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Progress and Deployment of Carbon Capture and Storage Programs in PR China by 2015

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Abstract

Climate change has been widely considered to be the major issue in the future, which threats human survival and development. To reduce the emission of CO_2 caused by human activity has become the consensus of the international community. CO_2 capture and storage (CCS) technology is considered as a technology that is most likely to achieve large-scale reduction of CO_2 emission in the future. However, in the Yangtze River Delta region leading by Shanghai, CCS development experiences a serious shortage, due to the lack of relevant platform to incent CCS innovation and industry development. This not only affects the ability of Shanghai and the Yangtze River Delta region to respond the climate change, but also influences the CCS in the project demonstration and deployment in China, and even the whole country's ability to cope with the overall climate change. There is an urgent requirement to strengthen the ability of the Shanghai and Yangtze River Delta to build CCS network.

Keywords: Carbon capture and storage; CCS; PRC; China; Greenhouse gas emissions

Background

As the largest developing country, China has become one of the world's largest carbon-dioxide emitters. Carbon emissions in China have been a major concern for the western countries. A draft summary of the report from the Wall Street journal shows, according to the current trend of greenhouse gas emissions, it is expected in less than 30 years, the global temperature will rise by two degrees Celsius compared to pre-industrial levels. The risk of great climate changes (such as the melting of ice sheets in Greenland) may reach an unacceptable level. In fact, as early as 2009, China officially announced the action goal for the control of greenhouse gas emissions, and decided to reduce the carbon dioxide emission per unit of GDP by 40%-45% till 2020 compared to that in 2005. Carbon capture and storage (CCS) technology [1,2] is the process of capturing waste carbon dioxide (CO_2) from large point sources, such as fossil fuel power plants, transporting it to a long-term storage site, and depositing it where it will not enter the atmosphere. CCS has the potential of large emission reduction, and it has a broad application prospect in the coal chemical industry, electric power, oil and gas, cement and other fields. The International Energy Agency estimates that CCS may undertake one fifth of the global emission reduction in 2050. In recent years, the main developed countries like UK, USA and Australia have invested heavily in the development of CCS research and demonstration work, and have formulated some corresponding policies and regulations, in order to take the lead in the development of global CCS and the low-carbon competition. Compared with Europe, USA and Japan and other developed countries, CCS research and development in China started late [3], but it developed rapidly in recent years. Under the guidance of national policy, some domestic universities, research institutes and enterprises have carried out many research and demonstration work on CCS. In some areas, the level of technology, demonstration scale and operating effect even lead the world.

Current Status of CCS Implementation in China

At present, China has achieved initial progress on CCS related work, mainly in the following aspects:

(i) R&D of technology [4] many universities and research institutes in China have studied on related theories, key technologies and policy. CNPC (China National Petroleum Corporation), the Shenhua Group, China Huaneng Group, CPI (China Power Investment Corporation) and some other enterprises carried out technical R&D and demonstration project. The project of carbon capture covers coal-fired plants, coal chemical industry and cement production industry. The project of carbon storage and utilization includes enhanced oil recovery (EOR), enhanced coal bed methane recovery (ECBM) and salt water layer storage.

(ii) Project demonstration [5] including those planned, under construction and in operation, there are 13 large scale CCS demonstration projects in China, mainly in the coal chemical industry and coal-fired power generation including demonstration project of the whole process integration. In the construction and operation process of the pilot demonstration project, technical and economic data has been accumulated, engineering experience was gained, and technical capabilities were improved. Shaanxi Yanchang Petroleum Group and the Global CCS Institute signed a cooperation agreement, and built a carbon dioxide capture plant of 100 thousand tons/year. They established the demonstration area of carbon dioxide storage and the technology of enhanced oil recovery. It not only can reduce carbon dioxide emissions, but also improve oil recovery for the oil field.

The demonstration project of CCS in Huaneng Shanghai Shidongkou Power Plant was one of the world's largest carbon dioxide capture equipment for the flue gas of coal-burning power plant (Figure 1).

The IGCC (Integrated Gasification Combined Cycle) project of Huaneng GreenGen in Tianjin, has also built a pilot system with thermal power of 20 MW, for carbon capture, utilization and storage.

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Table 1 lists the main CCS demonstration projects in PR China (Figure 2).

(iii) Policy and regulation [6,7] "Twelfth Five Year" work plan for controlling greenhouse gas emissions of the State Council, "Twelfth Five Year" special planning of national carbon capture and sequestration technology development of the Ministry of Science and Technology and "Notification on promoting carbon capture, utilization and storage demonstration" of the National Development and Reform Commission all made more explicit requirements for CCS development.

During the "Twelfth Five Year Plan" period, China will promote the carbon capture, utilization and storage demonstration as an important task to control greenhouse gas emissions [8]. In the reality of coal-dominated energy structure in China, the development of CCS is significant to tackle climate change, to control greenhouse gas emissions and promote low carbon shift of relevant industry in the long-term.

(iv) Potential CO_2 geological storage regions [9,10] all kind of CO_2 point emission sources and onshore and offshore aquifer storage have many opportunies in Songliao Basin, Bohai basin, Ordos basin, Subei basin, Jianghan basin (Figure 3).

(v) System and mechanism [11] to promote the coordination of relevant departments, and to form an integral force push CCS development, the National Development and Reform Commission established departmental coordination mechanism. Led by the department of climate change, the related departments of the National Development and Reform Commission, the National Energy Administration, the relevant departments of the Ministry of Science and Technology, the Ministry of Environmental Protection, the Ministry of Industry and Information, Ministry of Land and Resources participate to promote the experiment and demonstration of CCS.

(vi) International cooperation the National Development and Reform Commission maintain a good cooperative relationship with the Asian Development Bank, the Global CCS Institute and other international institutions, to actively promote the development of CCS in China by international technology and funding. Through international cooperation, it effectively improved the capacity-building of research institutions and enterprises in China.

Facing Problems

During the promotion of carbon reduction, China still faces many difficulties and obstacles, specifically in the following aspects:

(i) The regional development of CCS is imbalance in China. In Northwest China and Northeast China, due to their potential advantages of CO_2 storage and enhancement of oil recovery by CO_2, they have gained certain ability in the project demonstration. Guangdong as the representative of the Southern China and Hubei as the representative of Central China, have also accumulated strong CCS development capacity. However, in the Yangtze River Delta region led by Shanghai, although there is some basis of CCS related work, it is relatively dispersed and lack of regional interaction and the overall capacity is weak, which not only affects balanced distribution and the whole development of CCS in China, but also lacks the expected contributions to CCS development of China.

(ii) The regional orientation is not clear and it lacks technology assessment [12]. With the promotion of each work of CCS in China, the position of CCS in tackling climate change and the roadmap of

Figure 1: 120,000 t/a Post-combustion capture from coal-fired power plant in Shanghai.

No.	Project Name	Scale	Demonstration content	Status
1	Huaneng Beijing Gaobeidian 3000 t/a Flue Gas CO_2 Capture Demonstration Project	3000 t/a	Post-Combustion Capture	Operational since 2008
2	Huaneng Shidongkou 120,000 t/a Flue Gas CO_2 Capture Demonstration Project	120,000 t/a	Post-Combustion Capture	Operational since 2009
3	Chongqing Hechuan Shuanghuai Power Plant CO_2 Capture Indyatrial	10,000 t/a	Post-Combustion Capture	Operational since 2010
4	Demonstration of 35 MWth Oxy combustion Carbon Capture (Huibei)	50,000-100,000 t/a	Oxy-combustion Carbon Capture	Under Construction
5	Huaneng Group Tianjin IGCC Demonstration	1.8 Mt/a	400MW IGCC+EOR	First Phase: operation; Third Phase: beiing designed
6	Shenghua Group's 100,000 t/a CCS Demonstration (Ordos, Inner Mongolia)	100,000 t/a	Capture from Coal Liquefaction Plant + Saline Storage	Operational since 2008
7	Guandong Huarun CO_2 Capture Project	100 Mt/a	Carbon Capture	Feasibility test

Table 1: Main CCS demonstration projects in P. R. China.

Figure 2: Huaneng Tianjin GreenGen 400MW IGCC project.

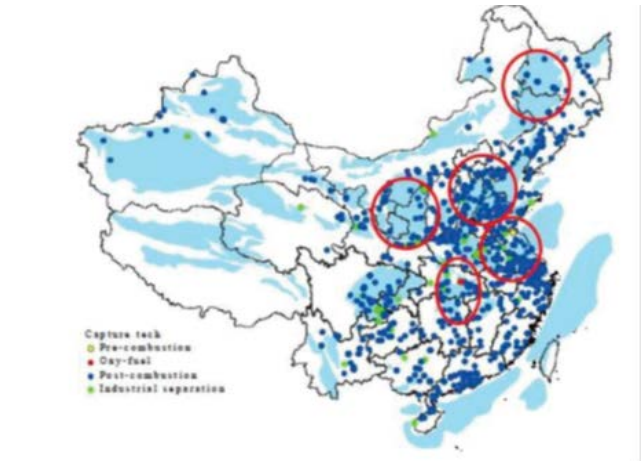

Figure 3: Potential CO_2 geological storage regions in China.

CCS development in China becomes clear. However, its position in the regional development plan is not clear. It blocks the entrance of related technology and funding, and then influences the development of CCS. In addition, various carbon capture technology and the whole process of system evaluation are insufficient, and the evaluation of its application ability also requires further study.

(iii) Lack of CCS related R&D. Although China has certain research basis of each technical link in CCS, the difference of development levels for each technical link is large. Application of CCS in China also faces high cost [13], high energy consumption, long-term safety issue and reliability which are required to be verified by promoting R&D and integrated demonstration efforts to enhance the maturity of the technology.

(iv) Regional industry-university-research is insufficient and regional united development mechanism is imperfect, which causes many works difficult to implement, and thus it cannot effectively promote substantial progress of CCS, especially in the industrial development and equipment manufacture for CCS.

(v) The related and specific policies in promoting the development of CCS in China is limited, it is difficult to provide effective support for the objectives and tasks of CCS demonstration in the "Twelfth Five Year Plan", especially in lack of clear objectives and incentive policies on the development of CCS. In the past, CCS policies more focused on promoting technology research and development, and paid less attention on the CCS demonstration work.

(vi) Public awareness is not enough. In general, the public is lack of CCS related knowledge and understanding of the status and role of CCS, there is a larger concern or even misunderstanding of the possible difficulties and risks in the development of CCS.

Outlook and Conclusion

Climate change has been widely considered to be the major issue in the future, which threats human survival and development. To reduce the emission of CO_2 caused by human activity has become the consensus of the international community. CO_2 capture and storage (CCS) technology is considered as a technology that is most likely to achieve large-scale reduction of CO2 emission in the future.

CCS development experiences a serious shortage in the Yangtze River Delta region leading by Shanghai. This not only affects the ability of Shanghai and the Yangtze River Delta region to respond the climate change, but also influences the CCS in the project demonstration and deployment in China, and even the whole country's ability to cope with the overall climate change. There is an urgent requirement to strengthen the ability of the Shanghai and Yangtze River Delta to build CCS network. In addition, due to the leading position of Shanghai in the economic, technical and market mechanism innovation and development, through strengthening CCS capability construction in Shanghai, it can not only improve the regional imbalance of CCS development to promote CCS project demonstration, but also help to accurately evaluate the application potential of CCS with technology development and industry-university-research construction, reduce the cost of carbon capture and promote the related equipment and industrial development.

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