HOW TO REDUCE WATER CONSUMPTION AND HIGH EMISSIONS FROM COAL CHEMICAL PLANTS THROUGH THE DEPLOYMENT OF CCUS TECHNOLOGY FOR ENHANCED OIL RECOVERY IN CHINA

Framework Step:

STEP 4. Support and contribute to innovation leading to new products and services
Innovation in the extractives sector can also lead to new products and services fostering new areas of comparative advantage for host countries. Initial comparative advantage in natural resources can be leveraged to push the production possibility frontier outwards and create dynamic comparative advantages through diversification. If a country uses its resource endowment in this way, over time, resources will become proportionally less important within their economy.

4. A What can host governments do?

- Support research and development efforts to identify, adapt, and transfer technology, making sure that these efforts are responsive to private sector demands. In doing so, develop ties with local universities, public research institutions, and participate in collaborative initiatives.

- Identify changing trends in global consumption and production patterns (progressive ore grades decline and increasing labour, transport, energy, processing, capital/ equipment costs), changes to end uses for minerals (innovation in final products), and carbon emissions trading.

4. B What can extractives industries do?

- Invest in specialised technologies for planning, handling, processing, maintenance, operational monitoring and recycling (excavation, concentration, ore prospecting, monitoring of the state of the environment) that reduce environmental impact.

Tags:

☐ local employment
☐ local supplier participation and development, including SMEs
☐ marginalised groups (women, indigenous people)
☐ skills development and upgrading
☐ access to credit
☐ shared infrastructure (transport, water, power)
☒ technology transfer
☒ innovation
☐ economic diversification
☒ Other: decarbonisation

Problem Statement:

With rapid changes in the global energy industry driven by cost-competitive clean energy technology developments, fossil fuel producing countries and companies come under pressure to decarbonise and contribute to global climate change efforts. Carbon Capture, Utilisation and Storage (CCUS) has been recognised to be an efficient way to mitigate greenhouse gas emissions.

Water flooding is a widespread method for secondary oil recovery, in which water is injected into the reservoir formation physically, sweeping residual oil to nearby production wells. The water flooding technology applied in the oilfield development process is water intensive. The recourse to this method in the water-stressed northern Shaanxi province was problematic, as its use would have led to more than 1% consumption of the available water resources, accounting for more than 30% of water resources in the oilfield area and exceeding 30 million cubic meters per year.

Parties Involved:

- National Development and Reform Commission of the People's Republic of China (NDCR): is a macroeconomic management agency under the State Council, which has broad administrative and planning control over the economy.
- The Ministry of Science and Technology of the People's Republic of China: is the central government ministry, which coordinates science and technology activities in the country.
- U.S. Department of Energy: a cabinet-level department of the United States Government
- Global CCS Institute: is an international think tank whose mission is to accelerate the deployment of carbon capture, utilisation and storage (CCUS).
- Asian Development Bank (ADB): is a regional development bank, which maintains 31 field offices around the world to promote social and economic development in Asia.

Common ground:

To meet its Nationally Determined Contributions (NDC) in line with the Paris Climate Agreement of 2015, the Government of the People's Republic of China (PRC) has committed to reduce its carbon intensity by 60-65% from its 2005 levels by 2030. The PRC is one of the countries that have included CCUS in their NDC as a technological solution to tackle climate change. The country depends heavily on fossil fuels, which account for more than 85% of the country's primary energy supply. The PRC considers CCUS as one of the major technologies that can abate 90% or more of CO_2 emissions from fossil fuel-based industrial and power plants. The use of CCUS in multiple, small projects is considered an opportunity to test the potential for the deployment of the technology at larger scale.

There was an alignment between the PRC's policy objectives and Yanchang Petroleum Group's interest to deploy a cost-effective CCUS solution to reduce the high CO_2 emissions and water consumption rates associated with its coal to chemicals (CTC) projects in the Shaanxi Province in North West China. This was done by gradually replacing water flooding with the CO_2- Enhanced Oil Recovery (CO_2-EOR) technology, increasing at the same time efficiency in oil production in a series of mature oil fields in the arid Ordos Basin.

The Yanchang Petroleum Group considered CCUS as a cost competitive technological solution, given the proximity of the CCUS facility to the different oilfields in the same area, achieving economies of scale. Compared to water flooding, CO_2-EOR was regarded as a more sustainable solution, from both an environmental and economic perspective, addressing the double challenge of emission reduction and water consumption.

Actions taken*:*

- In a joint effort, the ADB and NRDC developed a roadmap for CCUS demonstration and deployment in PRC, which was launched at a side event at the COP 21 meeting in 2015. The

roadmap combines a long-term strategy with short-term actions to kick-start CCUS demonstration within the Thirteenth Five-Year Plan (2016-2020) period. To promote the long-term deployment of CCUS, the roadmap called for early stage demonstration projects in the coal chemical industry, including the operations of Yanchang Petroleum in the Ordos Basin. The ADB entered into a technical assistance agreement with the PRC in collaboration with the NDRC to implement key recommendations of the ADB roadmap for CCUS demonstration and deployment in China. In its 2015 report, the ADB recommended prioritising early-stage demonstration of low-cost projects for CO_2-EOR and identifying priority regions for potential deployment, including the Ordos Basin (further information available at: www.adb.org/sites/default/files/publication/175347/roadmap-ccs-prc.pdf). It helped identify unique low cost opportunities, and recommended a gradual two-phase approach to CCUS deployment in the country, starting with pilot projects then moving to large-scale ones. It also provided a complementary set of policy actions to enable such deployment at scale. Yanchang Petroleum focuses on the research and development of CCUS technology. From 2007, the company first deployed one well for a CO_2 injection test, then extended it gradually to a full-chain CCUS project including CO_2 capture, transportation, Enhanced Oil Recovery and storage and monitoring sections. The CCUS facility in the Ordos Basin captures 50.000 tonnes per year of high concentration CO_2 (>99%) at the Shaanxi Yanchang Yulin Coal Chemical plant in Yulin city. The captured CO_2 is then delivered by truck tankers to Jingbian and Wuqi – two CCUS pilot sites for CO_2-EOR and geological storage. The application of CO_2-EOR contributes to addressing water stress in the arid region of the Ordos Basin while increasing the oil production by 8%.

Obstacles:

- When oil prices are low, coal-fired power plants, steel or cement plants, face considerable challenges to invest in CCUS technology. The cost of deploying such technology is relatively more expensive in smaller demonstration projects like the pilot in the Ordos Basin. Therefore, government funding has been important to overcome financial barriers.
- There are no long-distance public pipelines for CO_2 transportation in the Ordos Basin. This adversely affects the potential development of large-scale carbon storage projects in the region.
- In the long run, CO_2 safety monitoring, measurement and verification (MMV) technology in low permeability reservoirs will need further research and testing. The government is providing additional funding to support research and development to address these challenges.

Enabling factors:

- In order to tackle climate change, the Chinese government published in 2007 a report titled "China action targets to control greenhouse gas emissions", with the objective of supporting the low-carbon transition in Chinese provinces and low-carbon pilot projects in Chinese cities. In 2015, during the Paris Climate Conference, the Government of China committed to reducing greenhouse gas emissions and to establishing an effective mechanism to tackle climate change. Since the Eleventh Five-Year Plan for 2006-2010, the PRC has included the promotion of research on CCUS in its National High-Tech Development Programme and promoted close collaboration with diverse development partners on capacity building, policy development and pilot testing of technology components in the field of CCUS. This also includes the technological combination of CO_2-EOR. The Chinese government approved the project and provided 12 million yuan of financial support via the

"China's National Key R&D Programmes" to develop a CO2-EOR and geological storage safety and monitoring technology.

- In 2015, the United States and China agreed to collaborate on the Yanchang CCUS project, which was enshrined in the "U.S.-China Joint Presidential Statement on Climate Change". Both countries committed to promoting the utilisation of clean energy and address greenhouse gas emission reduction. The Chinese and U.S. governments jointly established the U.S.-China Clean Energy Research Centre (CERC), aiming at developing clean and low carbon technologies. Yanchang Petroleum received 600,000 yuan to invest in the implementation of the CO2-EOR pilot project. The U.S. Department of Energy, Global CCS Institute led and coordinated international and domestic universities participating in Yanchang Petroleum's CCUS project, strengthened the application of technological innovation on on-site practice, promoting knowledge spreading and sharing.
- The Australian Global CCS Institute offered financial support to Yanchang petroleum to carry out R&D in the area of CO2 capture, monitoring and verification and strategy planning. It also assisted the project by building an international platform for technical reporting, experience sharing and online publishing. The project also received financial support on a grant basis from the ADB's Carbon Capture and Storage Fund under the Clean Energy Financing Partnership Facility. The Carbon Capture and Storage Fund is a multi-partner trust fund supported by the United Kingdom and Australia to accelerate the physical deployment of carbon capture and storage demonstration projects. The Fund provided financial assistance for the feasibility assessment of a large-scale carbon capture and storage demonstration project and development support to Yanchang Petroleum Group for the implementation period October 2017-October 2020.

Lessons Learned:

- CCUS is one technological innovation for the decarbonisation of the fossil fuel industry that also increases productivity and efficiency of oil production, reducing costs and contributing to environmental sustainability. For China, CCUS technology is a promising way to reduce carbon emissions and achieve sustainable development while there is steady demand for coal in China. The deployment of CO_2 storage and Enhanced Oil Recovery in oil fields makes crude oil production more productive and efficient with economic and social benefits.
- The commitment of the Chinese government to tackle climate change through the development of CCUS technologies and the financial resources mobilised to achieve this objective were vital to ensure the feasibility of CCUS project in the Ordos Basin.
- The fact that the coal chemical plants (carbon source) and oilfields (carbon sink) are in the same region (short distance) and are operated and managed by the same company contributes to lower project operation and management costs. This operating model could be used for other projects under similar circumstances.
- According to the ADB, political commitment was helpful in the pilot phase, but for large-scale CCUS projects that require higher investments, a clear and coherent policy framework is key. Challenges around the economic viability of such projects without government funding financial support and insufficient carbon pricing hinder the deployment of this technology at larger scale.

Validated on 25 November 2019

13th Plenary Meeting of the Policy Dialogue on Natural Resource-based Development, OECD, Paris