Tapping into coal

Swan Hills Synfuels, a private Canadian developer, has secured reserves of deep coal in Alberta, Canada, and is adapting existing in-situ coal gasification (ISCG) technology to turn this deep stranded coal into clean synthesis gas that can be used as fuel for clean power generation or processed further to create other clean energy products.

In-situ coal gasification (ISCG) combined with carbon capture and storage has excellent environmental attributes, including significantly reduced air emissions, non-fresh water use in the gasification process and minimal surface disturbance. The clean gas from the ISCG process, when used for fuel for power generation, creates an efficient power generation facility that has a dramatically better emissions profile than existing coal-fired facilities or power generation from natural gas.

The province of Alberta in Canada, with its abundance of deep coal that is too costly and technically difficult to mine, represents one of the best locations globally to develop commercial ISCG projects. The energy content in the deep coals in Alberta is greater than the energy content of all of the oil sands and all of the conventional oil and gas reserves remaining in Alberta.

Many factors make Alberta attractive for ISCG:

- deep, thick coal seams;
- access to the coal for ISCG development;
- support for energy innovation;
- proximity to oil development provides opportunity to sell CO_2 for EOR;
- CO_2 sequestration capabilities;
- access to energy transmission infrastructure and markets;
- experienced well-drilling service providers;
- provincial and industry initiatives to produce clean energy.

Improved drilling technology and European test projects in the 1990s demonstrating the technical, economic and environmental benefits resulting from deep coal ISCG have resulted in significant advances. More recently, economic factors, including energy prices and the availability to secure value for CO_2 produced in the ISCG process have also encouraged development in this field.

The majority of gasification plants operating worldwide are surface gasification plants designed to produce chemicals, fuels, electricity and fertilizers. Volatile oil and natural gas prices, more stringent environmental regulations and a growing consensus that CO_2 management should be required in power generation and energy production has led to a growing interest in gasification and world gasification capacity is expected to grow rapidly over the next five years, especially in Asia.

In gasification plants, feedstock is exposed to high temperature and pressure. In the presence of steam at these conditions a series of chemical reactions occur which convert the feedstock into syngas.

> **Alberta, one of the best locations to develop ISCG projects**

In the case of ISCG, this chemical conversion of the feedstock (deep coal) takes place in the original coal seam. The resultant syngas consists primarily of hydrogen, methane, carbon dioxide and carbon monoxide.

Two wells are drilled into the deep coal seam. A horizontal injection well is used to introduce oxygen and water into the seam; the oxygen supports a limited and controlled amount of combustion, raising the temperature of the coal and boiling the water to generate steam.

The naturally existing, deep, underground pressure, along with the elevated coal temperature and the presence of steam, together form the right conditions to gasify the coal. The vertical production well is used to conduct the raw syngas to the surface. Char and ash, which are remnants of the original coal, remain deep underground (Fig.1).

The coal seam for ISCG development at the Swan Hills Synfuels site is 1,400 m beneath the surface, approximately 800 m below the Base of Groundwater Protection (depth limit of fresh groundwater – below this depth groundwater is saline), eliminating potential for fresh groundwater contamination. Saline water is used for injection into the coal seam through the horizontal well, virtually eliminating the need for fresh water in the ISCG process.

Demonstration project

Swan Hills Synfuels has developed an ISCG demonstration project located 17 km southwest of Swan Hills. The first phase of the demonstration project was completed in June and July 2009 and resulted in a range of measurable successes that will assist in the future development stages of the commercial project. The demonstration project well pair is full commercial scale and will be one of several identical pairs in the commercial project, each independently providing syngas to a central gas plant.

The project was the first of its kind in North America with the deepest underground coal gasification ever conducted. The clean burning excellent quality syngas successfully produced from its deep coal resource at 1,400 m below the surface revealed that clean syngas can be successfully manufactured at these depths. Key ISCG control fundamentals including elevating coal to very high temperatures to create gasification were successfully demonstrated. The successful injection of saline water in the gasification process demonstrated a viable alternative from utilising fresh water and provides significant environmental advantages over processes

requiring the use of fresh water for energy generation. The ability to control shutdown and restart capabilities of the gasification process were also demonstrated.

The demonstration project has confirmed that the Swan Hills Synfuels deep coal resource gasification process behaves in accordance the substantial body of worldwide experience with ISCG and reinforces that Swan Hills Synfuel's coal resource has excellent geology and coal properties for ISCG.

The next steps comprise gathering operational data for the design of the large scale commercial development, securing financing for larger commercial scale project development and interpretation of actual construction and operating costs of the demonstration project to accurately forecast requirement for Swan Hills Synfuels commercial scale operation.

First commercial project

Swan Hills Synfuels' first major commercial project is the Swan Hills in-situ coal gasification and Sagitawah power generation project located in Central Alberta. This clean energy system will produce syngas that will be used as fuel for very efficient low-emissions power generation, producing 300 MW of baseload electricity supply for Albertans.

The project will use ISCG to tap deep, unmineable coal to produce syngas that will be processed in a conventional gas plant to remove CO_2 as a byproduct stream. The syngas will then be pipelined to a combined cycle power generation station located near Whitecourt, Alberta to produce low emissions electricity (Fig.2).

The project will capture and sequester over 1.3 million tonnes of CO_2 each year. The Alberta government will invest $285 million in the Swan Hill project, from its $2 billion Carbon Capture and Storage Fund. Construction is expected to begin in 2012 with carbon capture scheduled to start by 2015.

The carbon dioxide created during the gasification process will be captured and used for enhanced oil recovery (EOR) in the Swan Hills area. The CO_2 will be used to increase the pressure in depleting conventional oilfields, allowing more oil to be produced.

Replication opportunities are plentiful and include the second phase of the Swan Hills ISCG/Sagitawah power project, which will result in a combined capacity of 600 MW of electricity and over 2.6 million tonnes of CO_2 sequestered per year.

Fig 1: **ISCG well pair schematic**

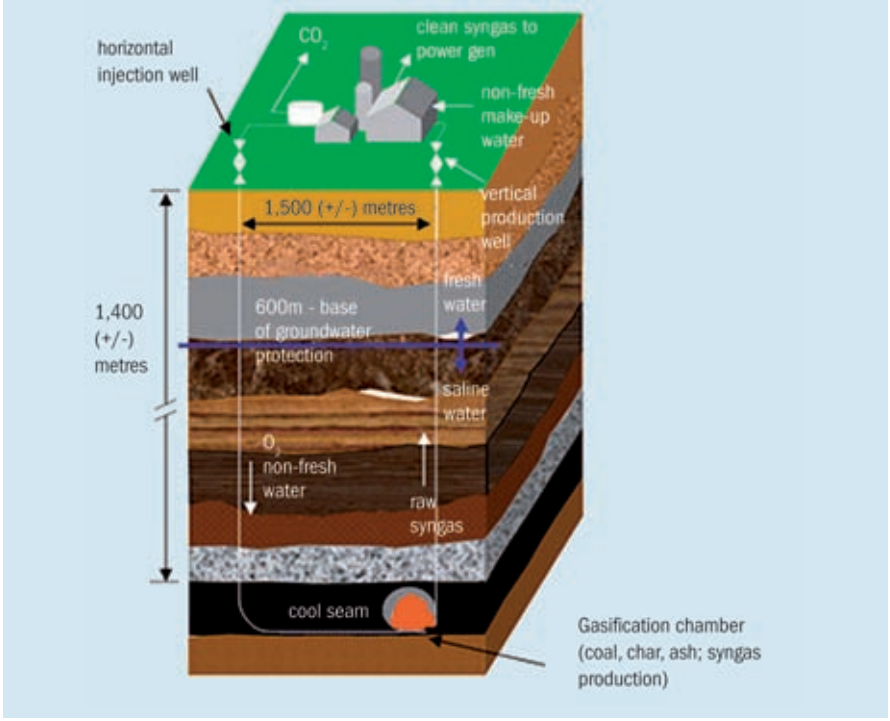

Fig 2: **Swan Hills ISCG/Sagitawah power project**