China has become a global leader in renewables—and it could do the same with carbon capture and storage (CCS).

**Report by Duncan Coneybeare.**

China is the top consumer of coal globally, and is building new coal-fired power plants faster than any other country in the world.\(^1\) Given its deep coal resources, fossil fuels are expected to remain the dominant energy source.

To reduce the environmental impact of coal, China is investigating a number of solutions, including CCS. With 11 projects at different stages of development (see Table 1), China is one of the global leaders in CCS. But insufficient government support means that businesses are bearing the majority of the costs of the pilot projects—which could limit the development of CCS in the country that could benefit from it the most.

**Businesses picking up the tab for CCS**

However, just as in other jurisdictions around the world (see “Future-proofing coal,” page 25), cost is proving to be a major obstacle. At present, support from the government is seen as being at an inadequate level and inconsistent. And with an immature carbon market, businesses are picking up the tab for CCS projects, says Dr. Di Zhou of the South China Sea Institute of Oceanology, Chinese Academy of Sciences.

Dr. Xi Liang, secretary of the China Low-carbon Energy Action Network (CLEAN) and lecturer in Business and Climate Change at the University of Edinburgh, believes change could happen quickly: “There is interest from large energy companies, but there’s a lack of financial incentive. The timescale for commercialization depends on the priority the government sets for CCS. If it receives the same amount of support as wind or solar, CCS will happen.”

Zhou agrees: “Our financial modelling for Guangdong province showed that

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**Table 1. Current large-scale integrated CCS projects in China**

<table>
<thead>
<tr>
<th>Asset lifecycle stage</th>
<th>Project name</th>
<th>State/district</th>
<th>Volume CO(_2)</th>
<th>Capture type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluate</td>
<td>HuaNeng GreenGen IGCC Project</td>
<td>Tianjin</td>
<td>2 Million tons per annum (Mtpa)</td>
<td>Precombustion</td>
</tr>
<tr>
<td>Evaluate</td>
<td>Sinopec Shengli Oil Field EOR Project</td>
<td>Shandong</td>
<td>1 Mtpa</td>
<td>Postcombustion</td>
</tr>
<tr>
<td>Identify</td>
<td>ShenHua/Dow Chemicals Coal to Chemicals Plant Project (Yulin)</td>
<td>Shaanxi</td>
<td>2-3 Mtpa</td>
<td>Industrial separation</td>
</tr>
<tr>
<td>Identify</td>
<td>Daqing Carbon Dioxide Capture and Storage Project</td>
<td>Heilongjiang</td>
<td>1 Mtpa</td>
<td>Oxyfuel combustion</td>
</tr>
<tr>
<td>Identify</td>
<td>Dongguan Taizhongwang IGCC with CCS Project</td>
<td>Guangdong</td>
<td>1 Mtpa</td>
<td>Precombustion</td>
</tr>
<tr>
<td>Identify</td>
<td>Dongying Carbon Dioxide Capture and Storage Project</td>
<td>Shandong</td>
<td>1 Mtpa</td>
<td>Not decided</td>
</tr>
<tr>
<td>Identify</td>
<td>Jilin Oil Field EOR Project (Phase 2)</td>
<td>Jilin</td>
<td>0.8-1 Mtpa</td>
<td>Precombustion (gas processing)</td>
</tr>
<tr>
<td>Identify</td>
<td>Liaoyangang IGCC with CCS Project</td>
<td>Jilin</td>
<td>1 Mtpa</td>
<td>Precombustion</td>
</tr>
<tr>
<td>Identify</td>
<td>Shangri International Energy Group CCUS project</td>
<td>Shandong</td>
<td>2-3 Mtpa</td>
<td>Oxyfuel combustion</td>
</tr>
<tr>
<td>Identify</td>
<td>Shen Hua Ningxia Coal to Liquid Plant Project</td>
<td>Ningxia</td>
<td>2 Mtpa</td>
<td>Industrial separation</td>
</tr>
<tr>
<td>Identify</td>
<td>ShenHua Ordos CTL Project</td>
<td>Inner Mongolia</td>
<td>1 Mtpa</td>
<td>Industrial separation</td>
</tr>
</tbody>
</table>

Source: Global CCS Institute\(^2\)
The question of storage

After cost, one of the biggest questions to answer is what to do with the captured CO₂. Lessons learned from Chinese demonstration projects highlight the need to consider CO₂ transport and storage from the onset. “A systemic assessment was not carried out on the Dongguan Taiyangzhou IGCC project. They hadn’t factored in the difficulties of installing pipelines in densely populated residential areas,” says Li.

Although captured CO₂ has been used for industrial application and food processing, these processes only use a small proportion of a power plant’s total CO₂ emissions. More promising is injecting CO₂ to assist with Enhanced Oil Recovery (EOR), says Li. “Two very successful EOR projects are China’s largest oil field, Daqing (CNPC), and the Jilin oil field (Sinopec). But EOR is still at least three to five years from commercialization.”

The alternative is to store CO₂ in deep underground geological formations.

“Onshore storage in geological formations is the cheapest solution. Northern China has good onshore storage sites, but this is not the case in southeastern China,” says Zhou. “Offshore storage is more feasible in the southeast, but the cost is much higher. However, we are looking into using depleted oil or gas fields for offshore storage to reduce costs.”

Insuring against leakage

Safety risks arising from CO₂ leakage are a concern in China, but Zhou believes these can be mitigated. “CO₂ leakages are avoidable if the site is chosen carefully and possesses sound storage conditions. Natural gas and CO₂ underground reservoirs have existed for many years with no issues identified,” he says.

“Insurance and risk sharing may be part of the solution,” adds Liang. He collaborated with Andrew Voysey at University of Cambridge and a number of major insurance and energy companies on a pioneering study by ClimateWise into the commercial insurability of CO₂ leakage risks in Europe.

“For the CCS-specific liabilities identified by the EU CCS Directive, ‘off-the-shelf’ insurance solutions do not exist. We’ve shown how some of these risks can be insured, but others will need to be shared with governments,” says Liang.

Future of CCS

CCS success depends on many factors including government support, the right geological conditions for storage, EOR potential and a sound regulatory framework. Still, we have seen what happens when China decides to invest in a new technology – as it did with solar and wind, becoming the global leader in a matter of years.

“The key to determining the success or failure of CCS will be policymakers’ understanding of CCS and their willingness to put it at the forefront of emissions reduction,” agrees Zhou.

Dr. Xi Liang

Lecturer in Business and Climate Change
University of Edinburgh

Professor Zhou leads the research project Guangdong CCS Readiness (GDCCSR). From 2003 to 2005 she was a lead author of the chapter entitled “Underground Geological Storage” in the IPCC special report Carbon Dioxide Capture and Storage. She has served as the Vice Director of the South China Sea Institute of Oceanology, Chinese Academy of Sciences, and as a standing member of the Guangdong Provincial Political Consultant Committee.

Dr. Di Zhou
Professor at the South China Sea Institute of Oceanology
Chinese Academy of Sciences

Dr. Xi Liang lectures at the University of Edinburgh and is Secretary of the China Low-carbon Energy Action Network (CLEAN). He has worked on several CCS research projects and participated in programs including the UK-China Chinese Advanced Power Plants Carbon Capture Options (CAPPCCO), the UK-EU-China Near Zero Emission Coal Initiative and the Guangdong CCS Readiness (GDCCSR) project.

CCS-equipped coal-fired power plants will be cost competitive when the carbon price reaches US$32 to US$56 per ton of CO₂. To commercially exploit the technology, “China must set a clear reduction target to drive forward carbon market developments,” says Professor Xiaochun Li of the Institute of Rock and Soil Mechanics, Chinese Academy of Sciences. Although CCS was included in the 12th Five-Year Plan (2011–2016), Li believes insufficient legislation for CCS is a key challenge, and that technology and legislation need to develop together to build confidence.

“The timescale for commercialization depends on the priority the government sets for CCS. If it receives the same amount of support as wind or solar, CCS will happen.”

Dr. Xi Liang
China Low-carbon Energy Action Network (CLEAN)