

Underground Coal Gasification

Underground Coal Gasification (UCG) is one of several clean coal technologies being investigated by Eskom.

UCG, a process where coal is gasified in place, was conceived in the late 1800s and has been developed in various countries across the world. A matrix of boreholes is drilled into the coal seam, sealed wells are created, the coal is ignited and air is pumped into the injection wells. Fire is essentially used to 'mine' the coal and produce synthetic gas (syngas) which can be used directly as a fuel for power generation.

This process avoids the need for coal mining, transportation, preparation, gasifier equipment and the transportation as well as disposal of ash, which has cost, labour and environmental benefits. Eskom's indicative calculated levelised life-cycle cost of electricity from a commercial UCG plant compares favourably to that from a new conventional super-critical pulverised coal power station. The cost of electricity would also be shielded from commodity fuel price fluctuations as domestic energy resources would be used.

UCG technology has been researched over the past 70 years in the former Soviet Union and has been in industrial-scale operation there for heating and power generation applications for more than 50 years. The piloting of the technology has been rapidly escalating in the rest of the world over the last decade. The Eskom pilot plant started operating in January 2007 and since then has continued to prove the technology and verify its performance for the phases to follow. Eskom licensed its UCG technology from Ergo Exergy Technologies Inc. (Canada) to accelerate the technology uptake. There are many emerging factors that give new impetus to the commercialisation of UCG. These include:

- An increasing need to reduce emissions from coal-fired power plants
- A desire to find alternatives to natural gas and oil due to escalating and unstable commodity prices
- Diminishing resource availability

UCG has synergies with conventional mining as it can make use of coal that would not normally be mined. Currently three quarters of South Africa's coal resources fall into this category. The implication is two-fold. Firstly, UCG and conventional coal mining can function in parallel without interference between sites and secondly, UCG can significantly increase the country's coal reserves. Eskom's conservative estimate is that there is an additional 45-billion tons of previously unminable coal suitable for UCG in South Africa.

Eskom's Strategic Drivers

The use of UCG gas as a fuel for advanced clean coal technology power generation has the potential to address a number of strategic drivers for Eskom and South Africa:

- UCG has the potential to supply base load generating capacity in the 2020 timeframe, from the Majuba coalfield in Mpumalanga.
- UCG-Integrated Gasification Combined Cycle (IGCC) promises emission benefits compared to conventional power generation. Coal currently provides much of South Africa's primary energy needs and UCG as a potential clean coal technology enables mitigation of the environmental consequence of this dependence, while alternatives to coal are developed.
- The UCG-IGCC technology enables modular expansion, which has cost and lead-time benefits. The technical risks are inherently low, as most of the modules have been proven elsewhere in the world. Adaptation is however required to suit local site conditions and fuel sources, as well as Eskom and national standards.



- Modularity is shown by the fact that Eskom's demonstration plant gas turbine is in the same size range as those proposed for the envisaged commercial plant. The mining and gas treatment modules will also be sized similarly to their commercial plant successors. This modularity will assist in reducing scale-up risk and in expediting the technology uptake.
- UCG enables utilisation of substantial unminable coal resources in South Africa, which has obvious primary energy inventory advantages. There are also advantages due to the broader geographic spread of such unminable coal.
- The significantly improved mining efficiency of UCG, compared to other conventional underground coal mining technologies, also has obvious primary energy inventory advantages as well as safety advantages as people do not need to work underground.
- UCG effectively shortens the coal value chain by reducing the number of steps between mining the energy resource and generating electricity. This has obvious advantages for the cost of electricity, as well as additional less obvious advantages for safety and the environment (due to the absence of handling and transportation of solids).

Project Status

- The Eskom pilot plant was commissioned in January 2007 and has run continuously ever since.
- The gas cleaning plant and condensate separation plant for a 15,000Nm³/hr co-firing demonstration have been commissioned.
- Mine production can be ramped up to provide the necessary gas flow for a co-firing demonstration in Unit 4 at Majuba Power Station.
- Initial co-firing at Majuba power station was achieved in October 2010.
- The design phase for a 100-140 MWE open cycle gas turbine demonstration plant using UCG gas is currently underway.



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