

Test Year for Chinese Coal-Based SNG

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Coal-based Synthetic Natural Gas production in China may be on the brink of a step-change in the industry's development. New projects coming on-stream this year promise the start of commercial scale production, moving the sector away from its traditional base in chemicals. SNG could provide a significant contribution to the country's gas supply, one that may outstrip shale gas in both quantity and timing.

While China's shale gas prospects have grabbed the headlines recently, less attention has been paid to the country's efforts in coal gasification. Coal is China's number one hydrocarbon resource and the Chinese coal industry is the largest in the world. Further exploiting the country's reserves, particularly coals unsuitable for power generation or inaccessible with traditional mining techniques, provides China with an additional means of offsetting its growing import dependency on oil and gas.

The syngas produced by coal gasification is versatile. It can be used as a direct burn energy source for power and heat, or be upgraded to Synthetic Natural Gas that can be fed into existing natural gas pipelines. It can also be used to make chemicals and via Fischer-Tropsch processes into liquid fuels.

There is also an environmental angle. Coal gasification allows pre-combustion separation of carbon dioxide from the syngas, which is cheaper than current

methods of post-combustion separation from power plant flue gas. As a result, coal gasification reduces the overall cost of Carbon Capture, Storage. However, for coal gasification to be classified as low carbon it must be combined with CCS, an as yet unproven and economically challenging process.

Supply Contribution

According to data from the state-owned China National Petroleum Corporation, China's annual gas demand is expected to rise to 350 Bcm by 2020 and 550 Bcm by 2030 from 130 Bcm in 2011. Other forecasts suggest demand could top 400 Bcm by 2020, while estimates made by the National Development and Reform Commission's Energy Research Institute last year put the 2020 figure lower at 270-330 Bcm.

China has contracted for imports of Central Asian pipeline gas to rise to 65 Bcm/yr by the end of the decade and expects to receive a further 12 Bcm/yr from

Myanmar by pipeline. Domestic output is expected to double between 2009 and 2020, with unconventional gas sources playing a key role. Based on the NDRC figures—which are at the conservative end of the spectrum—LNG should be able to fill the gap between expected supply and demand in 2020.

It is unclear where SNG sits within this framework. CNPC does not appear to take SNG production into account, focusing instead on conventional gas, tight gas, shale gas and coalbed methane. US bank JP Morgan provides a model which assumes Chinese gas demand of 400 Bcm in 2020, but specifically omits SNG production, owing to the technical, economic and infrastructural risks associated with the sector's development. However, the bank does see a potentially significant additional contribution to China's domestic gas supply from SNG, one currently not incorporated within the bank's models.

Existing Gasification

China already produces significant amounts of coal gas, but the syngas produced is used almost entirely in the chemicals industry. Of total installed capacity, 66 of 69 gasification facilities are directed towards syngas for chemicals production, representing 95% of syngas output by nameplate capacity, according to the Gasification Technologies Council database.

The predominant gasification feedstock is coal, which accounts for 55 projects or 89% of syngas output capacity. The remainder is made up primarily of petroleum residues, where there has been

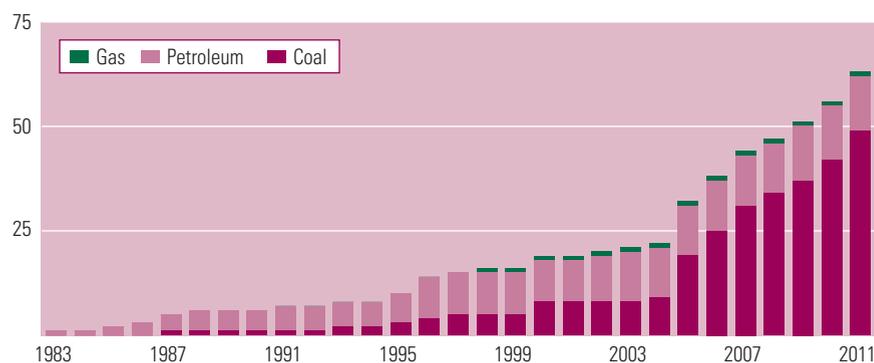
a marked slowdown in new projects, the last being built in 2009 and the one before that in 2003. However, 2012 should mark a new direction for the gasification sector in China, with the start up of two projects designed to produce upgraded gas that can be put into natural gas pipelines.

JP Morgan's research lists 15 coal gasification projects under construction in China through to 2016. If first phase completion is achieved under the timetables described, total SNG output would reach 21.24 Bcm/yr of pipeline quality gas by 2016. If full target capacity is reached, coal gasification could supply 89-96 Bcm/yr, not far short of 25% of total gas demand in 2020. According to the World Clean Coal Week conference total projects under construction, planned and proposed amount to some 150 Bcm/yr gas, although many of these projects are unlikely to be realized.

The first two commercial coal gasification projects are Qinghua Coal Group's project in Yili, Xinjiang. First phase capacity is 1.38 Bcm/yr, rising eventually to full potential capacity of 5.5 Bcm/yr, although the timeline for future expansion is unclear. The second project is Xinjiang Guanghui's 0.5 Bcm/yr capacity plant, also in Xinjiang. Four more projects are slated for completion in 2013, two in Inner Mongolia and two more in Xinjiang. Combined, these represent first-phase capacity of an additional 7.36 Bcm/yr, with scope for expansion to 22 Bcm/yr.

Although it is hard to assess the timing of project completion, as many of the proposed projects lack approvals, as well as likely operational levels, there have

1. Number of Chinese gasification projects by feedstock (cumulative).



Source: Gasification Technologies Council

been some concrete developments in addition to the two plants expected to start up this year. The China Power Investment Corporation's 2-6 Bcm/yr project in Yili, for example, which is expected to produce first SNG in 2015, has eight coal gasifiers on order from Siemens Energy. Each gasifier uses up to 2,000 tons of coal a day.

Transportation

A notable aspect of these projects is the high level of involvement in the SNG upstream of coal and power companies rather than China's traditional oil and gas producers. However, China's big state oil and gas companies do have a crucial role to play. Producing potentially large volumes of SNG in Inner Mongolia and Xinjiang—areas far from China's demand centers—means the gas has to be piped long distances to consumers. Neither the coal nor power companies involved have the capacity to build the necessary pipelines.

Sinopec announced last year that it would invest in two pipelines with total transmission capacity of 30 Bcm/yr to transport coal-based synthetic gas to China's eastern coast. The first will be 7,373 kilometers long and link Xinjiang with Guangdong and Zhejiang provinces. The expected cost is over Yuan 130 billion (\$20.4 billion), including five trunk lines. The second pipeline will also start in Xinjiang and run to Shandong and Jiangsu provinces, spanning over 4,463 km. The pipelines are expected to be operational by 2015.

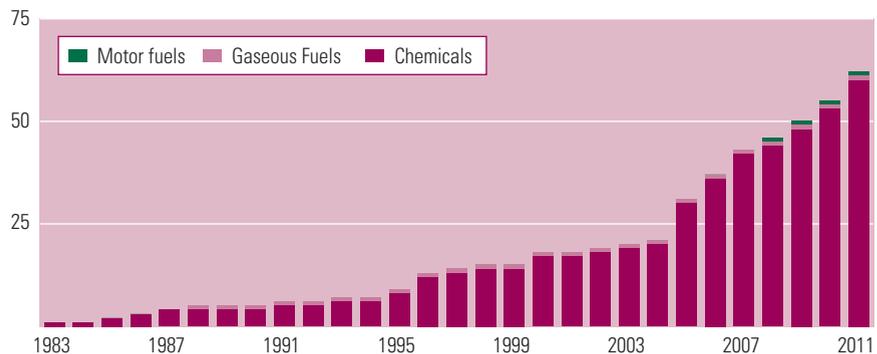
Sinopec said that the longer pipeline

would serve 13 provinces and municipalities including Gansu, Ningxia, Shaanxi, Shandong, Jiangxi, Zhejiang, Guangdong and Fujian, while the second pipe will pass through seven major areas, including Hehan, Anhui, Tianjin, Jiangsu and Beijing.

Sinopec signed a deal with the Xinjiang government and nine local companies—including state power company Huaneng—in December to procure synthetic gas for the pipelines. Of the 15 projects listed by JP Morgan that are expected to complete by 2016, seven are in Xinjiang, with one each in Shanxi and Gansu, which could be connected to the longer of Sinopec's two proposed pipes. Sinopec is also interested in SNG production itself and has a project in Xinjiang which is slated to start up in 2015—the same schedule as for the pipeline—with capacity of 8.0 Bcm/yr.

Sinopec's Xinjiang SNG pipeline project was reported by local media to have been submitted to the NDRC for approval in August 2011. The pipeline appears to have first been proposed in 2009, but no mention is made of it in the group's 2011 annual report as a company priority. It is not clear whether it forms part of the blueprint for the natural gas sector under the 12th Five Year Plan, which was submitted for approval by the NDRC to the State Council in May, but has yet to be publicly released. SNG production comes under the chemical coal sector in the 12th Five Year Plan, which was released in March. It only mentioned that syngas from coal should be developed but did not specify any output targets.

2. Number of Chinese gasification projects by product (cumulative).



Source: Gasification Technologies Council

Supply Competition

Media reports give the impression that there is some competition between Sinopec and CNPC in Xinjiang to secure SNG volumes. Xinjiang has traditionally been the preserve of CNPC. The company's subsidiary PetroChina built the West-East pipelines that take Central Asian imports and Xinjiang's own production to China's east.

The first West-East pipeline has capacity of 12 Bcm/yr and runs 3,843 km from the western Tarim Basin in Xinjiang to Shanghai. It started operations in 2003. The 30 Bcm/yr Second West-East pipeline brings in Turkmen gas. It was fully commissioned in May, when the link to Shenzhen city in southern Guangdong province was launched. It was built at a cost of Yuan 142.2 billion, with a total length, including trunk lines, of 8,704 km and is already said to be operating close to capacity.

The third line is expected to cost Yuan 116 billion, according to *The China Securities Journal*. The new pipeline will link with the Central Asia-China gas pipeline network and start in Horgos in western Xinjiang province on the border with Kazakhstan—the same start point as the Second West-East pipeline. It will pass through 10 provinces. The main trunk

line will be more than 5,000 km long, according to CNPC.

Construction of the third West-East pipeline may provide capacity for SNG to be taken east. CNPC signed framework agreements with local state-owned and private companies to secure funding for the 30 Bcm/yr Third West-East pipeline end-May. The company said then that construction would begin within a year, with commercial operations targeted to begin in 2015.

According to a report in July from *Interfax*, quoting a company source, the Kingho Energy Group will start trial output from its coal-to-gas project in Xinjiang this year before moving to the production phase in 2013. The project has eventual capacity of 5.5 Bcm/yr. The report said key equipment for the first phase of the project has been installed. According to the report, CNPC's West-East gas pipeline network will take the output. Other local media sources say 14 coal-to-gas projects were started in 2011 in Xinjiang.

The China National Offshore Oil Company also has an interest in coal gasification, both upstream production and in transportation. Local media have reported that the company wants to build a 30 Bcm/yr capacity pipeline to take SNG from

3. Coal gasification projects—under construction and proposed.

Operator	Location	First phase (Bcm/yr)	Target (Bcm/yr)	Year of first phase
Qinghua	Yili, Xinjiang	1.38	5.50	2012
Xinjiang Guanghui	Xinjiang	0.50	0.50	2012
Datang	Inner Mongolia	1.40	4.00	2013
Xinwen	Yili, Xinjiang	2.00	10.00	2013
Huineng	Ordos, Inner Mongolia	na	2.00	2013
Huaneng	Zhundong, Xinjiang	4.00	6.00	2013
Shenhua	Ordos, Inner Mongolia	na	2.00	2015
Sinopec	Xinjiang	na	8.00	2015
Guodian	Ulanhot, Inner Mongolia	2.00	10.00	2014
Xinjiang Guanghui	Fuwen, Xinjiang	4.00	4.00	2015
Datang	Fuxin, Liaoning	na	4.00	2016
China Power Investment Corp	Yili, Xinjiang	2.00	6.00	2015
CNOOC New Energy Investment	Shanxi	4.00	6 to 15	2015
Gansu Hongshengqi	Gansu	na	4.00	2015
Sichuan Petrochemical/Linde	Sichuan	na	15.00	MOU

Source: Company data, JP Morgan

Inner Mongolia to more central and eastern demand centers. CNOOC New Energy Investment has plans for a first phase coal-to-gas project with capacity of 4.0 Bcm/yr in Shanxi, a province south of Inner Mongolia, starting up in 2015.

Comparison with Shale

Based on the projects outlined by JP Morgan, SNG output from coal gasification could outstrip the contribution of shale gas to Chinese gas supply in the period to 2020. According to CEO Chris Faulkner of US independent Breitling Oil and Gas, China's shale gas targets are over ambitious, owing to the size of the investments required and infrastructural constraints such as pipeline connections and water supply and disposal. These concerns have also been highlighted by officials from China's state-owned oil and gas companies.

Beijing is targeting annual output of 6.5 Bcm/yr of shale gas output by end-2015, although state oil companies PetroChina and Sinopec have only outlined output targets of less than half that. Sinopec's target of 2 Bcm includes shale, coalbed methane and tight gas.

Investment capital is also likely to be a constraint. Despite a number of cooperation agreements with International Oil Companies, China's Ministry of Land and Resources, which controls the country's shale acreage, launched its first bid round last year, with only a handful of local state-related companies allowed to participate.

Of the four areas offered, only two attracted bids, and those were awarded to Sinopec and Henan Provincial Coal Seam Gas Development and Utilization Co. A second round is expected this year, but participation is again expected to be limited to domestic companies.

Speaking at the Shale Gas World conference in Singapore in July, Faulkner said, "There's a massive gap between the activity in the country and full-scale development ... That's why I really don't think China is going to get anywhere by 2015 or 2020, for that matter. It's going to be a 2022, 2025 play for them ... The pace at which China is moving is not going to allow it to create the amount of production it needs by 2015."

Complementary Technologies

China's initial push for SNG production is based on traditional coal mining, with the innovative phase coming in the gasification and methanization that produces syngas and then upgrades it to SNG. The advantages include the more efficient extraction of coal's energy value, the potential use of poorer quality coals and the prevention of pollution in densely-populated areas.

Piping gas produced in Xinjiang or Inner Mongolia to eastern and southern demand centres saves on rail and truck transport of coal to power stations in those areas. However, any SNG produced is as likely to displace oil products as much as direct coal burn because China's expects a rapid increase in city gas consumption over the next decade and is putting the infrastructure in place to facilitate this.

Other technologies complement the expansion of coal gasification. Foreign companies involved in Underground Coal Gasification, for example, appear to be migrating from their home patches, where resistance to coal-related technologies is stronger and environmental controls more stringent, to jurisdictions in Asia.

Australia's Linc Energy, a leader in the UCG sector, recently agreed a joint venture with GCL Projects, a subsidiary of Hong Kong-based Golden Concord Holdings, to build its first multi-gasifier project in China. Linc offers integrated UCG to Gas-to-Liquids technology to produce transport fuels from coal.

Another Australian firm, Cougar Energy, is also reported to be in talks with local Chinese partners to use its UCG technology on prospective coal areas in Inner Mongolia. Focusing on UCG for power generation, Cougar is currently involved in site selection for a UCG project in the Wu Ni Te coal basin. Cougar saw its Kingaroy UCG pilot project in Australia shut down in July 2010 on environmental grounds that it is still contesting in court.

In July last year, at a UK-China summit, a \$1.5 billion partnership was announced between UK UCG developer Seamwell International and the state-owned China Energy Conservation and

Environmental Protection Group to develop a 1,000 MW UCG project in China on the Yi He coal field in Inner Mongolia. If built, the project would be the largest of its kind.

UCG involves the combustion of coal underground to produce syngas. It avoids the need both for traditional mining and an above ground gasification plant, but is struggling to prove itself on environmental and operational grounds. If it can be made to work reliably at scale, it could hugely extend the exploitable coal resource. Given China's vast coal reserves, UCG could represent a second development phase to complement current efforts in SNG production that, in theory at least, could create a new industry on a scale commensurate with existing conventional gas production.

The second complementary technology is Carbon Capture and Storage. Owing in part to its heavy coal use, China's greenhouse gas emissions are rising fast. As a developing country, China is not bound by any emissions reduction targets other than those it sets itself. Coal gasification is often portrayed as a 'clean coal' technology, but its main claim in this area is its efficiency and its separation of CO₂ pre combustion, which makes it easier to capture and store CO₂. Without CCS, it represents a means of extending coal use rather than lowering its carbon impact. It may produce clean burning gas, but the CO₂ is emitted earlier on in the process.

China has a number of CCS projects, but as in Europe and the United States, commercial deployment remains at least a decade away. For projects such as the Seawell joint venture or that announced with US company CoalTek last year for a 'clean coal' processing facility in Inner Mongolia, the focus is on energy production and the efficient use of coal rather than capturing and storing CO₂.

According to an MIT report on one of the most advanced projects, Shenhua's Direct Coal Liquefaction Production Line at Ordos, Inner Mongolia, CO₂ liquefaction in preparation for storage, as well as some pilot storage, has been achieved, but full-scale operation is not expected until 2020 at a cost of \$1.46

billion. Similarly, the Tianjin GreenGen coal gasification plant is behind schedule and is only the first of three phases, the last being a CCS project, which is scheduled for 2015-2020.

Two projects announced in 2011 were also based on CCS enabling projects rather than CCS itself. Alstom Power in July last year said it was in discussion with China Datang Power to build a 350 MW Oxyfuel plant in Daqing, Heilongjiang, China's historic center of oil production. The plan is to use CO₂ for enhanced oil recovery.

A second project under discussion was a partial post-combustion capture project for a proposed 1,000 MW plant in Dongying, Shandong, near the Shengli oil field. At the time, Climate Change Minister Xie Zhenhua noted that cost effective uses for CO₂ were essential and that anything beyond that would require international finance.

As a result, coal-based SNG production can be seen from two viewpoints. First, as a means for China to exploit more fully its coal resource and thus ultimately to use more coal and make more emissions. Second, as a preliminary stage on the road to creating a genuinely low carbon process for the use of coal, which in its initial phase makes some emission gains through using coal more efficiently.

Clearly, as in other countries, other motivations ride alongside environmental concerns. China needs energy to develop and economic development is a key priority. It also wishes to reduce its growing dependence on imported oil and gas. As a domestic resource, SNG allows it to do both by substituting for imported gas and oil products in heating and cooking.

Based on the projects under construction, the next 18 months are likely to demonstrate whether coal-based SNG can deliver commercial scale quantities of pipeline quality gas. If they do, and the oil and gas companies are sufficiently confident to move ahead with their ambitious pipeline proposals, there is a real possibility that SNG will make as big, if not a larger, contribution to Chinese gas supply than shale gas out to 2020, and possibly beyond. ■