The comeback of coal

Underground coal gasification might give European coal reserves a new lease on life. The biggest hurdle is carbon dioxide emissions.

by Rembrandt Koppelaar

One of the solutions to some of Western Europe's energy woes is likely to come from an unexpected corner – the European coal industry. The industry has long been on the decline as Western Europe's coal production decreased by 65% from 640 to 220 million tons in the past two decades. But a radical turnaround is possible. Rising energy prices, depleting natural gas reserves and concerns about energy security mean the UK is turning to an old technique that has great potential: underground coal gasification (UCG). This is an energy production system in which oxygen, air or steam is injected underground to ignite coal. The result is the partial combustion of the coal seam and formation of combustible syngas containing proportions of methane, hydrogen, carbon monoxide and carbon dioxide, which can be removed through an extraction well and processed for energy usage. Commercialisation is well underway in the UK according to Rohan Courtney, the founding director of UCG Partnership. 'Commercialisation could happen immediately if the licensing were approved. The UK Government is working hard to sort that out. There is likely to be an environmental review, which actually doesn't take very long. So my view is that we should have commercialisation in the UK in two years.' Several companies in the UK, including BP and BCG Energy, have already announced their intention to develop commercial UCG projects.

This is a hopeful development for Europe since UCG holds many advantages. Deeper coal layers that cannot reached by conventional strip and long wall mining can be utilised, thus vastly expanding coal reserves. Preliminary estimates suggest that 130 billion tons of coal could be extracted by means of UCG in Europe, which is ten times more than the current proven mineable reserves. UCG is also the only technique that can unlock vast offshore coal reserves under the North Sea. This may be closer to happening than most people realise, according to Courtney. 'Actually, commercialisation will more likely be offshore than onshore. Directional drilling, which is a simple matter in the oil and gas industry, can be used to drill down into the coal seams. A lot of the coal is only just offshore.' The process is also far more economical than above ground-gasification and powdered coal. No gasifier or boiler is needed to create the syngas. The coal does not need to be transported or washed and there is no ash to handle. The syngas that results can be used for not only power generation but also for liquid fuel production, such as diesel conversion with proven gas-to-liquids (GTL) technology and, in the future, cost-effective hydrogen reformation.

The commercial basis of UCG was pioneered in the Soviet Union in the 1930s and eventually led to five syngas-fed power plants. But development halted in the 1960s due to the discovery of abundant cheap natural gas deposits in West Siberia. The power plants were dismantled, with the exception of Yerostigaz in Uzbekistan. With a thermal content of 1,000 Btu per cubic feet for natural gas versus 300-400 for initial raw syngas, it was a logical choice. No commercial ventures have been undertaken since then. Trial projects did continue, however, mainly in the US during the oil crisis, as well as in Spain, Belgium and the United Kingdom with the primary aim of improving control of the UCG process to establish sound engineering practices. Valuable lessons were learned from these trials. In the Spanish trial from 1993 to 1998, for instance, a lack of coal exploration data led to a breach in the wall of an unknown nearby aquifer. That could have led to large water inflows in the UCG cavity, a potential environmental hazard. The lesson was that good preparation of underground coal seam data in onshore production and emergency water treatment plans were necessary. The original water inside the cavity was transported to the surface, along with the syngas, where it was decontaminated and discharged into the local environment. Another potential problem for onshore production could be subsidence risk. No surface subsidence has occurred so far at the small UCG trial sites but it might occur in the more extensive cavities used in large scale operations. Caution in site selection and scaling up the process is a necessity.
After the trials in Spain, further development of UCG was spearheaded in the UK. The Department for Business, Enterprise and Regulatory Reform (BERR, formerly DTI) has undertaken many assessments of the technique since 1999. Their most recent cost estimate for a 300 MW UCG syngas-fired power plant without carbon capture and storage lies between 2.8 and 4.2 eurocents per kWh. This is competitive with traditional coal-fired power capacity. The onshore resource potential for the UK is deemed to be sufficient to warrant 27 GW of power capacity in practical locations where electricity production and gas processing is possible near coal seams, higher than the current 25 GW coal-fired generation capacity in the country. Offshore resources could in theory supply all of Britain's power for decades to come.
Countries outside Europe are also developing UCG technology. The South African company Eskom is one amongst several that have bought specific project licenses for UCG technology from Ergo Exergy. Their UCG pilot plant in Majuba, South Africa, is now operational, providing enough syngas for 6 MW of power to the existing 4.2 GW power plant in the region. Eskom eventually wants to produce 1,200 MW of power by means of UCG syngas. Another company is Australian Linc Energy, which undertook a large UCG trial between 1999 and 2003 with controlled shutdown in Chinchilla, Australia. This venture was originally undertaken with the aid of Ergo Exergy but the partnership ended in 2006. Not long after terminating the partnership, Linc bought up the remaining UCG power plant in Yerostigaz and partnered with the Skochinksy Institute of Mining in Moscow where UCG technology was first commercialised. The firm now intends to scale up syngas production on its Chinchilla site and couple it with GTL technology from the Syntroleum Corporation to produce 20,000 barrels of GTL diesel fuel per day. Linc Energy claims that it can reap high profits from the combination of UCG and GTL, citing a production price of $30 per barrel.
The only big hurdle to UCG seems to be carbon dioxide emissions. Emissions from UCG are lower than other coal-based electricity routes because the carbon dioxide in the syngas-stream can be returned at almost no extra cost to nearby coal seams that cannot be mined. The carbon dioxide, however, that results from electricity production is still significantly higher than natural gas-based electricity due to the composition of the syngas. For a sound climate policy, carbon capture and storage implementation is necessary. ■

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Cheap hydrogen from coal

Poland and the UK are involved with UCG development in a technically challenging research project. The Hydrogen Oriented Underground Coal Gasification for Europe, or HUGE, project aims to deliver the technical means for cheap hydrogen production from coal. Eleven research institutes across Europe will join forces from July 2007 until July 2010. They will have a budget of €3.2 million to build a dynamic geo-reactor in which UCG will be combined with CO_2 sequestration in coal deposits as well as the reformation of hydrogen. If proven viable, it would be the cheapest zero emission hydrogen production method available, costing $0.20 to $2.40 per gigajoule, according to the International Energy Agency.