

carbon capture journal

IEA - progress of CCS must be speeded up

Pöyry - flexible CCS for power generation

B9 Coal - UCG with fuel cells CCS project

Sept / Oct 2010

Issue 17



US Federal Task Force concludes CCS is viable

Paying for CCS in oil refineries

UK Biochar Research Centre - carbon capture through biochar in soils

British Geological Survey - sub-surface expertise for CCS

Oxand - risk management methodology for CO₂ storage

Institute of Petroleum Engineering at Heriot-Watt University

- experimental observations of CO₂ for storage

B9 Coal UCG with fuel cells CCS project

B9 Coal, based in the UK, has developed a novel project which involves using syngas from Underground Coal Gasification (UCG) to generate power from alkaline fuel cells.

About a third of UK electricity is generated from coal, a feed stock which emits more CO₂ per unit of electricity than any other form of generation. Tackling emissions from coal therefore must be a priority for the UK. In 2007 the Department of Energy and Climate Change (DECC) opened a government funded competition, demonstrating the UK's call to action to tackle climate change. With cutting greenhouse gasses a top priority, carbon capture and storage (CCS) projects were called for to secure future energy supplies whilst minimizing the environmental impact.

In August 2010, B9 Coal, a UK based clean energy company, introduced a 500 megawatt (MW) project aimed at meeting DECC's call for CCS in industry. According to the company, the key combination of technologies behind the project are a world first. The proposal brings together alkaline fuel cells and underground coal gasification, two technologies which receive little attention in power generation, but B9 Coal says that by combining them CO₂ capture upwards of 90% can be accomplished at no extra cost.

The project has huge partner support, including WSP Group, AFC Energy and Linc Energy, all key players in their industries, plus a proposed Rio Tinto Alcan site in the North East.

"I firmly believe that we cannot afford to simply put a sticking plaster on old, dirty technologies" explained Alisa Murphy, Director at B9 Coal. "Our combination of technologies is truly game-changing, and if the government is to achieve their stated aim of showing global leadership on CCS, the competition needs to support new, emerging technologies that are built for the future."

Underground coal gasification

Underground Coal Gasification (UCG) is the process of gasifying coal in-situ, where it lies under the ground. UCG provides access to coal 'stranded' deep underground, eliminating the need to mine it and process it through a surface gasification plant. The process produces a high quality synthetic gas (syngas), containing carbon monoxide, hydrogen and methane.

The technology has evolved through numerous trials since the early 1900s. Commercial scale UCG sites for power generation have been operating in the former Soviet Union for over 40 years. In the UK alone,

UCG could potentially give access to an extra 17 billion tonnes of coal, without the major environmental impacts of conventional mining. The process could therefore have immense benefit in terms of UK energy security and the ability to power the country from indigenous resources.

Last month, the Environment Agency released a position statement on UCG explaining that, "the UK has significant coal reserves that are believed to be suitable for UCG and cannot be accessed using conventional techniques such as deep shaft or open cast mining," and stating that, "the government supports the development of UCG."

B9 Coal is working with Linc Energy, a forward-thinking energy company and Australia's leader in clean coal technology. Linc Energy is well-positioned to take their proven technologies to UCG-suitable locations around Australia and the world. With significant coal deposits suitable for UCG technology, Linc Energy can provide alternative sources of liquid fuels and power generation well into the foreseeable future.

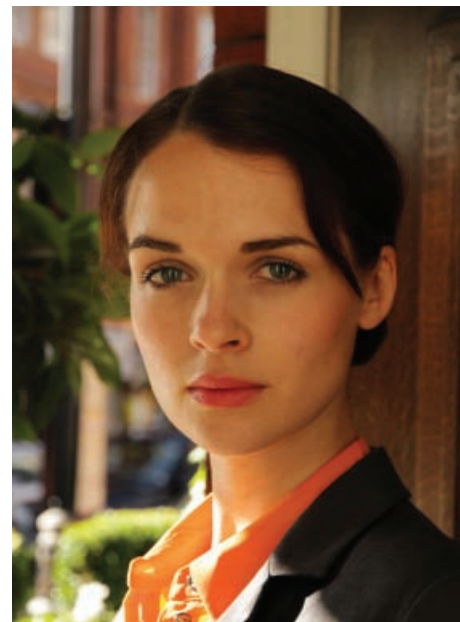
Alkaline fuel cell technology

The alkaline fuel cell was first demonstrated by Sir William Grove in 1839. In 1939, Sir Francis Bacon resurrected the technology from its former design and created the first working model, producing 5KW of power. Alkaline fuel cells work by passing hydrogen and oxygen over a catalyst to create water, heat and electricity.

Since 'Bacon's Fuel Cell', the technology has been used by NASA to fly man to the moon in the 1960s, but as companies speculatively took it to market, the expensive materials and heavy weight slowed progress, labelling the technology as unviable for commercialisation.

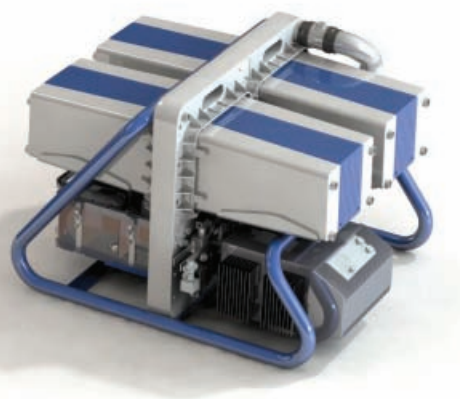
UK Company AFC Energy have taken this out-of-fashion technology and created a commercially viable method for clean power generation. Their fuel cell is low-cost, low-temperature and low-pressure. Uniquely, the technology is also fully scalable and modular, giving the B9 Coal model the ability to load follow to meet peak demand.

A recent technical review of AFC Energy's technology from Dr.



"We believe we have a world-leading template that delivers on DECC's key requirements: delivering value for money, demonstrating international leadership on CCS, and proving the potential of this technology." - Alisa Murphy, Director, B9 Coal

Jon Helliwell, Project Manager of Fuel Cell Applications at the Centre for Process Innovation (CPI), highlighted the substantial strides the company has made over the last 5 months, as well as the significant headway achieved in commercialising the system and delivering on partner expectations. AFC Energy boasts world-leading partners including AkzoNobel, Ineos, Centrica, Air Products, WSP Group and Linc Energy. The technolo-



AFC Energy's alkaline fuel cell

gy is gaining momentum across a range of markets including chlor-alkaline, waste-to-energy, clean coal and natural gas.

AFC Energy's technology is focused on large-scale industrial applications and the objective of producing the lowest possible unit cost electricity. AFC Energy's alkaline fuel cells convert hydrogen to electricity at up to 60% efficiency and, when combined with UCG, can provide a possible cost per kWh of as low as 4p.

Ian Balchin, CEO of AFC Energy described the B9 Coal project as, "an impressive integration of technologies which addresses the energy challenges we are currently facing. It gives us the opportunity to maximise our coal resources but in an environmentally sensitive way."

In June 2010, AFC Energy's fuel cell system was successfully deployed and operated at Linc's underground coal facility in Chinchilla. This was the first time that an alkaline fuel cell had been deployed with UCG and represented a major step towards the world wide opportunity of establishing UCG partnered with alkaline fuels cells as a breakthrough technology.

"This effectively demonstrates that combining the AFC Energy's fuel cell technology with hydrogen from Linc Energy's syngas, produced from the world-class UCG at Chinchilla, is a feasible route to achieve the ultimate in clean electricity from stranded, sub-economic coal, of which there is an abundance in the world," explained Linc Energy CEO Peter Bond.

The B9 Coal project in action

The B9 Coal proposal would mark the first-ever large scale deployment of these technologies in a CCS project. UCG produces syngas which is then passed through a clean-up process resulting in separate streams of hydrogen and carbon dioxide. The hydrogen is used to power the highly efficient fuel cells whilst the carbon dioxide is ready for transport and storage. The project will offer greatly enhanced efficiency conversion of coal to electricity, whilst enabling upwards of 90% carbon capture.

Rio Tinto Alcan's Lynemouth Plant in Northumberland has been announced as a potential site for the plant. The proposal has the support of the North East Process Industry Cluster (NEPIC) and RENEW, the organisation tasked with commercial energy and environmental technology projects across North East England.

"Together these technologies have the potential to transform coal from the dirtiest fossil fuel to the cleanest," remarked Alisa Murphy. "We believe we have a world-leading template that delivers on DECC's key re-



Linc Energy's UCG flare and Gas to Liquids facility at its Chinchilla Demonstration Facility, Queensland, Australia

quirements: delivering value for money, demonstrating international leadership on CCS, and proving the potential of this technology."

Commenting on the project, Neil Crumpton, a UK energy specialist working for the Bellona Foundation environmental group said, "the B9 project is revolutionary and undoubtedly world-leading. An early successful demonstration at scale of AFC Energy's remarkable fuel cell and underground gasification with CCS would open up several strategic-scale opportunities to the UK in terms of variable power generation, energy security, climate policy and UK manufacturing jobs."

"As this project proposal becomes more widely noticed, power generators around the world, even some governments, will start watching closely to see how the UK Government responds to this unique and huge opportunity," he continued.

Natural gas CCS

B9 Coal, and its affiliate B9 Gas, also recently announced their intention to create a unique, climate-friendly natural gas power station in response to the Committee on Climate Change (CCC) call for the application of CCS to natural gas to be included in the DECC competition.

The project would use the known technology of steam methane reforming (SMR) to convert natural gas to hydrogen which is then fed to AFC Energy's alkaline fuel cells to create a modular, on-demand, decarbonised power plant.

"The proposal would offer significant

advantages over conventional natural gas power plants with turbines, primarily the ability to load follow," said B9 Coal. "Excess hydrogen can be stored overnight and used to generate electricity to meet peak demand, guaranteeing a consistent and reliable supply of power. The scaleable nature of the fuel cell system ensures that there is no loss of efficiency during up and down cycles, unlike conventional gas turbines."

B9 Gas is in talks to acquire an existing hydrogen generating plant with potential CCS and hydrogen storage facilities. By using existing facilities with operating permits in force, the B9 Gas plant has the potential to be operational within 3 years.

"The B9 Gas project is a technically advanced solution to the problem of carbon emissions and climate change," explained Alisa Murphy. "The combination of natural gas with alkaline fuel cell technology is another exciting template for clean energy generation with carbon capture. Our model offers CCS without inflated cost or loss of efficiency, as well as major implications for UK energy security, job creation and technological achievement."

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More information

B9 Coal was established in 2009 with the objective of developing projects combining underground coal gasification (UCG) with Carbon Capture and Storage (CCS) and alkaline hydrogen fuel cells.

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