Profiles

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CCS challenges and opportunities for China

Climate change has been increasingly highlighted within China, as seen with the implementation of the eleventh Five-Year Plan and with the early announcements of the twelfth Five-Year Plan. The vision for 2020 includes reducing carbon intensity by 40–45% from 2005 levels, and meeting 15% of the total energy demand with non-fossil fuel, with much of the focus on power generation. However, coal use, especially in the power sector, will continue to dominate, since much of the existing power plant capacity is new, having been introduced in the last decade. Consequently, much of this modern power plant fleet will be available for operation until about 2050.

Various modelling studies have been undertaken by Chinese and international organisations, to develop possible energy growth scenarios for China, including the impact of various policy measures on the timing of possible large-scale deployment of mitigation measures. All of these studies indicate that, under the current policies, while levels per unit of GDP should fall, absolute energy demand and CO_2 emissions will continue to rise, but at decreasing rates. It seems possible that, with the continued application of these initiatives to meet announced targets and goals for energy efficiency improvements together with the further introduction of low and zero carbon technologies, a very broad plateau in annual CO_2 emissions may be reached by about 2030. If it is assumed that there will not be any premature retirement of advanced coal-fired plant with replacement by, say, nuclear units, then it would almost certainly require the introduction of CCS to ensure that this expected plateau would decline in the period to 2050.

None of the new coal-fired power plants will include CCS within the period of the twelfth Five-Year Plan, as the NDRC does not yet see this as a viable way forward for China due to perceived high costs and lack of maturity of the first generation of technologies. At the same time, it is a research and development priority for MOST, covering all capture options, transport and storage, with a near-term emphasis on CO_2-driven EOR to help limit China's growing oil imports. The drivers are to reduce the energy penalties and high costs for the first generation technologies while implementing very significant levels of research at universities and institutes towards the development of second generation systems. Many of these R&D activities include a strong level of international co-operation, through capacity-building programmes with, amongst others, Australia, Canada, the European Commission, Italy, Japan, the UK and the USA.

With regard to progression beyond research, various Chinese power generation, coal and oil companies are becoming involved in major CCS projects, including funding and implementing large industrial pilot-scale trials. The next stage would include construction of one or more large-scale demonstration units to enable potential users to gain experience with all aspects of the process including construction, commissioning and operation. The rationale and choices for such projects in China are strategic considerations. The national context, technology status and other factors, such as feasibility, stakeholder interest, timing and cost, will be taken into account by the Chinese authorities in determining what is required. From a technical perspective, China is well positioned to move forward on several demonstration options. These might include:

- A 1 Mt/y CO_2 capture project to be led by the Huaneng Group, which would build on their impressive 120 ktCO_2/y capture and utilisation project on an advanced coal-fired power plant near Shanghai. This would further provide an excellent opportunity for the CO_2 to be used in a major EOR project in a nearby oilfield.
- Providing Phases 1 and 2 of the GreenGen project proceed successfully, including the 40–60 kt/y CO_2 EOR trial, there would be merit in proceeding to Phase 3, which would include the construction of a 400 MWe IGCC with full CO_2 capture and the CO_2 to be used for an EOR demonstration in a nearby oilfield.
- A 1–3 Mt/y CO_2 capture and storage project to be led by Shenhua Group, which would scale up the current 100,000 tCO_2/y integrated capture and storage in an aquifer project on the major coal to liquids demonstration plant near Ordos, Inner Mongolia.
- A 1 Mt/y CO_2 EOR trial in the Jilin Oilfield to be led by PetroChina and building on their smaller scale activities.

In addition, it is important to recognise that the non-power gasification based coal to oil, gas and chemicals sector offers some potentially interesting CCS demonstration opportunities, even though it is much smaller in total coal use compared to the power sector. Many of the coal gasification sites are significant large scale emitters of concentrated streams of CO_2. More importantly, there are clusters of sites in various industrial locations within China. These represent cumulative large point sources for CO_2 release and offer the prospect for demonstrations of integrated CCS networks within China at significantly lower marginal costs compared to the power sector and to individual non-power options. As such, they represent important early opportunities for demonstration that will aid China in building up expertise on all aspects of the CCS chain.

However, for any demonstrations to take place, the global CCS community would need to fully engage with China as to how these projects could best be financed and how (and to what level) the information arising could be disseminated to aid complementary projects elsewhere.

At the same time, China might benefit from further assistance to establish a national CO_2 storage capacity map, covering oil and gas reservoirs in all regions as well as a rigorous assessment of saline aquifers. A related issue is the need to ensure that storage of CO_2 will be safe on a long-term basis, because of the potential risks to people and the environment associated with release of CO_2. In order to address this, China needs to gain experience with monitoring and verification as part of an overall risk assessment process, together with the need to establish legal and regulatory frameworks for the implementation of CCS.

It is also important to recognise that if coal-fired power generation is fitted with CCS then more coal has to be burnt, as a result of the efficiency losses associated with the CO_2 capture technology. Consequently, if significant deployment of CCS should be required, this would have a very adverse impact on China's coal supply-transportation systems. At the same time, coal-fired plants with CCS included would require equally significant increases in water usage, which may not be readily available dependent on location. As such, these additional environmental consequences must be considered when weighing up the needs and benefits of CCS introduction to China. Support for studies to assess these issues should be encouraged.

Finally, China is becoming well positioned to move to the forefront on many aspects of CCS, certainly on CO_2 capture and, for the moment, on CO_2 utilisation. Given that many CCS systems are based on the application of known techniques, China is becoming well placed to become a serious supplier of CO_2 capture technology alongside its initiatives to export advanced supercritical coal fired boilers within the Asian region and elsewhere, where it has a significant cost advantage compared to OECD suppliers. It would also be well placed for the various gasification subsectors, including IGCC should its ongoing development programme prove successful.

Main structure showing the CO_2 stripper (left) and absorber (right) on the sidestream from the Gaobeidian PC CHP plant in Beijing

Each issue of *Profiles* is based on a detailed study undertaken by IEA Clean Coal Centre, the full report of which is available separately. This particular issue of *Profiles* is based on the report:

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