

THE DEVELOPMENT AND FUTURE OF UNDERGROUND COAL GASIFICATION IN THE AUSTRALASIAN REGION

By

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1. Introduction

The international development of Underground Coal Gasification (UCG) technology is dominated by the work undertaken over the past 70 years in the Former Soviet Union (FSU). This work is summarized by Gregg et al (1976), and Kreinen (1992), and its significance is evidenced by the fact that Gregg et al in 1976 placed a value of US\$10 billion on the effort required to reproduce it. Kreinen (1992) estimated that ‘...about 15 million tonnes of coal have been gasified in the USSR, and more than 50 billion m³ of gas has been produced’. This historical work has undoubtedly provided the catalyst for the growing commercial interest in the technology in Western countries.

Considerable R & D effort was expended in the US in the 1970’s and 1980’s, sponsored by the US Government, during which time it is estimated that some 50,000 tonnes of coal were gasified in more than 15 field trials. The program culminated in the RM1 test in Wyoming (Bloomstran et al, 1988), but was terminated a few years later. In Western Europe, a number of small pilot tests have been undertaken over the past 50 years, the last being in Spain in 1997, during which some 300 tonnes of coal were gasified at a depth of about 550m.

With the substantial funding provided to these programs over a long period of time, it is of some interest to record the historical development of UCG technology in Australia which led to the successful Chinchilla project in Queensland, to review current activity in the country and the potential for the development of projects in the Asian region.

2. UCG Activity in Australia

Technical work on UCG was initiated in Australia in the late 1970’s, and was strongly advocated by the late Professor Ian Stewart of the University of Newcastle, who directed a program of laboratory test work into in-seam gasification sponsored by the Federal Government. Professor Stewart visited a variety of research organizations in the US, USSR and Europe in 1976, and concluded that “...in-situ gasification of deep seams of hard coal should be commenced now to provide for future power and syn-gas requirements....”(Stewart 1984). Concurrently with this work, he obtained Government funding for an engineering feasibility study into the application of the UCG process to produce gas for power generation at the existing Leigh Creek coal mine in South Australia. The study concluded that the cost of power generation using gas turbines was economically competitive when compared with a conventional coal-fired power station. An application for funding for a test burn at Leigh Creek was made but was unsuccessful, and further Government funding for the technology ceased.

Having been involved in the Leigh Creek study in 1982/83, the writer in 1989 initiated a preliminary study into the potential for using UCG gas in existing boiler systems at the Swanbank power station in Queensland. The power station was partially disused at that

time, and is located within the Ipswich coal field. This study was the first of a series of privately funded efforts to initiate a UCG-fuelled power generation project, which culminated in formation of Linc Energy Ltd by the writer in October 1996, and an association with Dr Michael Blinderman of Ergo Exergy Technologies Inc (Ergo Exergy) in February 1997, which led to a more detailed joint feasibility study on the Swanbank UCG gas-fuelled power station concept later that year.

The level of interest within the power industry at that time was not encouraging, largely due to the established expertise and low cost of producing power in conventional coal-fired plants, and the perceived risks associated with a new technology. However, as a result of these developments, CSIRO organized a seminar on UCG in Brisbane in March 1999, and following recommendations made by the writer, initiated a research program on UCG process modeling.

In July 1999, the association between Ergo Exergy and Linc Energy was formalized, and the Company obtained both private and Government funding to initiate the Chinchilla UCG project, which was planned to progress from an initial pilot burn to the establishment of a 40MW power project (Walker 1999), using gas clean-up and turbine technologies developed in the IGCC program sponsored by the Department of Energy in the US. The success of the pilot burn has been well documented (eg Walker et al 2001), it having operated from December 1999 to April 2002, gasified some 35,000 tonnes of coal, achieved all required environmental clearances, and confirmed potential economic viability.

Unfortunately, funding for completion of the project could not be obtained and decommissioning of the operations commenced in 2002, following the departure of the writer from the Company. This decommissioning was managed by Ergo Exergy up to its termination of the agreement with Linc Energy in September 2006. The Chinchilla project was undertaken at a time of little international interest in UCG technology, and its success was unique in the Western world. The writer believes that it is only now, with a changing attitude to energy sources, that its value in creating confidence in the technology has become evident.

Over the past two years, significant interest in UCG has developed within the private sector in Australia. Linc Energy, under new management, achieved Australian Stock Exchange (ASX) listing in May 2006, and is proposing to use the Chinchilla site to develop a coal gas to liquids project. At the time of writing, the pilot burn has not been re-started. The CSIRO, on the basis of its R&D work, has formed a Joint Venture with another ASX listed company, and is proposing to undertake a 3 year test burn at a new site near Chinchilla in Queensland. It is understood that this project will use the CRIP technology tested in the RM1 trial in the US in the late 1980's.

The writer's interest in the commercialization of UCG technology has remained undiminished after some 25 years. In February 2006, he formed a new company (Cougar Energy Ltd) to undertake UCG developments in Australia and internationally, again using Ergo Exergy as its UCG technology provider, and utilizing the commercial

experience gained from the Chinchilla project. This company achieved ASX listing in September 2006. The Company has identified an immediate project in Queensland, and has also negotiated the rights to a large coal deposit in Pakistan, where major power shortages are being experienced.

This relatively short history of UCG activity in Australia has focused on utilizing the work undertaken by others to move quickly to the development of commercial projects. UCG project development in the country has not been greatly encouraged by the established energy industry, and as a result the lead has been taken by small entrepreneurial groups using the public markets for fund-raising. The writer is confident that a strong commercial UCG industry will be established in Australia within a few years.

3. Cougar Energy’s Kingaroy Project

In May 2006, Cougar Energy acquired farm-in rights to a number of coal leases held by others in Queensland. Each individual coal lease has been the subject of previous exploration drilling, largely for investigating the prospectivity of open cut mining, resulting in most holes being restricted to about 100m depth. However, with a few deep holes, and an understanding of the regional geology, preliminary assessments can be made of the potential for development of a UCG project.

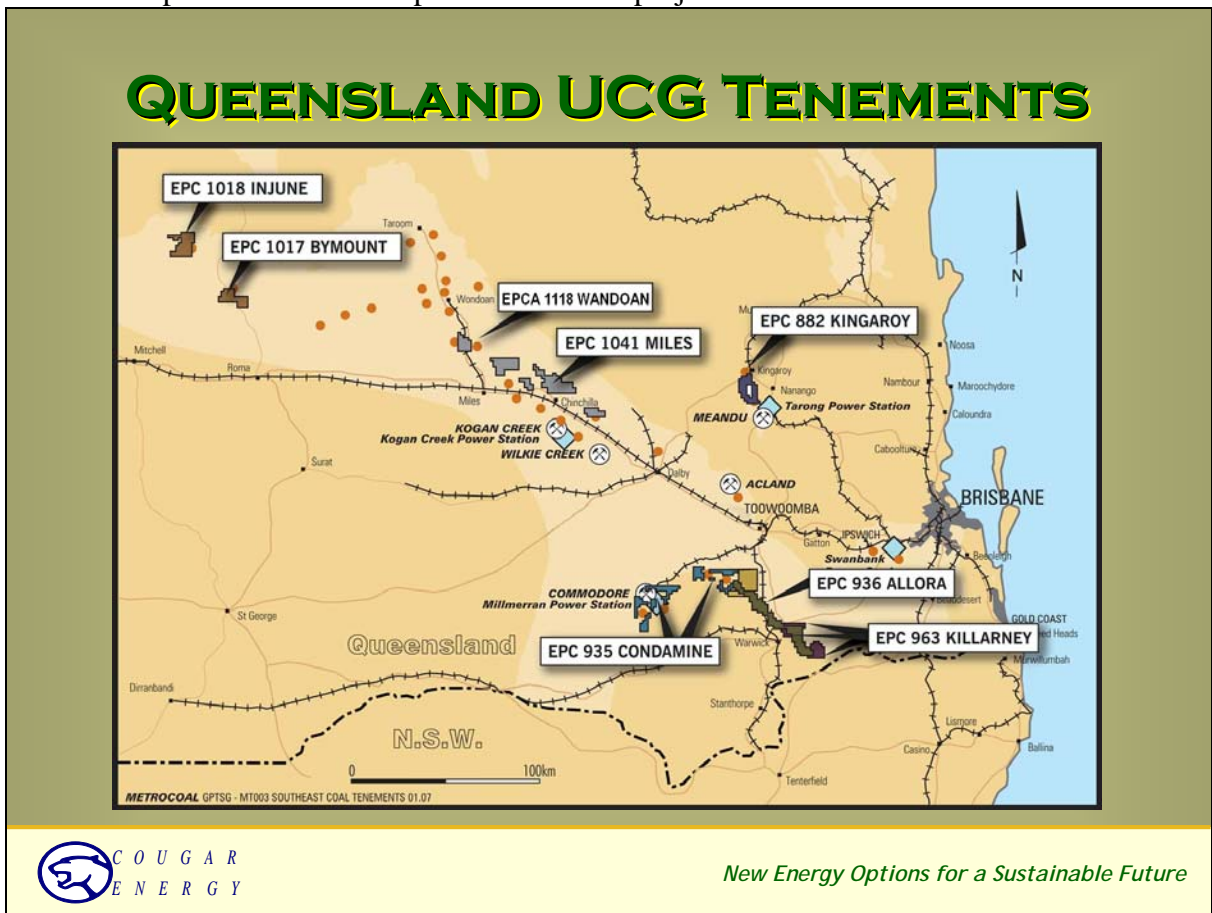


FIGURE 1 Cougar Energy Coal Interests - Queensland

Of these leases, the most attractive is EPC 882 which is near the town of Kingaroy, some 150km north-west of Brisbane, and 100km east of the site of the Chinchilla project (Figure 1).

Within the large lease area is a coal basin, part of which (the western side on Figure 2) has been subject to extensive drilling for open cut coal, with a resource of 180 million tonnes of coal having been identified to a depth of about 100m. The coal seam dips to the east before cutting out at the edge of the basin. Cougar Energy acquired the rights to access the deeper part of the basin (outlined as the UCG Area in Figure 2) to investigate the potential for establishing a UCG project within the area, producing fuel gas for a combined cycle power plant.

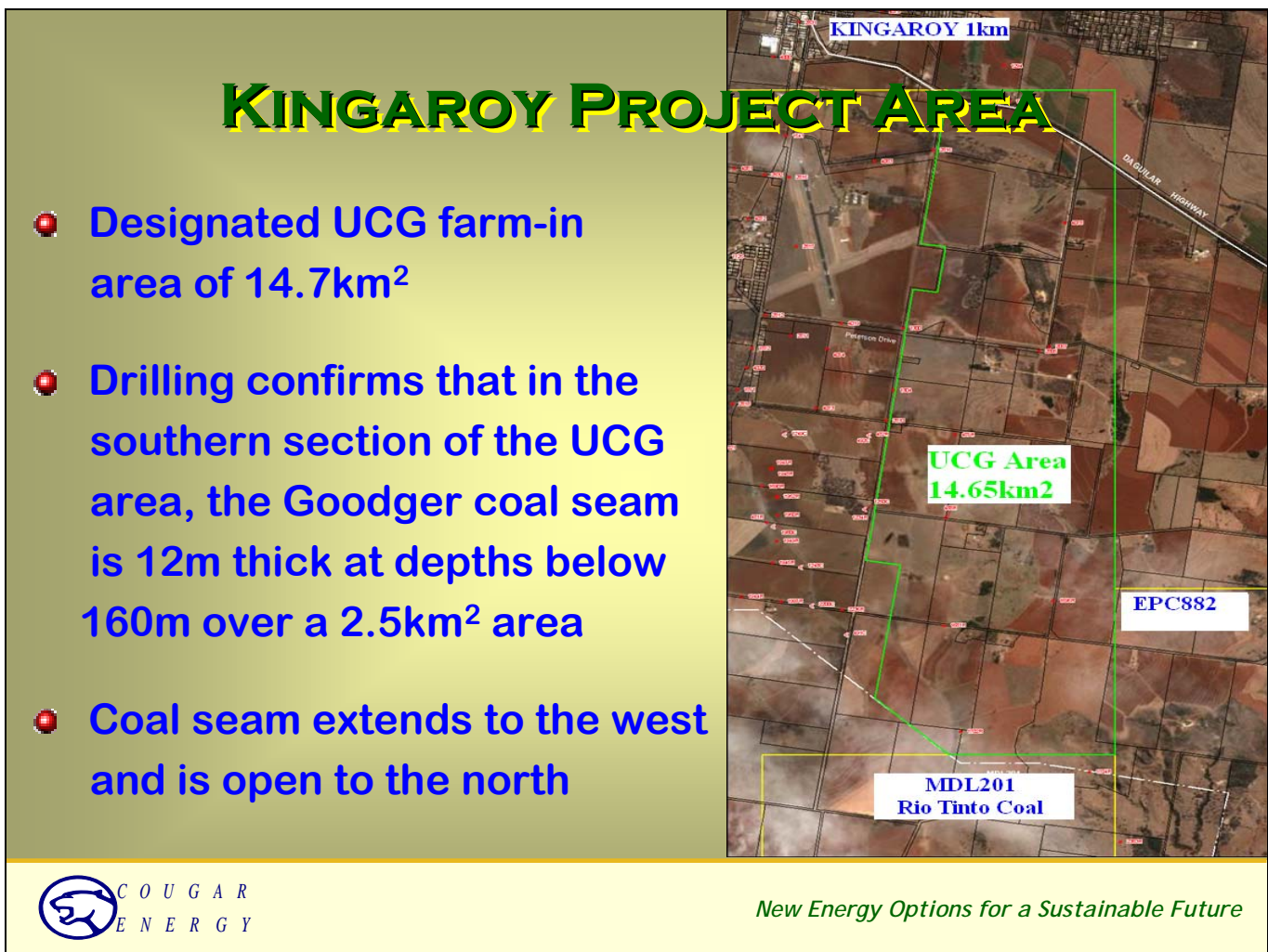


FIGURE 2 *Kingaroy Lease Development Area*

A number of existing deep holes to the south of the UCG Area intersected the Goodger coal seam around 12m thick at depths of more than 160m, with a stratigraphy encouraging for UCG development. In February this year, the company drilled five holes in the same area which confirmed conclusions from the original drilling. Using an area of influence of 500 metres radius for each drillhole, these results confirm that an area of at least 2.5km² exists within the UCG Area containing a coal seam with a minimum 11.8m thickness at a depth of at least 157m, with a known extension to the west and open-ended to the north. It is estimated that the coal within this established coal area would be sufficient to provide fuel to a 400MW combined cycle power station for at least 20 years. Expansion of the coal resource area can realistically be expected.

Using the experience obtained from the Chinchilla project, the Company has undertaken a preliminary economic evaluation of a power project at the Kingaroy site, and is aggressively moving towards a detailed site characterization program later this year to obtain data for design of the initial burn prior to project development. The Company is working with Ergo Exergy as its technology provider in the planning and execution of this program.

4. Prospects for Developments in the Asian Region

It is evident that international interest in the commercialization of UCG technology has grown significantly over the last 5 years. The current project in South Africa and potential developments in India have been well publicized, while Cougar Energy has recently announced its commitment to investigating the potential for a large power station in the Thar coal field in Pakistan. The writer has also been involved in discussions regarding projects in a number of other countries in the Asian region, and it clear that a wide range of commercial applications exist.

Walker et al (2001) estimated that the cost of power generated in Australia in an IGCC plant using UCG gas as a fuel could be in the range US1.0-1.5 c/kWh depending on plant size. Even allowing for increased costs with time, and more difficult construction conditions in some Asian countries, the cost of power might be expected to be well below their prevailing costs which generally exceed US4c/kWh.

Two specific project situations might illustrate the range of opportunities which may develop in the future. The first example relates to countries such as India and Pakistan, where significant and growing power shortages exist, and blackouts are common even in the capital cities. Both countries have very large coal deposits which are deep (>150m) and uneconomic for open cut mining. The prospect for development of large long-term power projects (>1000MW) using gas from UCG plants as a fuel is high, once local approval systems have adjusted to the new technology, and project financing can be achieved.

At the other end of the project size spectrum lies Indonesia, made up of a number of islands, with the main population centres being on the island of Java, which has no significant coal deposit, and whose power needs are serviced by large power plants using imported coal or natural gas as a fuel. The coal is mined from significant coal deposits

on the islands of Kalimantan and Sumatra. On these islands, the population is smaller and wide-spread, and it would be hard to justify construction of the large coal-fired power stations which are required to achieve low power costs. In such situations, the prospect of using UCG on deeper deposits, with smaller power plants (eg 70MW combined cycle) creates the opportunity to provide low-cost distributed power at the appropriate scale, with modular size increases available to match population growth.

5. Conclusions

This paper endeavours to record the role played in the international development of the commercialization of UCG by the activities undertaken in Australia, principally as a result of the association between the writer and Ergo Exergy. It is now evident that this activity is spread amongst a wide range of countries on every continent, and that a number of financially viable operations will be created over the next few years. The economic attraction of the low cost of UCG gas gives encouragement that a number of Asian countries which have increasing power needs, and a supply of coal at depth, may benefit significantly from the introduction of the technology.

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