



IEA-MOST Workshp: Advances in deployment of fossil fuel technologies

# Insight on the development of CCS-EOR in China

Dr. Qin Jishu

RIPED, CNPC

State Key Laboratory of EOR

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# Content

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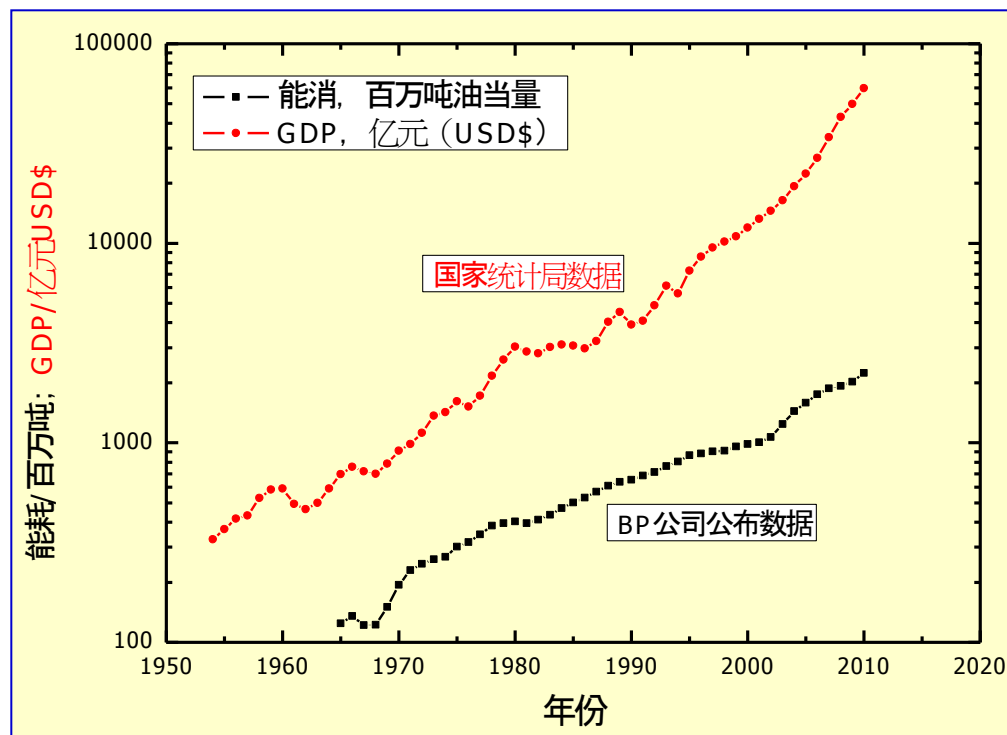
1. The energy structure & commercial development in China
2. The low-carbon, green, sustainable technology of CCS-EOR
3. The critical development on CCS-EOR in CNPC
4. The insight of CCS-EOR
5. The suggestions on industrious construction of CCS-EOR



# 1. The energy structure & commercial development in China

(1) The requirements of energy is soaring due to the commercial development in China

It was a historical issue that the industry was developed at the cost of high rate of energy consumption in China, which led to a rapid increase of the energy requirement. (UNCTAD, 2013)



The curves of GDP & energy consumption in China  
(Data sources: National Bureau of Statistics of China, BP Co., Ltd)



# 1. The energy structure & commercial development in China

(2) The coal plays a key role in energy structure in

It is hard to change the energy structure in short period in China

The energy structures of China, World & America in 2012

Category	America		China		world	
	10 <sup>8</sup> Ton/oil equivalent	%	10 <sup>8</sup> Ton/oil equivalent	%	10 <sup>8</sup> Ton/oil equivalent	%
Fossil	8.50	37.19	4.29	17.62	40.28	33.56
Nature gas	6.21	27.17	0.98	4.03	28.58	23.81
Coal	5.25	22.95	17.14	70.45	35.56	29.63
Nuclear energy	1.92	8.41	0.17	0.69	6.26	5.22
Hydroelectric power	0.59	2.57	1.63	6.71	7.76	6.46
Renewable energy	0.39	1.71	0.12	0.50	1.59	1.32
Total	22.86	100.0	24.32	100.0	120.024	100.0

(Data source: BP.,2013)



# 1. The energy structure & commercial development in China

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## **(3) China government has focused on the issues of carbon emission & climatic change**

- ✓ Negotiated UNFCCC in 1990 then endorsed the convention in 1992
- ✓ Set up the Committee of National Climate Change in 1998
- ✓ Submitted The People's Republic of China Initial National Communication on Climate Change in 2004
- ✓ Published the reports on National assessment of climate change in 2006 and 2011, respectively
- ✓ Published the National Scheme to facing climate change in 2007



# 1. The energy structure & commercial development in China

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## **(3) China government has focused on the issues of carbon emission & climatic change**

- ✓ Issued the white paper of a Progress Report on China's Policies and Actions for Addressing Climate Change in 2008
- ✓ Proposed The Greenhouse Gas Emissions Reduction Targets of 2020 in world climate conference in Copenhagen in 2009
- ✓ Issued China CCUS Technology Roadmap in 2011
- ✓ Compiled China CCUS technology Development Program in 2013

In general, as a developing country, China has carried out the obligation of fighting global warming for the Earth



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## 2. The low-carbon, green, sustainable technology of CCS-EOR

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### (1) The conception of CCS & CCS-EOR

- ✓ CCS means Carbon Capture and Storage
- ✓ The CCS technology is mainly applied in the field of coal power plant, steel mill, cement plant and etc. to capture the produced  $\text{CO}_2$  then storage in underground space.
- ✓ CCS-EOR means  $\text{CO}_2$  flooding companied with CCS, one of terminology of CCUS (Carbon Capture, Utilization and Storage)  
that means the  $\text{CO}_2$  was stored during the process of  $\text{CO}_2$  flooding



## 2. The low-carbon, green, sustainable technology of CCS-EOR

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### (2) The main characteristics of CCS

- ✓ The main steps of CCS process: CO<sub>2</sub> Capture, Transportation and Geo-storage
- ✓ The 3 main modes of storage: Pre-combustion, Post-combustion and oxy-combustion CO<sub>2</sub> Captures. Currently, the 3 modes increase energy consumption by 25% with the cost of more than 300RMB/Ton
- ✓ CO<sub>2</sub> transportation ways: pipeline and vehicle/shipment and etc. with the cost of over 90RMB/Ton-100 Kilometer
- ✓ CO<sub>2</sub> Geo-storage means the captured CO<sub>2</sub> was injected in saline layer, which requires geo-exploration, security assessment, drilling, injection and real-time monitoring and so on. The cost of geo-storage is over 50RMB/Ton according to the current technology
- ✓ The total cost of CCS is over 440RMB/Ton-CO<sub>2</sub>
- ✓ (Data source: CCUS Roadmap, Sep., 2011)



## 2. The low-carbon, green, sustainable technology of CCS-EOR

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### (3) The main characteristics of CCS-EOR

- ✓ The technologies of CO<sub>2</sub>Transportation, CO<sub>2</sub>-flooding, Utilization and Geo-storage are routine techniques developed better
- ✓ The data from more than ten oilfields applied CO<sub>2</sub> flooding technique show that One Ton crude oil was displaced by 2-5 Ton CO<sub>2</sub> (averaged 3.5 Ton)
- ✓ The cost of CO<sub>2</sub> Capture is of 350RMB/Ton, transportation of 90RMB/Ton-100 Kilometer, and in-situ operation of 850RMB/Ton. Therefore, the the minimum cost of CO<sub>2</sub> flooding is of 2390 RMB/Ton (is equivalent to 60\$/b) according to the averaged data
- ✓ Therefore the technology of CCS-EOR low-carbon, green and sustainable



## 2. The low-carbon, green, sustainable technology of CCS-EOR

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### (4) A win-win mode will achieve by the development of CCS-EOR in social and economical fields

It is reported by the China CCUS Roadmap in 2011

- ✓ The minimum storage-cost of  $10^8$  Ton  $\text{CO}_2$  was 44 billion RMB according to the CCS roadmap, which is hard to be carried out because of without commercial profit
- ✓ A win-win mode will achieve by the development of CCS-EOR in social and economical fields according to CCS-EOR roadmap, which will be a critical way to carried out the  $\text{CO}_2$  reduction both in current and future



## 2. The low-carbon, green, sustainable technology of CCS-EOR

### (5) The potential of the CCS-EOR in China

It was reported by the National Basic Research Programs of China (No. 2006CB705800, 2011CB707300) that

- ✓ Approximately, geological reserves of 13 billion tons are suitable
- ✓ About 1.9 billion tons more recoverable reserve including more than 60% reserve of low permeability
- ✓ Approximate 5–6 billion tons of CO<sub>2</sub> will be stored

CO<sub>2</sub> storage potential in China (the National Basic Research Programs of China 2006–2010 (10<sup>8</sup> Ton))

<i>Stored Location</i>	<i>Proved reserves</i>	<i>increased recoverable reserve</i>	<i>Stored CO<sub>2</sub></i>
<i>miscible-phase displacement reservoir</i>	<b>70</b>	<b>7.2</b>	<b>20-25</b>
<i>low permeability reservoir which is hard to be recovered</i>	<b>60</b>	<b>12</b>	<b>30-35</b>



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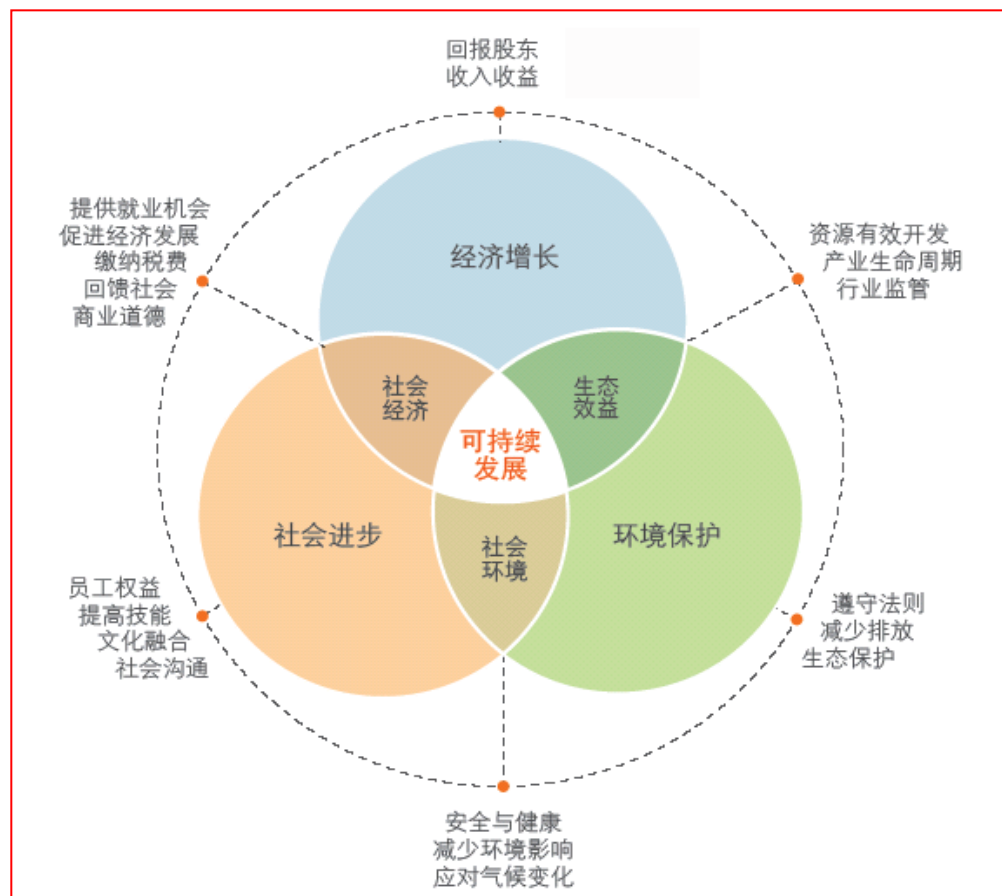
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### 3. The critical development on CCS-EOR in CNPC

#### (1) The conception and mode of CCS-EOR development in CNPC

- ✓ The development conception:  
“Environmentally friendly, Safety, high quality and people oriented”
- ✓ The development mode:  
“safety with cleaning, good quality with cost effective and sustainable development”

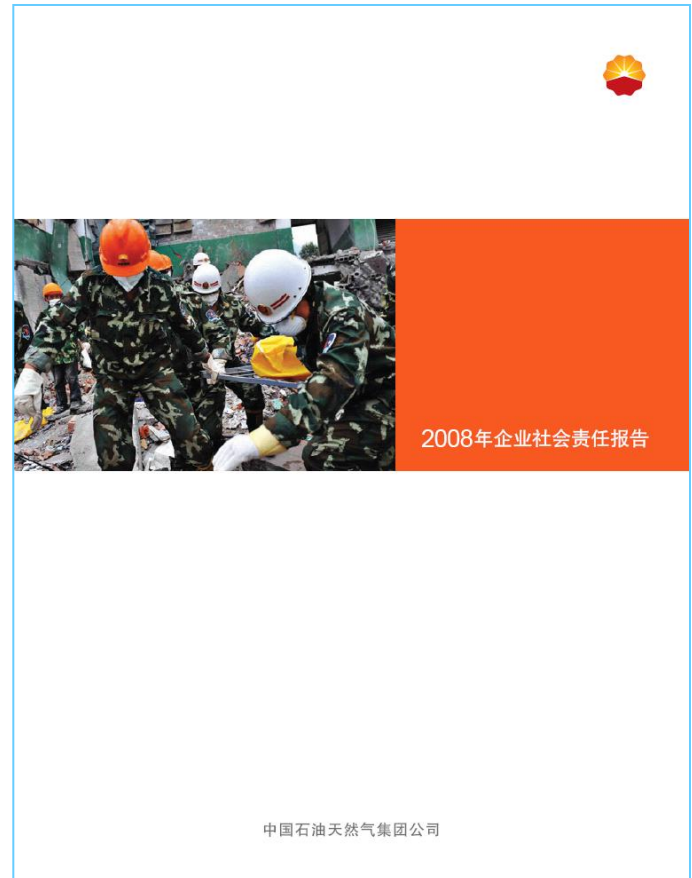




### 3. The critical development on CCS-EOR in CNPC

#### (2) The cases of CCS-EOR organized by CNPC

- ✓ Issued The Report of Society & Environment in 1999 and The Report of Social Obligation of Enterprises in 2006
- ✓ Set up a middle and long term environmental protection of “the Eleventh Five-year” development planning, to carry out the green gas controlled steps
- ✓ Joint-ventured Tianjin Climate Exchange in 2008 to develop the cleaning system
- ✓ Completed large scaled Forest carbon sequestration project in 2009
- ✓ Organized CCS-EOR international conferences and Corporation





### 3. The critical development on CCS-EOR in CNPC

#### (3) The CCS-EOR technology progress in CNPC

- ✓ The survey on CO<sub>2</sub> emission of enterprises from 2000
- ✓ The research projected of The CCS-EOR with storage potential started from 2004
- ✓ CCS-EOR projects of “973” , “863” and have been undertaken from 2006 to present
- ✓ The two steps of demonstration project of The safety development of natural gas with CO<sub>2</sub> and CO<sub>2</sub> flooding were carried out from 2007 to 2011
- ✓ In 2008 completed the first domestic 10 million tons of carbon trading



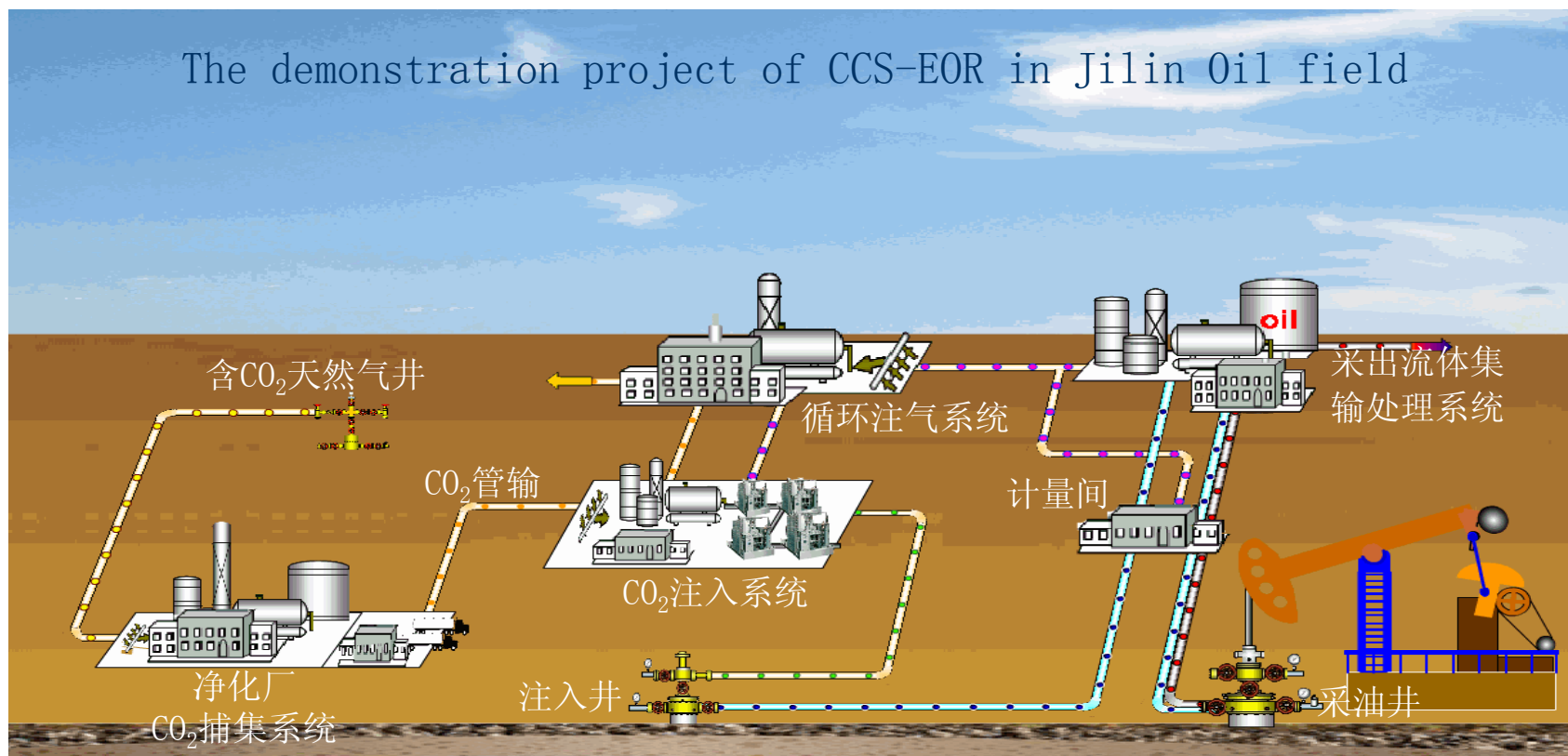
The photos of CO<sub>2</sub> flooding & storage



### 3. The critical development on CCS-EOR in CNPC

#### (4) The demonstration project of CCS-EOR

The first demonstration project of CCUS in China has been built combined the processes of decarbonation from natural gas (Capture), transportation with pipeline in Jilin Oilfield in 2008. The accumulated amounts of injection  $\text{CO}_2$  were 0.58 million tons and 0.32 million tons production crude oil till to the end of 2013





### 3. The critical development on CCS-EOR in CNPC

#### (4) The demonstration project of CCS-EOR

The first processing equipment of industrious decarbonation by using MDEA has been set up in China. The treatment capability of nature gas is 1.2 million M<sup>3</sup>/D with CO<sub>2</sub> production of 600 ton/D, the CO<sub>2</sub> reduction rate is more than 90% and the CO<sub>2</sub> content is less than 3% in the commercial natural gas

The treatment plant photo of natural gas including CO<sub>2</sub>





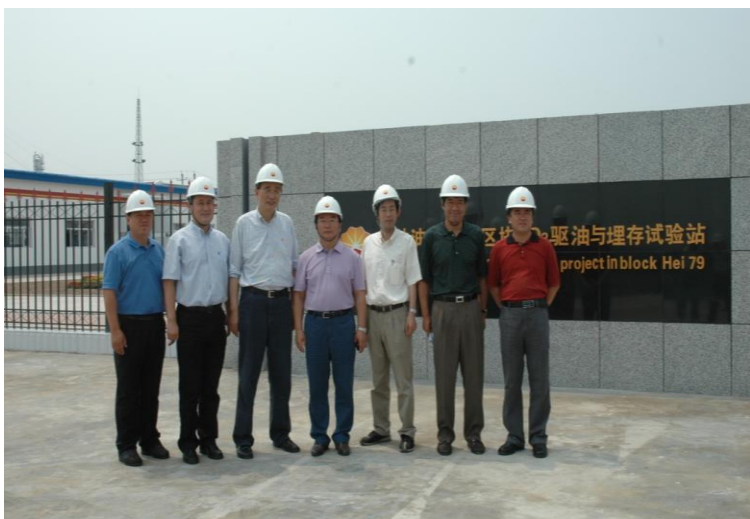
### 3. The critical development on CCS-EOR in CNPC



MOST experts inspecting the demonstration



Experts from ExxonMobil, America



Experts from RITE, Japan





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## 4. The insight on CCS-EOR

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### (1) The challenges of CCS-EOR in China

- ✓ It is hard to be organized due to multi organizations and areas with high operation risk because of large scaled space, long period and vast investment.
- ✓ The CCS-EOR technology and planning are managed by the corporation of the nation, local governments and enterprises
- ✓ The investment and financing system, responsibility of carbon transferring, security and monitoring system and related regulations are not completed
- ✓ The CO<sub>2</sub> resources could not match to the application, the CO<sub>2</sub> emission is focused on the East due to the various local commerce while the suitable stored spaces are located in the West
- ✓ The CCS requires high level technology because the suitable storage layers are of complicated conditions



## 4. The insight on CCS-EOR

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### (2) The advantages of CCS-EOR developed by petroleum enterprises

- ✓ The information of oil and gas fields for almost 60 years has been collected, the geo-data and related information of main basins in China were also managed by the petroleum enterprises
- ✓ With the support of China government, the petroleum enterprises have completed the potential assessment on suitable reservoirs of CCS-EOR application
- ✓ CCS-EOR technology is one of routine technologies in the petroleum enterprises
- ✓ CCS-EOR projects has been built or being built

Therefore, the petroleum enterprises has the ability to organize CCS-EOR projects of multi organizations and areas according to its characteristics of information, technology and resources



## 4. The insight on CCS-EOR

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### (3) The catalog and Utilization strategy of CO<sub>2</sub>

- ✓ **CO<sub>2</sub> content principle:** The CO<sub>2</sub> content is of 10% produced by coal power plants, steel mills and etc.; The high content CO<sub>2</sub> is produced by petrochemical、IGCC、coal chemical plants; The various content of CO<sub>2</sub> of by products of oilfields
- ✓ **CO<sub>2</sub> emission amount principle:** The coal power plants, steel mills, petrochemical produced great amounts of CO<sub>2</sub>; The small scaled plants, transportation tools let out small amounts of CO<sub>2</sub>
- ✓ **Priority utilization strategy:** With the stable supply condition, the associated gas of CO<sub>2</sub> with short distance will be utilized priority, then the high content CO<sub>2</sub> with low cost and short distance, then the low cost CO<sub>2</sub> with low cost and better transportation condition
- ✓ **Planning Principle:** The supplied source and applied location were optimized according to CCS-EOR assessment by planning





## 4. The insight on CCS-EOR

### The introduction of main locations of CCS-EOR

Loaction	Introduction
Songliao Basin	The Songliao Basin is rich of oil and gas (the nature gas including CO <sub>2</sub> ). Petrochemical enterprises are located in the area of hundred kilometer, which produce great amount of byproduct of CO <sub>2</sub> . It is a suitable location to carry out the CCS-EOR industry
Hailar /Erlian Basin	The Hailar /ErlianBasin are rich of oil, gas and coal. The volcano formation is water-sensitive with lowest-permeability. The displacement technology is prefer CO <sub>2</sub> flooding and the crude oil is light. The IGCC project is being set up will provide CO <sub>2</sub> for CCS-EOR.
ErDOS Basin	The ErDOS is rich of oil, gas and coal. The pilot tests were carried out in the Ghangqing and Yanchang oilfields. There are coal chemical projects in the location.
Northern /Southern Xinjiang basins	Two locations:, the Junggar and Tuha in the Northern Xinjiang basin, Tarim located in the Southern Xinjiang basin are rich of high quality of oil and for CO <sub>2</sub> miscible-phase displacement. The coal power plant and chemical fertilizer plant will provide CO <sub>2</sub> for CCS-EOR project.



## 4. The insight on CCS-EOR

### The introduction of main locations of CCS-EOR

Location	Introduction
Bo Hai Coastal Region	Bo Hai Coastal Region has more than 100 billion ton oil and gas. The Shengli, Dagang, Liaohe, Jidong and Huabei oilfield are located in the region. There are coal power plants, chemical plants and IGCC project to provide CO <sub>2</sub> , It is a better location to carry out CCS-EOR.
Middle Eastern area	The middle Eastern area including the Central Plains, Nanyang, Jiangsu, Jiangnan oilfields. There are coal power plants and chemical plants to provide CO <sub>2</sub> , It is a better location to carry out CCS-EOR.
Offshore area	offshore area is rich of gas and oil, and nature gas reservoir with CO <sub>2</sub> is proved in Qionghai area. It is a better location to carry out CCS-EOR.
Shanxi and shaanxi ECBM	Shanxi and Shaanxi are rich of ECBM with CO <sub>2</sub> . It is a better location to carry out CCS-EOR.
Sichuan-Chongqing basin	Sichuan-Chongqing basin is rich of nature gas with CO <sub>2</sub> .



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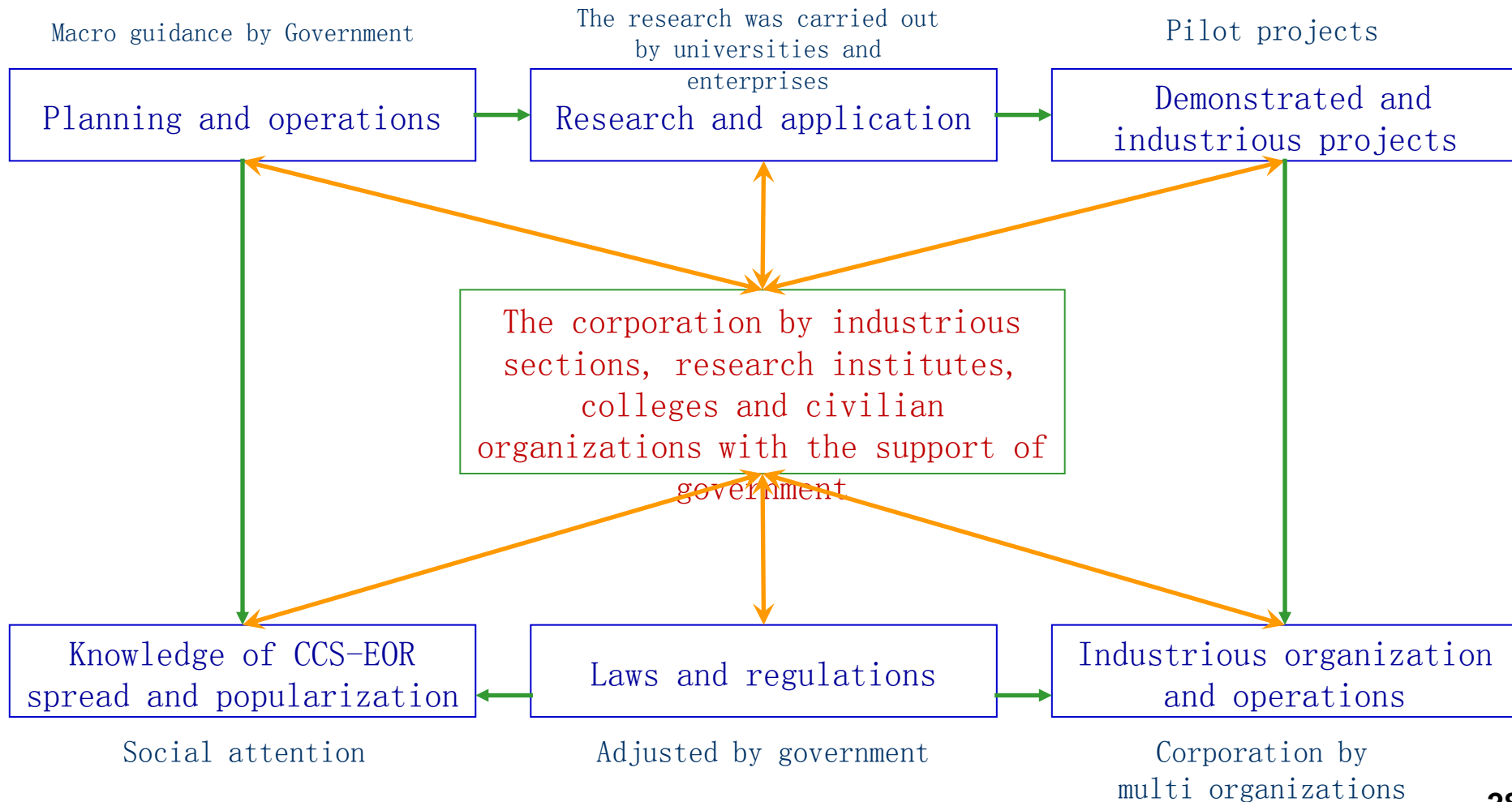
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## 5. The suggestions on industrious construction of CCS-EOR

### (1) The suggestions on CCS-EOR (CCUS) organization





## 5. The suggestions on industrious construction of CCS-EOR

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### (2) The suggestion of 3 steps on CCS-EOR development

- ✓ On the base of matured technology of energy industry, the CO<sub>2</sub>-EOR、EGR and ECBM are carried out focused on CO<sub>2</sub> sources with low cost or zero cost by using the integrated and applied technology of CCS-EOR to set up large scaled CCS-EOR projects
- ✓ According to high content of CO<sub>2</sub> and compared concentrated emission sources, the CCS-EOR industrious chain in China is constructed by using the advantages of the petro-industry
- ✓ According to the various industries, the great amount of CO<sub>2</sub> emission in dispersive locations are planned to set up a CCS-EOR industrious chain



## 5. The suggestions on industrious construction of CCS-EOR

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### (3) Improved research on industrious policy of CCS-EOR

- ✓ Improve research on industrious policy of CCS-EOR. Specificate the social obligation of CCS-EOR, commercial and social profits to reach the effective corporation among enterprises
- ✓ Accelerate the investment and financing system and construct related law & regulations to set up the industrious policy of CCS-EOR system
- ✓ Trace and analyze the international policies of CCS-EOR, investigate and achieve suitable policy and stagey to take part in the international organizations for China development



# Conclusions

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1. China has rejected the climate change positively by organizing and taking part in international events, editing related law and regulations, planning projects and spreading low carbon knowledges, carrying out basic research of CCS-EOR and pilot projects.
2. The enterprises of China also has responded and take part in the events of climate change positively. The win-win way of social and commercial profits based on CCS-EOR has been explored by organizing and applying CCS-EOR projects, special the demonstration projects



*Thanks for your  
attention!*

