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Written by Tom Vulcan | October 31, 2011

Underground Coal Gasification: An Old Energy Revolution Whose Time Has Come

Energy generation technique is nearly 100 years old, but potential mostly untapped.

"*The world-famous British chemist, William Ramsay, has discovered a method of obtaining gas directly from a coal seam*."

—V.I. Ulyanov (Lenin) *A Great Technical Achievement*, Pravda, April 21, 1913, pg. 91

So, writing in exile as he was, what exactly was Lenin writing about? And why did he consider it such an achievement? One, he thought, that "will bring about an enormous revolution in industry."

Now, more than 98 years after Lenin penned his article for Pravda, perhaps underground coal gasification may finally be on course to bring about such a revolution. But, if it does, it will be a "revolution" in the world of energy generation as opposed, as Lenin envisaged it under socialism, to releasing the labor of millions of miners.

What Is Underground Coal Gasification?

Underground coal gasification (UCG) converts coal, *in situ* underground, into gas.

The gas so produced can then be used in a number of important ways, including:

- For generating power
- For industrial heating
- As chemical feedstock
- A source of hydrogen

Short History Of UCG

As can be seen from the quotations from Lenin above, UCG has been around a long time. Indeed, the concept was first developed in mid-19th-century London, with the aforementioned William Ramsay all set to start his own work on UCG in the north of England when World War I ended his efforts.

While testing in the U.K. may not have recommenced until the 1950s, this did not stop the erstwhile Soviet Union from taking up the UCG baton.

Following various successful and unsuccessful tests during the 1930s, in 1939 the Soviets had their first UCG plant up and running, at Lisichansk, the Donbass coalfield, in Ukraine. Subsequently, though, it shut down during World War II. By the end of the 1960s, however, there were some 14 working UCG plants in the former Soviet Union; apart from Lisichansk, the four main were:

- Angren, Uzbekistan
- Gorlovka, Ukraine
- Podmoskova, Moscow basin
- Yuzhno-Abinsk, the Kuzbass coalfield, Russia

Perhaps surprisingly, the rest of the world took up the UCG baton pretty much only after the middle of the 20th century. Apart from some trials in Europe at Bois-de-la-Dame, near Wandre in Belgium in 1947 and 1948, and Newman Spinney in Derbyshire in the U.K. from 1949 to 1959, trials in the U.S. only started in the early 1970s, in France in 1981 and Australia, New Zealand and Spain in the mid- to late-1990s.

In China, however, following the establishment of a special UCG unit at the China University of Mining and Technology, trials have been taking place since the 1980s at some 16 different sites, usually disused mines. And, according to the World Coal Association, now "China has about 30 projects in different phases of preparation that use underground coal gasification."

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How Does UCG Work?

UCG turns coal, through partial combustion, into gas without it having to be mined. The gas produced – syngas – is similar to, but remains distinct from, not only natural gas, but also such gases as coal bed methane (CBM), methane hydrates, shale gas or the gas from tight gas sandstones. Rather, as a combination of carbon dioxide, carbon monoxide, hydrogen and methane, chemically, syngas is akin to old-fashioned town gas. (Following water cooling and removal, syngas derived, for example, from sub-bituminous coal is a combination of: CO_2 - 37.7 percent; H_2 - 28.4 percent; CO - 17.9 percent; CH_4 - 15.0 percent; and, H_2S - 1.0 percent.)

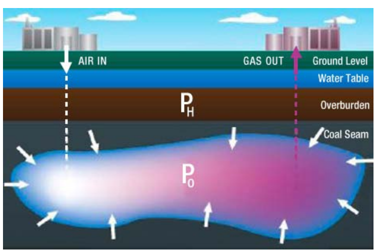
The basic UCG process is really very simple.

Identify a suitable un-mined coal seam and:

- Sink two wells into the coal seam: one through which to inject oxidants (for partial combustion), the other, some distance away, through which to remove the syngas to the surface
- Heat the coal at the base of the first well
- Inject and regulate a flow of O_2/air and, sometimes, steam (to ensure the gas separates, through partial combustion, into syngas, as opposed to burns)
- Remove syngas to surface

The gasification process takes place both under high pressure and high temperatures (1,290-1,650ºF, but sometimes as high as 2,730ºF), heat at which the coal would normally burn.

Diagrammatic Representation of Basic UCG Process



Source: UCG Association

While the basic, "vertical wall" method (as used originally by the Soviets on thin, shallow, coal seams) of UCG involves two unlinked wells, various further methods have also evolved. These include:

- The "vertical wall" method, but with the two wells linked horizontally with boreholes (used by the French in the late 1970s)
- The controlled retraction and injection point (CRIP) method — the injection point can be moved during the process (used in Spain and the U.S., and particularly suitable with deeper seams)
- The manmade cavern method — used by the Chinese

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Why Interest In UCG Now?

The current interest in UCG is a result of the conjunction of two different sets of circumstances. On the one hand, advances in, or, perhaps better, the reapplication of drilling technology have rewritten the economics of UCG; and, on the other, the need for alternative clean, safe, cheap and sustainable energy sources has become increasingly pressing.

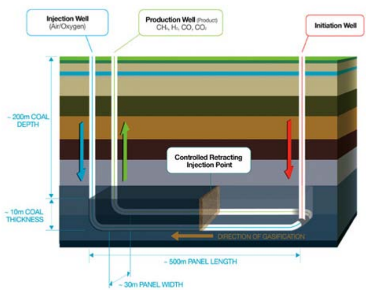
Horizontal Drilling

While UCG may have been around for nearly a century and a half, its accepted commercial viability has always been open to question (the Soviet Union was a command economy). It has always really been a process (or series of processes) waiting for technology to happen.

In a particularly interesting instance of cross-industry development, techniques developed in the oil and gas industry — specifically, directional and horizontal drilling (as used, for example, in the shale gas industry in the U.S. to reach previously uneconomical resources) — have revolutionized UCG.

Whereas before, wells were restricted to the vertical, down into the coal seams, now wells can actually be driven horizontally *through* the coal seams, allowing access to considerably more of the coal than before.

Diagrammatic Representation of CRIP UCG Method



Source: © Carbon Energy

Clean, Safe, Cheap And Sustainable Energy

As an energy source alone, UCG is possibly unique in being able to address all these issues positively.

Since the whole gasification process takes place underground, there are lower emissions. For example, methane gas is captured and not released to the atmosphere. And particulates stay underground. And again, since everything happens underground, the surface impact is significantly reduced. (The possibility might exist, too, of using the empty combustion "chambers" from the UCG process to sequester CO_2 — either third party or from the generating planting actually using the syngas.)

On the safety front, if nothing else, nobody works underground. While much has been made of the potential risks of groundwater contamination, subsidence and uncontrolled fire, the choice of site is probably one of the most, if not *the* most, important factors in deciding upon the viability of a UCG project. However, the use of very deep coal seams can render those concerns akin to academic.

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Because UCG is both ideally suited to deep, inaccessible coal, which is uneconomic to mine traditionally, and "operates at up to 80-85 percent efficiency — the amount of the syngas recovered at the surface is about 80-85 percent of the original heating value of the coal feedstock" (recent UCG Association presentation), its potential as a cheap source of energy is significant.

According to the UCG Association: "Applying UCG technology to stranded, low grade, coal seams vastly increases the amount of exploitable global reserves," with estimates suggesting that UCG could increase recoverable coal reserves in the U.S. alone by 300-400 percent.

Potential also exists in such emerging markets as China, India and South Africa. With, of course, the added advantages that: 1) plant costs are low (everything takes place underground); and, 2) there are no transport costs – the coal isn't taken anywhere.

Not Just For Power Generation

Syngas can be used in a number of different products and contexts, not just for power generation.

Hydrogen	*Ammonia*
	Chemicals
	Fuel Cells
Methanol	*Acetic Acid*
	Dimethyl Ether (DME)
	Ethylene
	Formaldehyde
	Methyl Acetate
	Petrol
	Polyolefins
Fischer-Tropsch	*Diesel*
	Naptha
	Petrol
	Wax
Synthetic Natural Gas	
Iron Reduction	

The Current Situation

While, except in China, there many not be that many UCG programs either operating commercially, or in a precommercial development stage — measured by the number of projects both announced and under review — there is increasing interest in the process around the world.

An Expanding Industry

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Those currently in operation, however, are spread around the globe:

Australia: There are two commercial UCG operations: at Chinchilla (Linc Energy Ltd – LNC:AU) and Bloodwood Creek (Carbon Energy Limited – CNX:AU) both in Queensland. While Cougar Energy Limited's (CXY:AU) operation at Kingaroy, also in Queensland, was closed (citing environmental reasons) by the Queensland government back at the end of September 2010, the company announced on Oct. 17 that it was now suing "the State of Queensland and three Queensland Government officials seeking damages in excess of $34 million" over their actions.

Canada: Swan Hills Synfuels, a privately owned Canadian company, has been operating a pilot plant at Swan Hills in Alberta since 2009, and, in July this year, was awarded a CDN$285 million grant by the Province of Alberta for a carbon capture project. Aside from its demonstration project, the company is developing its Swan Hills ISCG/Power Project, which it describes as a " … full scale Cdn$1.5 billion project [that] will commence service in 2015. Expansion and/or replication potential are significant."

China: More than 30 different UCG projects are currently under development in China. These are being developed both by local entities, for example, ENN Coal Gasification Mining Co., Ltd. – part of the ENN Group and Chongqing CECEP – part of CECEP (state-owned), and in international partnerships with the likes of Cougar Energy and privately owned U.K.-based Seamwell International.

South Africa: Eskom has operated a 9 MW demonstration site at Majuba in KwaZulu-Natal since 2007. It plans to build a 42 MW demonstration plant by 2015.

Uzbekistan: Majority owned by Linc Energy, the Yerostigaz facility in Angren, Uzbekistan is not only the oldest (since 1961) operating UCG site in the world, but it is also the only remaining such site in the former Soviet Union.

An Investment Opportunity?

UCG is certainly not going to light up the world overnight. However, it does make a forceful story, not least because of both the current, and continuing, need for acceptable alternative sources of energy and the technological advances in the UCG process that have revolutionized its economics. It is a source of energy worth watching closely.

For investors with an eye to "now" as opposed to "then," apart from the participants in the field that have already been mentioned, there are several other fully publicly owned, albeit small, companies out there looking at UCG. These include:

- Clean Global Energy Limited (CGV:AU)
- Europa Oil & Gas (Holdings) plc (EOG:LN)
- Liberty Resources Ltd. (LBY:AU)
- MetroCoal Ltd. (MTE:AU)
- Wildhorse Energy Ltd. (WHE:AU)

And the private companies to keep an eye on, in case of an IPO, include:

- Clean Coal Ltd.
- GreatPoint Energy Inc. — catalytic gasification technology
- Laurus Energy Inc.
- Riverside Energy Ltd.
- Solid Energy New Zealand Ltd.
- Thornton New Energy Ltd.

Resources

Carbon Energy Limited

Clean Coal Limited

UCG Association