technology revolution and innovation (2016–2030)	2016
30	13th five-year plan for science and technology innovation on climate change	2017
31	Catalog of national key energy-saving and low-carbon technologies	2017
32	ADB memorandum of understanding on supporting China's large-scale carbon capture and storage demonstration technology assistance program	2017
33	Flue gas CO_2 capture and purification engineering design standards	2018
34	Technical roadmap of CCUS in China	2019

Lots of supportive policies, but none for commercialization of CCS and CO_2-EOR

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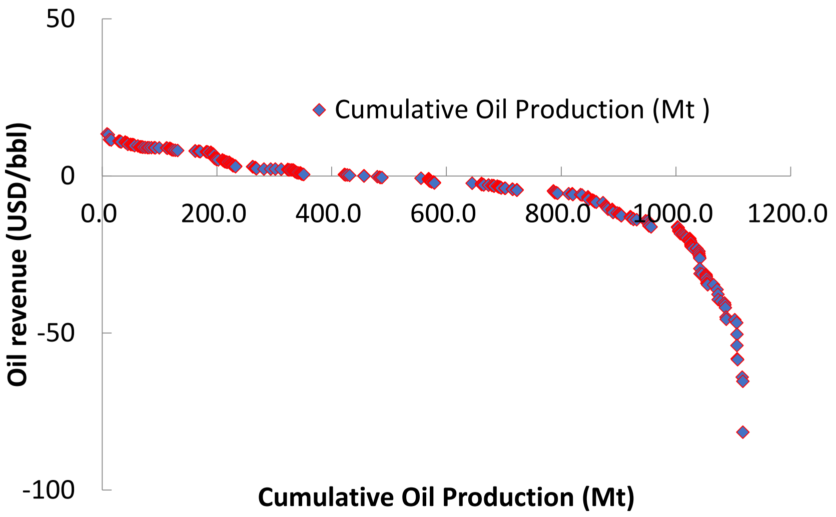
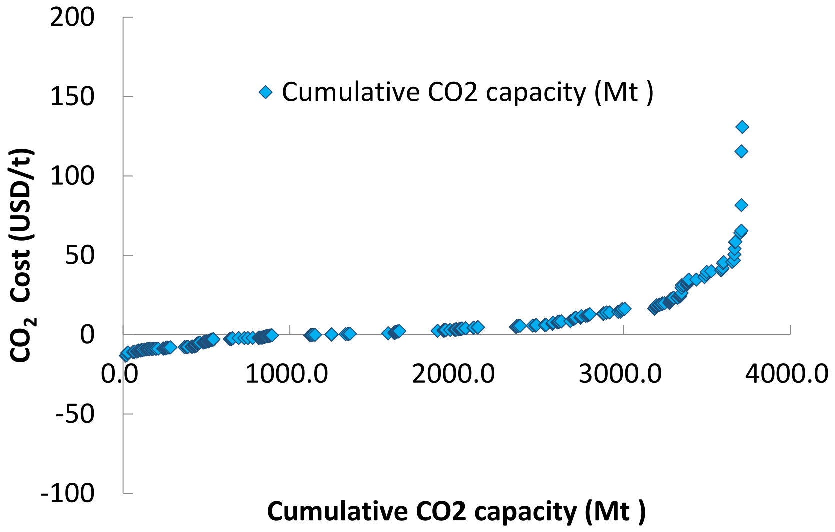
Economics of CO_2-EOR / Cost Curves, China (Wei, CAS)

(Model based on $40 /bbl oil price and $50/tonne CO_2).





LEFT: CO_2 EOR can produce ~500 MM tpa oil profitably without any incentive policies
RIGHT: With increasing CO_2 utilization, cost becomes a barrier.

Non-technical barriers to CO_2-EOR in China:

1) Perception: fossil is a dying industry (& renewables can replace) and fossil power can’t be carbon neutral;
2) Lack of incentives and high tax on EOR oil;
3) Lack of enabling regulation and legislation;
4) Public acceptance of CO_2 geological storage.

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[Note: ~6 bbls per tonne of oil]

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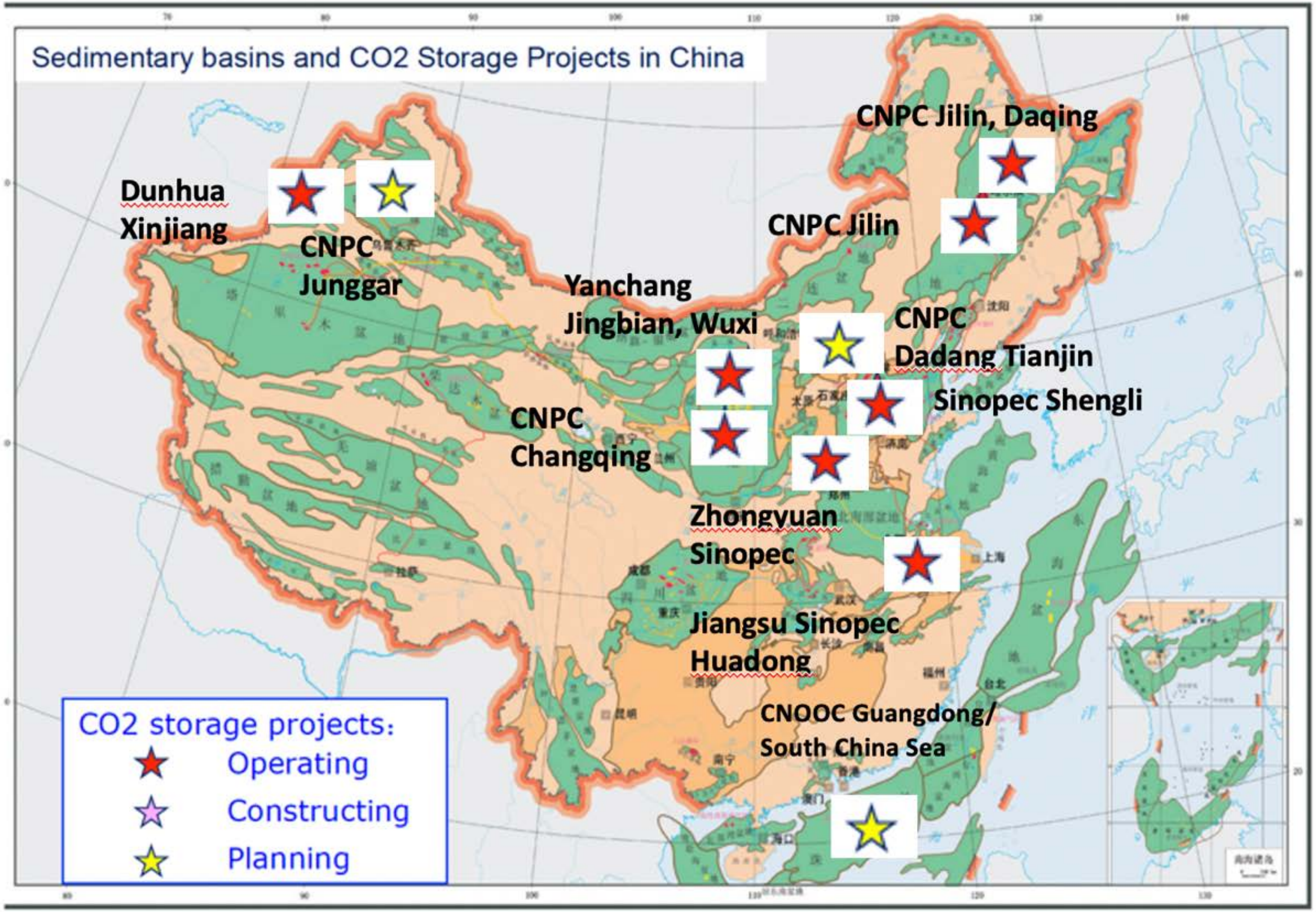
Supportive CCUS Policies in China

A strategy for CCUS commercialization in China is necessary to bridge the “ valley of death” between R & D and economic commercialization of CO_2-EOR projects

Including:

- Public perception:
  - Fossil power can be as carbon neutral as renewables if retrofitted with CCUS technology.
  - Geologic storage is safe and permanent
- Incentives, tax exemption, and financial support are needed to make CO_2-EOR operations profitable. for example, 45Q in the U.S. (China’s carbon market is not accessible for EOR projects in China).
- Legislation and regulatory supporting CO_2-EOR and other CCUS technologies.
- National plan of commercialization to spur the large-scale deployment of CO_2-EOR and CO_2 storage projects in China. E.g. a national plan with price incentives, priority for fossil/CCUS power on grid, legislation and regulation support, public acceptance, RD&D funding, environmental policies.

China's CO_2 EOR Projects



Modified after Prof. Zhou Di (2016)

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Sinopec

Table 2

EOR field data summary, Sinopec. (Shen and Dou, 2016; Guo et al., 2018; Jiang, 2019; Li and Lu, 2002, Zhang and Wang (2010)).

Province	Oil Field Production Block	CO_2 Source/Injected to 2016	Geologic Description	Miscibility	Injection depth (m)	Porosity (%)	Permeability (mD)	Injectors/ Producers	References
Shandong	Shengli Gao-89	Trucked liquid and pipelined naturally-sourced gas/ liquidified CO_2 from DongYing power station and QiLu CTX area/240,000	Fluvial sandstone	Miscible	2950 (2800~3200)	13 %	0.1–24 (5) mD	5/15	Dou et al (2016); Guo et al (2018); Jiang (2019); Ma et al. (2018).
Henan	Zhongyuan	Trucked from Sinopec Zhongyuan Oilfield Company Petrochemical Plant where 20,000 tpa installed in 2016*	Fluvial sandstone	miscible	3800–4400	18–28%	123–690 mD	22/38	Dou et al (2016); Guo et al (2018); Jiang, (2019) ; u et al (2016a)
Jiangsu	CaoShe Fu-14	Barge and truck, Natural and captured industrial/ conflicting data	Fluvial sandstone	Miscible	[2090] & 2800–3250	16–23%	[854] 24–114 mD (241)	4/2	Guo et al (2018); Shen and Dou. (2016); Zhang and Wang (2010).
Jiangsu	Huadong YYT JL	Naturally sourced from Huang Qiao CO_2 gas field/no data	Fluvial sandstone	Miscible	2300	12%	5–10 mD	43/117	Shen, P., Dou, H. (2016). Fan Zhenning (2017)

Sinopec Shengli Gaoqing-89 Project, Bohai Basin

Basin	Bohai
Field/block	Gaoqing 89
Geology	Fluvial Sandstone
Age	Cretaceous
Depth	3000 m.
Year Start EOR	2008
Permeability k	5 mD
Porosity ϕ	13%
Injectors	11
Producers	14 (5 spot)
CO2 source	Natural and industrial capture trucked. Pilot recycle?
CO2 volume	260,000T (2019)
MMP	28 MPa
Formation P	30 MPa miscible
Future	2 Pipelines, gas, supercritical

- Pipeline with natural gas-phase CO_2 (99% purity) & trucked captured CO2 from Qi Lu.
- Short gas phase pipeline to liquefaction plant
- 14 production wells, 5 injectors
- 5-Spot patterns
- 120 TPD gas phase pipeline-natural CO2

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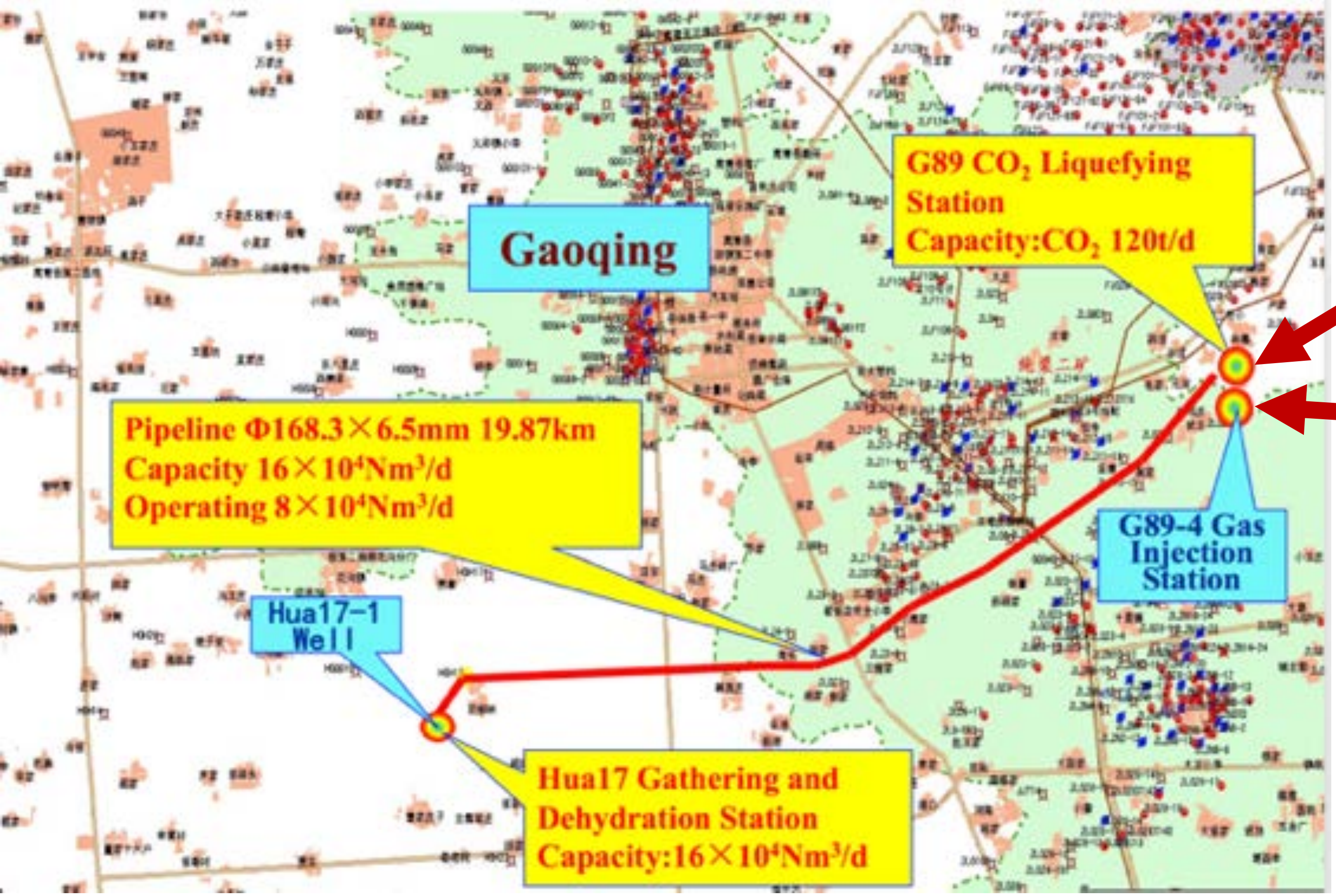
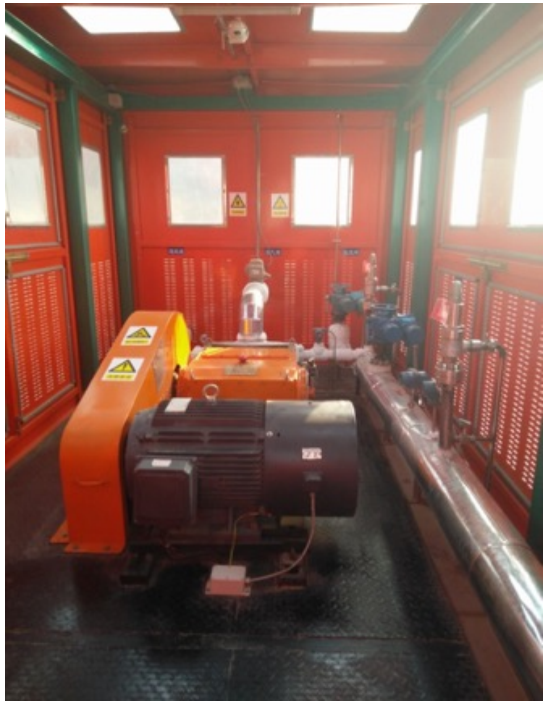
Sinopec Shengli Zhenglizhuang Oil Field Gaoqing 89 Block



Injection Station Skid with Liquid CO_2 Tank and Pump on Well Pad at Gaoqing.



Injection P
20-32 MPA
(200-320 bars)

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Photos: Sinopec

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Sinopec Shengli Power Plant Capture

- 50,000 TPA MEA capture pilot.
- Planned Expansion to 1Mt
- 80 km Supercritical Pipeline to Gaoqing Block for EOR
- Unit 3 Capture Ready.

Shengli Capture

Commercial Scale Capture ready.

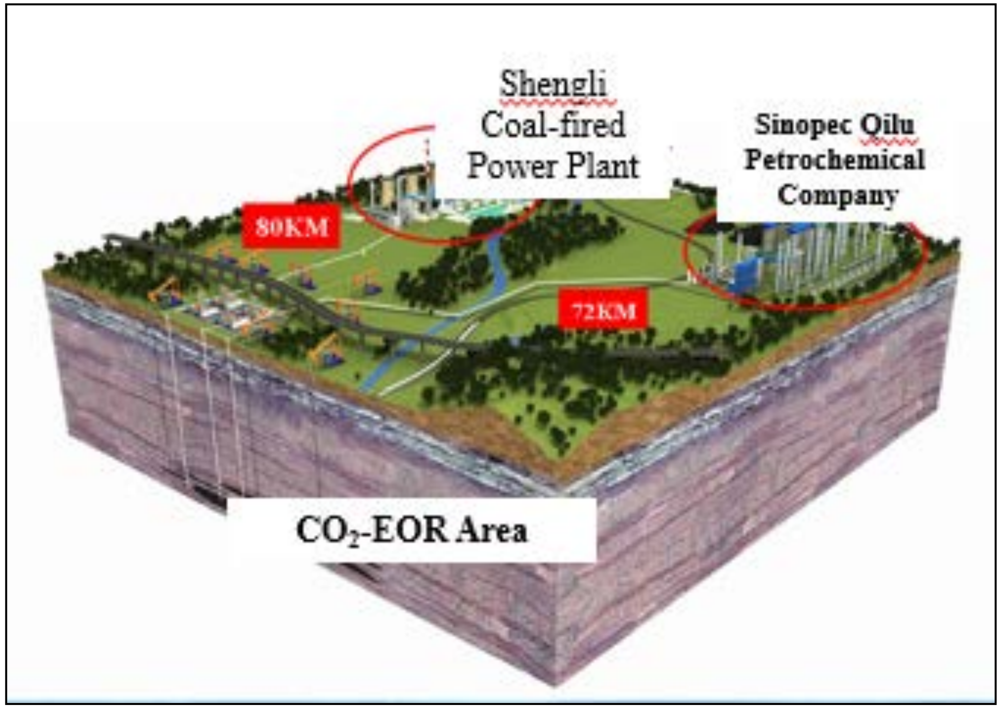

Illustration: Sinopec

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Shaanxi Yanchang Petroleum Co.

Table 3
EOR field data summary, Shaanxi Yanchang Petroleum Company. Data Sources: Yanchang, (2015); Shen, P., Dou, H. (2016); Li, G., Lu, M., (2002), Gao, R. (2016a), Gao, R. (2016b) [16, 21, 30-31].

Province	Oil Field Production Block	CO_2 Source/Injected to 2016	Geologic Description	Miscibility	Injection depth (m)	Porosity (%)	Permeability (mD)	Injectors/ Producers	References
Shaanxi	Jingbian Qiaojiawan	Yulin Coal to chemical (methanol) Industrial CO_2) trucked from Yulin City to Jingbian oil field./ 60,000 t	Detrital river delta-lake sandstone	immiscible / near miscible	600–1900 (1600)	8–14% (12)	1–10 mD (1)	5 (16)/20	Yanchang, (2015); Shen and Dou, (2016). Gao, (2016a; Gao 2016b); Ma et. al. (2017)
Shaanxi	Wuqi	Yulin Coal to chemical (methanol) Industrial CO_2 trucked from Yulin City to Wuqi oil field./ 8125	Detrital river delta-lake sandstone	immiscible	1120–1420	17 %	91–475	4 injectors starting 2014; planned: 37/ 110	Yanchang, (2015); Gao (2016a),b)

- Fluvial- deltaic sandstone facies.
- Industrial CO_2 from methanol plant.
- Immiscible; Porosity 8-17%; Permeability: 1 mD to 475 mD

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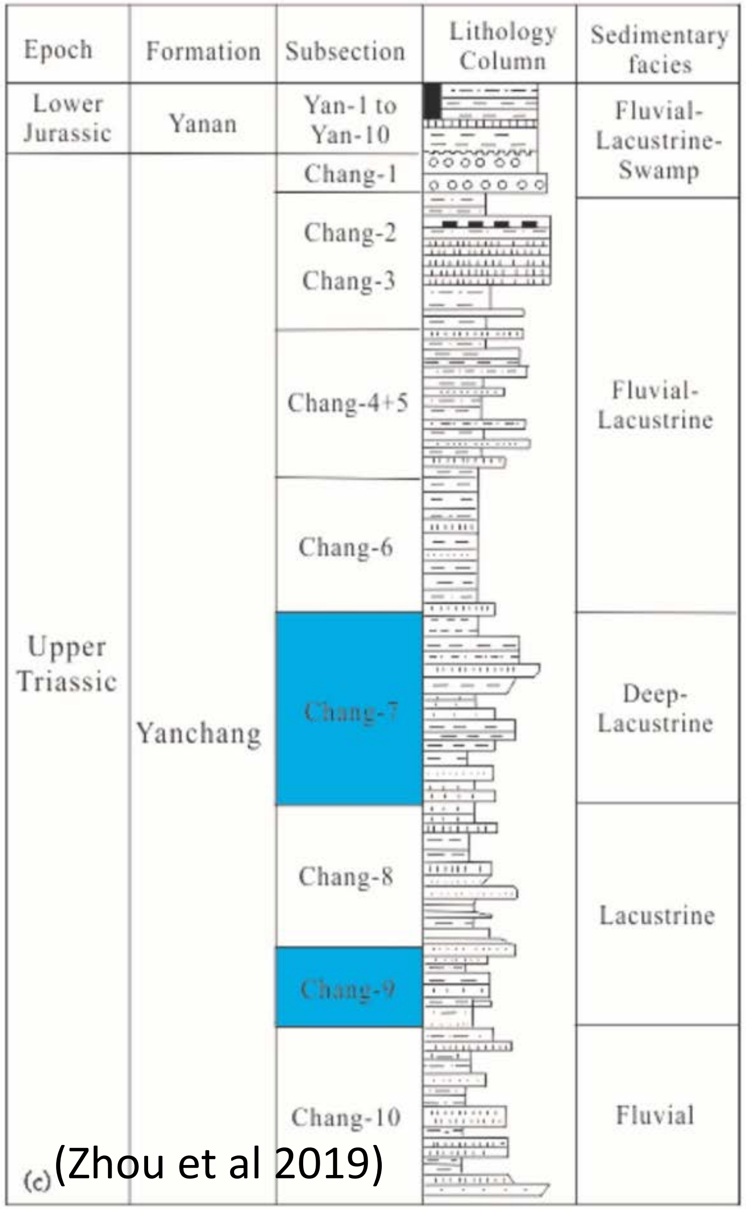
Shaanxi Yanchang Jingbian Project

Yulin-Jingbian Full Chain CCUS.

Basin	Ordos
Field/block	Jingbian
Geology	Yanchang Fm. Chang-6 tight channeled sandstone
Age	Late Triassic
Depth	1600 m.
Year Start EOR	2012
Permeability k	1 – 12 mD
Porosity ϕ	8-14%
Injectors	20
Producers	68
CO2 source	Industrial capture, trucked
CO2 volume	50,000 TPa; 720,000 total
MMP	
Formation P	13 Mpa immiscible/near miscible
Future	Pipeline Yulin to Jingbian, Wuxi

- Yanchang Yulin CTX Plant, acetic acid production source of CO_2
- 50,000 TPA CO_2 capture.
- Liquid CO_2 trucked 3x /day 80 km to Jingbian Oilfield.
- Phase 2 360,000 TPA planned.



(Zhou et al 2019)

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CO_2: Shaanxi Yanchang (YPC) Ordos Basin Methanol Plant

- Potential to be China's first full-chain CCUS.
- Pre-FEED pipeline planned Yulin to Jingbian and Wuxi fields by Sinopec Engineering.
- US-China "Presidential Project" under Presidents Obama and Xi in 2015.
- Scarce water. CO2 utilization will reduce stress on water resources.
- YPC Experimenting with CO2 fracs & horizontal drilling

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PetroChina

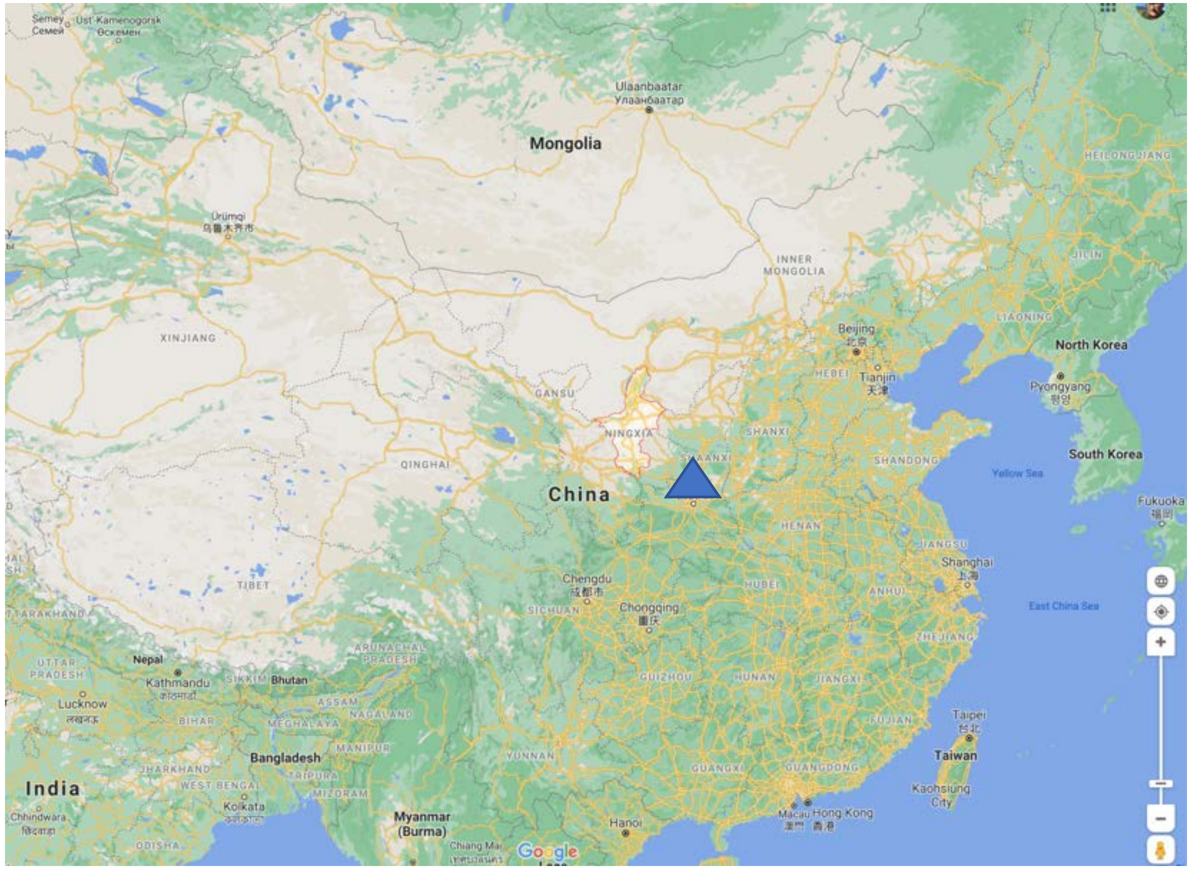
Table 1

EOR field data summary, CNPC (PetroChina). (Shen and Dou, (2016); Guo et al (2018), Ren et. al. (2016); Peng (2010); CNPC (2014b), 2018; Chi et al. (2013); Cheng et al. (2017); Cheng (2018); Li and Lu (2002); Zhang et al. (2018); Rungan (2018), Wang et al. (2014).

Province	Oil Field Production Block	CO_2 Source/ Injected tonnes to 2016	Geologic Description	Miscibility	Injection depth (m)	Porosity (%)	Permeability (mD)	Injectors/ Producers	References
Jilin	Block 228	Liquified natural gas separation, Changshen gas field/no data	no data	immiscible	1500	12%	<1mD	1/no data	Shen and Dou (2016)
Jilin	H 87–2	Liquified natural gas separation, Changshen gas field/no data	no data	immiscible	2300	10 %	<1 mD	1/no data	Shen and Dou (2016)
Jilin	Jilin HEI-59	Liquified CO_2 natural gas separation, Changshen gas field/ 341,000	Tight fluvial sandstone	immiscible	2445	11%	3mD	5 or 6/24	Zhang et al (2015); Shen and Dou (2016); Ren et al (2016). Peng (2010); CNPC (2018).
Jilin	H-79N	Liquified natural gas separation/ Changshen gas field/no data	Sandstone Q1	immiscible	2400–2450	12–16	5–10 mD	18/63	Shen and Dou (2016); Zhang et. al. (2018); Guo et al (2018).
Jilin	H-79B	Liquified natural gas separation/ Changshen gas field/no data	Sandstone Q1	immiscible?	2450	13	5 mD	10/19	Shen and Dou (2016); Zhang et. al. (2018); Gou et.al. (2018).
Heilongjiang	Daqing B-14	liquid industrial CO_2 trucked/no data	Tight fluvial sandstone	immiscible	1730	14	1mD	10/no data	Shen and Dou (2016)
Heilongjiang	Daqing Fang-48 pilot block/ Fuyu reservoir	liquid industrial CO_2 trucked/no data	Sandstone	immiscible	1880 (2003) /1742 (2007)	15	1 mD	1 (2003) 15 (2007)/5	Chi et al. (2013); Guo et al. (2018)
Heilongjiang	Daqing S101	liquid industrial CO_2 trucked/ no data	Sandstone F1	immiscible	2120	11	1	8/no data	Shen and Dou (2016)
Shaanxi	Changqing/ Jiyuan Block	liquid industrial CO_2 trucked/ 376,000 tonnes	Tight fluvial sandstone and delta fan	miscible	1000–1350. 2750 m	7%	50–254	Sep-37	Cheng et al (2017); Cheng (2018); Rungan (2018); CNPC, 2014b., Wang et al (2014).

PetroChina Jiyuan Block, Shaanxi, Ordos Basin

Basin	Ordos
Field/block	Jiyuan Oilfield, Huang 3
Geology	Sandstone of Majiagou Fm., highly fractured
Age	Triassic
Depth	1100 m.
Year Start EOR	2000s
Permeability k	10 mD
Porosity ϕ	7%
Injectors	9
Producers	36 (?) 9- spot patterns
CO2 source	Industrial CO2
CO2 volume	50,000 tpa; total 370,000 t
MMP	19.8 MPa, miscible, near miscible
Formation P	19.7 MPa
Future	1 Mt Ningdong pipeline. CNPC modeling suggests 5 pipelines could serve 80% Ordos wells.



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PetroChina Jiyuan Block, Shaanxi

Changqing Oilfield, Shaanxi/Ningxia border, Ordos Basin

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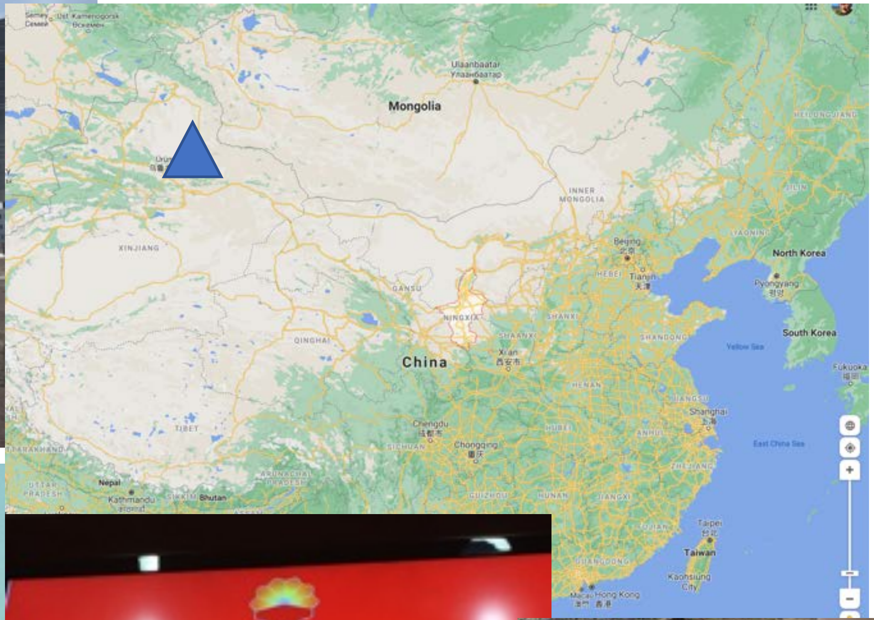
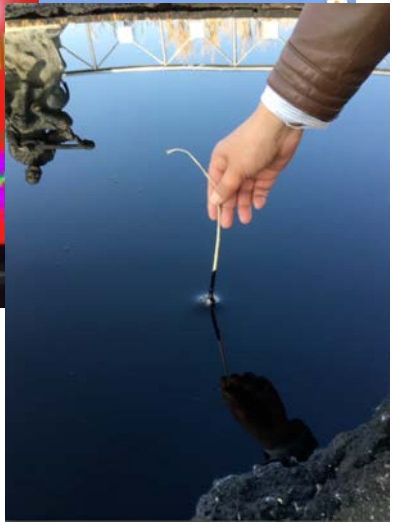
PetroChina CO_2 Hub in Xinjiang Autonomous Region, Western China?





- China’s major growth region in oil, coal, CTX development
- Half of Chinas 50+ proposed CTG plants in Xinjiang
- Multiple high volume concentrated coal-based sources in region: CTX, cement plants, fertilizers, power
- Pilot CO2 tests in Junggar Zhundong, Karamay Oilfields
- Water-limited region.

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In Summary

- China has a long history of CO_2 for enhanced oil recovery. China's oil fields are in decline. As a result, China is prioritizing CCUS (CO_2 EOR) over saline storage.
- China's petroleum geology is dominated by tight continental sands and has proved more challenging than in U.S. marine basins.
- Recycle facilities and supercritical pipelines can help provide greater volumes of CO_2 to flood these tight depleted reservoirs.
- Meeting China's 2060 carbon neutrality goal will require reducing CO_2 from China's power plants, coal to chemical and petrochemical plants.
- There can be a profitable marriage between pure sources of CO_2 and nearby oilfields where CO_2 could be utilized to increase oil production while reducing carbon emissions.
- A commercialization strategy is necessary to move CO_2-EOR forward including enabling legislation and regulations, supplemented by incentives. We aim to help that process along by knowledge sharing and building partnerships.

谢谢！ Thank You!

So many people made this possible. Many thanks to all China friends who helped with travel, logistics, translation and our hosts made this possible including Dr Li, ISRM; Ming Sung, CATF China Advisor; PetroChina; Sinopec; Shaanxi Yanchang Petroleum; Ms Chen Min.

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International Journal of Greenhouse Gas Control 103 (2020) 103173

Contents lists available at ScienceDirect

International Journal of Greenhouse Gas Control

journal homepage: www.elsevier.com/locate/ijggc

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CO_2-EOR in China: A comparative review

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ARTICLE INFO

Keywords:
Carbon dioxide
Enhanced oil recovery (EOR)
China
United States
CCUS
Capture
Storage
CO_2 flooding
Monitoring

ABSTRACT

Given China's economic dependence on coal for energy and industry, carbon capture, utilization and storage (CCUS) technology is a critical decarbonization strategy. Carbon dioxide (CO_2) enhanced oil recovery (EOR) is critical to success of CCUS in China, providing the industrial know-how for long-term carbon storage. Carbon dioxide flooding in both China and the United States began in the 1960s. While the United States produces about 300,000 barrels of EOR oil per day, China's EOR efforts still face significant hurdles. This paper presents a compilation and brief review of CO_2-EOR data, some of it previously unpublished, from the three major Chinese oil companies (China National Petroleum Corporation, Sinopec, and Yanchang Petroleum Company) and one private company (Dunhua) that presently maintain pilot CO_2-EOR floods. The authors have visited several of the projects discussed in the paper and some observations from these visits are included. China's EOR projects generally produce from deep, tight, largely continental clastic reservoirs requiring hydraulic fracturing to create flow paths. There are no separation and recycle facilities—necessary to contain CO_2 in the system– and there are presently no supercritical pipelines for CO_2 supply. Several CO_2-EOR projects have established monitoring and storage pilot projects but the absence of recycle means determination of net storage is not possible. China's projects could benefit from improved reservoir selection, new CO_2 monitoring tools and operating strategies, expanded front-end investments in CO_2 infrastructure such as pipelines and modern surface separation and recycling facilities that will serve to reutilize and store CO_2.

1. Introduction

Carbon capture, utilization and storage (CCUS) could be an important carbon mitigation tool toward meeting China's decarbonization goals; China's 13th 5-year plan sets out a goal of reducing CO_2 emissions per unit of GDP by 18 % by 2020 against a 2015 baseline. China, with the world's largest CO_2 emissions, rich coal reserves and waning oil production, has undertaken an effort to develop CO_2-EOR utilization methods in its oilfields to both decrease carbon emissions while increasing oil production. Since its 11th Five Year Plan China has invested approximately 3 billion Chinese Yuan (CNY) (approximately one half billion U.S. dollars) in CCUS development, including 14 pilot capture and storage projects. In addition, China has committed to decrease its carbon intensity by 60–65 % of 2005 levels by 2030 (Asia Development Bank, 2017). This paper attempts to fill a gap in available CO_2-EOR data published in English-based scientific publications by providing an overview of known CO_2 flooding projects in China. We briefly compare the current status of CO_2-EOR with selected projects in the U.S., and make recommendations toward advancement of CO_2-EOR storage in China. We have collected information from a wide variety of sources including publications only available in Chinese language, workshops and conferences, and from site visits by the authors, generously hosted by several oilfield production companies (Yanchang Jingbian, CNPC Junggar, Sinopec Shengli, CNPC Jiyuan) between 2014 and 2018. This is the first English language review of CO_2-EOR projects across China we are aware of and presents information that may be helpful in understanding the potential for CO_2-EOR to play a role in emissions mitigation in China.

China's coal-fired power and coal-based industrial petrochemicals sectors continue to expand, with attendant increases in carbon dioxide (CO_2) emissions. Modern CO_2-EOR processes can play a role in mitigating these emissions, providing a net reduction in carbon emissions from captured sources while improving hydrocarbon production and revitalizing depleted oilfields (IEA, 2015). With CO_2-EOR, emissions from these sources can be reduced, while producing oil that has a lower carbon intensity/footprint than average (Cooney et al., 2015).

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https://doi.org/10.1016/j.ijggc.2020.103173
Received 7 February 2020; Received in revised form 13 August 2020; Accepted 18 September 2020
Available online 1 November 2020

November 2020 International Journal of Greenhouse Gas Control

2020 CO_2 Conference December 8-10