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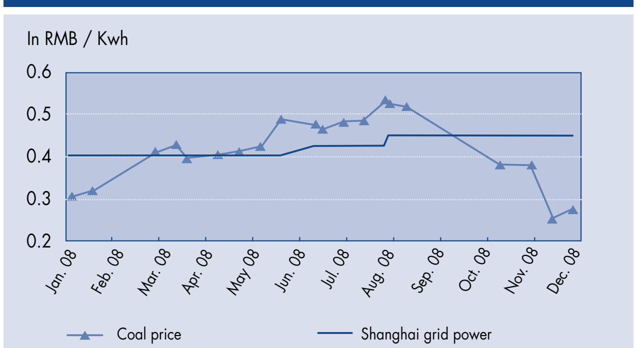
Digging in Deep

Carbon Capture and Storage Technology in China is Driven by Energy Security Concerns

Carbon capture and storage (CCS), a technology that prevents carbon dioxide produced by coal plants and other CO_2-intensive industries from being released into the atmosphere, is essential in order to cut carbon emissions and thus mitigate the impacts of climate change. China, the world's largest miner and consumer of coal, already has a range of CCS technology demonstration projects underway. As it continues to build a large number of coal-fired plants to fuel its economic and social development, the ability to one day deploy CCS for China's coal-fired power fleet could be crucial in a world with uncertain but evolving carbon policies.

A number of CCS projects that span a range of technologies and commercial models (see table on page 32) are now being developed in China, driven by concerns over energy security. Developing CCS technologies in the right way might decrease oil-import dependence and enhance the reliability of China's coal supply. But despite the high importance of these strategic concerns, China faces many obstacles in successfully implementing CCS, ranging from obstacles created by unbalanced energy reforms and the impact of CCS deployment on the coal supply-chain to the high costs of the technologies involved.

China's Power Market Cannot Bear the Cost of Coal



Source: Shanghai Development and Reform Commission; Reuters

Energy Security Drives CCS Projects

The first major CCS projects in China – Shenhua's coal-to-liquids (CTL) project in Ordos, Inner Mongolia and the GreenGen integrated gasification combined cycle (IGCC) plant in Tianjin – have progressed rapidly because they explore technologies with implications for China's long term energy security. But in the case of technologies that do not address China's underlying concerns about local air pollution and fuel security, China has been slower to undertake major projects and is eager to spread risks across international partnerships.

Shenhua CTL

The strategic logic of CTL technology is all about replacing oil imports, and Shenhua's CTL venture is slated to become the first major CCS project in China. Because coal is China's largest domestic energy resource, converting coal to transport fuel serves as a hedge against oil-import dependence. Integrating CCS into CTL processes would further boost security of oil supply by providing high purity carbon dioxide (CO_2) streams with little additional capture cost – the largest cost of CCS in power generation. These streams could be pumped into declining oil reservoirs to yield previously unrecoverable oil supplies (enhanced oil recovery, or EOR). Indeed, deployment of CTL in China, as in other places, is closely linked to oil prices. When prices were high in 2008, 12 projects were in the pipeline. As prices fell, many of those projects, but not all, were put on hold. Clearly, given the incremental costs, CTL-CCS projects are likely to be pursued where EOR opportunities exist.

GreenGen IGCC

CCS technology integrated with IGCC, as envisioned by GreenGen (the first IGCC project to be deployed in China), is now the major focus of state-supported CCS for power plants. The main advantages of CCS with IGCC are the high combustion efficiencies of IGCC and the relative ease of CO_2 capture compared with post-combustion CO_2 capture (where CO_2 capture is complicated and expensive).

Energy security, reduced local pollution, and synergies with chemicals production make IGCC power plants a state priority. First, China's own internal energy policy provides strong incentives for developing IGCC as an efficient coal combustion technology. China's national energy-efficiency policy targets a 20 per cent drop in energy intensity of gross domestic product (GDP) from 2005 levels by 2010 and depends heavily on generating electricity from coal more efficiently. The long-term planning for the reliability of electricity supply necessarily emphasises using coal efficiently as remaining domestic resources are finite, and production and associated transport costs will increase as the best and cheapest coal reserves are exhausted over time.

Second, developing intellectual property and technological capability in IGCC will save China from dependence on foreign power-plant manufacturers in the future. An additional benefit for China of developing indigenous technology is the commercial opportunity to export it to other countries.

International Co-operation

China is leveraging international support for developing CCS wherever possible, but especially in cases in which domestic benefits are less clear, and it is engaged in partnerships such as the UK-China Near Zero Emissions Coal (NZEC) project. Australia is also a partner in Huaneng's Beijing post-combustion capture demonstration plant. In 2008, Japan and China announced a co-operative project to capture CO_2 from a Chinese coal-fired power plant and inject it into a Chinese oil field for EOR.

Obstacles to Wider Deployment of CCS

No matter which technology goes forward as the leading contender for deployment of CCS – CCS with CTL; CCS with IGCC; or post-combustion CCS – the costs will be daunting. For the purposes of CCS, the most relevant markets are the coal market and the power market, where the relative imbalance of reform in China creates serious problems.

China's central planning apparatus, the National Development and Reform Commission (NDRC), keeps tight control over electricity prices in order to meet its larger socio-political agenda. Thus, the Chinese power sector is marked with considerable state intervention to serve political exigencies. On the other hand, China now has mature markets for coal that are increasingly exposed to international prices.

The conflict that arises between unevenly reformed coal and power sectors illustrates a key problem for CCS in the Chinese energy system: The power market cannot internalise increased costs. This means that the Chinese power market is designed in a way that makes it nearly impossible for it to deploy a commercially-viable CCS model on its own. If the structure of Chinese power markets means that generators can barely support the cost of their primary input (coal), supporting the cost of CCS is currently unthinkable without major power sector reforms.

China's potential for geological carbon sequestration (the capture and long-term storage of CO_2) is huge. Unfortunately, the country's relatively unexplored geology, at least from a CO_2 storage perspective, raises question marks over the feasibility of long term CO_2 storage in China. More surveys of storage locations, such as oil basins and deep saline aquifers, need to be conducted.

Current CCS Projects in China

CCS projects	Technology	Partnership model	Financial arrangement	Status (Aug. 2009)
GreenGen Corporation	IGCC	Huaneng with seven other state-owned energy companies: China Datang Group, China Huadian Corporation, China Guodian Corporation, China Power Investment Corporation, Shenhua Group, State Development & Investment Corporation, China Coal Group,	Registered capital: About USD 44 million (RMB 300 million)	Under construction
	Pre-combustion de-carbonisation	Peabody Energy	Huaneng 51%, and other 7 in the group 7% each	
	Gasification or partial oxidation shift plus CO_2 separation		Total Investment will reach USD 1 billion (RMB 1 = approx. USD 0.14)	
Shenhua CTL	Coal to synfuels	Shenhua Group	USD 1.4 billion	CTL operational, CCS expected to start in late 2009
	(direct coal liquefaction)	Sasol		
		West Virginia University		
Huaneng Beijing Thermal Power	Post-combustion	Huaneng	USD 4 million research project by CSIRO	Operational since 2008
		Australia CSIRO		
Near Zero Emission Coal	R&DD	UK	USD 5.6 million (GBP 1 = approx. USD 1.60) from the UK Government's Department of Energy and Climate Change	In planning stages
		China Ministry of Science and Technology		
COACH project (Cooperation Action within CCS China-EU)	R&DD	COACH project groups 20 partners (R&D, Manufacturers, Oil & Gas Companies, etc.), 12 for Europe and 8 for China	Partially funded by European Union	In planning stages
Shanghai Huaneng Shidongkou	Post-combustion	Huaneng	Corporation investment	Under construction

Source: PESD

The True Costs of CCS Implementation

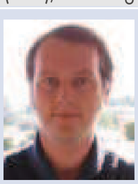
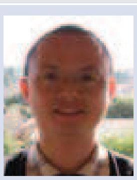
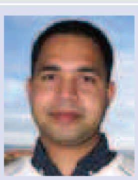
Adding CO_2 capture reduces power generation efficiency by 20-30 per cent. CCS thus requires an increase in coal consumption of around 20-25 per cent to produce the same amount of electricity. Coal supply chains already struggle with soaring demand; wide deployment of CCS would greatly exacerbate those strains.

Issues with deploying CCS at a large scale, therefore, cannot be understood as limited to the power sector only. They also permeate China's entire coal-based energy infrastructure. Because industry and infrastructure development is normally arranged in a five-year plan system, major infrastructure projects first are proposed, approved, and funded in the plan and then deployed. Thus, ensuring the availability of coal supply for CCS at scale entails co-ordination of the entire energy industry and the economic development system.

The implementation of CCS at scale in China faces some important technological, economic, and political questions: Issues that arise from the costs, the storage, the risks, and the uncertainties. While China is taking a lead in developing CCS technologies, the world shouldn't count on China taking the lead in deploying them until it makes better strategic sense, or someone else steps up to pay the bill. ■

Profile

This article is a condensed version of the working paper by Richard Morse, Varun Rai, and Gang He, "The Real Drivers of Carbon Capture and Storage in China and Implications for Climate Policy", Stanford University's Program on Energy and Sustainable Development Working Paper #88. The original paper can be downloaded at http://iis-db.stanford.edu/pubs/22621/WP_88_Morse_He_Rai_CCS_in_China.pdf. The editors would like to thank the authors for permission to reprint their main findings. The Program on Energy and Sustainable Development (PESD) at Stanford University is an international, interdisciplinary programme that draws on the fields of economics, political science, law, and management to investigate how the production and consumption of energy affect human welfare and environmental quality. Richard Morse leads PESD's work on global coal markets. PESD's coal research examines the political economy of coal and coal's long term role in the world's energy mix. Other research includes carbon policy and carbon markets, renewable energy markets, and financial markets for energy commodities. Gang He is a Research Associate at PESD focusing on China's energy and climate change policy. Varun Rai's research focuses on technologies and policies for carbon capture and storage (CCS), technological innovation and diffusion, and the technology and energy policy of India. He leads the carbon capture and storage (CCS) research at PESD.

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