

Panel: Gasify 100Mt coal by 2030 – the UCG Option

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Introduction

Coal gasification is an efficient and environmentally advantageous way to access the energy and chemicals available in India's large coal resources. The syngas produced by gasification is a versatile product which can readily be converted into many useful and essential products. It has been shown that in the right geological conditions, gasification can be done in situ, and avoid high cost surface gasification plant. Operating protocols for underground gasification have been developed that optimise syngas quality, and ensure environmental compliance at the highest level.



Coal Gasification Underground

UCG Underground Coal Gasification or In-Situ Gasification ISG

UCG - a Safe, Economic Option

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National priority for coal gasification

India has recognised the potential in coal gasification, and set a target for its introduction, suggesting it will achieve 100Mt by 2030. An attractive option is gasifying the coal in situ, or underground coal gasification. This is a low cost option - it avoids the costs of mining and coal transport, and the construction and operation of expensive high pressure and temperature surface plant.

The ability to produce commercial scale UCG syngas has been proven. Trials have been carried out for a hundred years, and cumulative learning from these efforts have produced an understanding of site geological requirements, operational rules and protocols, and environmental management techniques for efficient and safe coal gasification. UCG has moved from the research and development phase into technology implementation.

One of the most critical factors is confirming that a coal deposit has the necessary geological characteristics that allow quality gas production in an efficient and safe way. Gas and chemicals underground must be contained by strata within the gasifier which requires specific geological conditions. Experience has shown that only 5-10% of coal deposits will have satisfactory conditions. Even with these restraints, the coal resource available in India is very large, sufficient to service national needs for many years.



TARGET: Gasify 100Mt coal by 2030

Underground Coal Gasification UCG (Insitu Gasification ISG)

- Lowest cost option
- Commercial production is proven
- Specific coal conditions (only 5-10% suitable)
 - Very large Indian resource

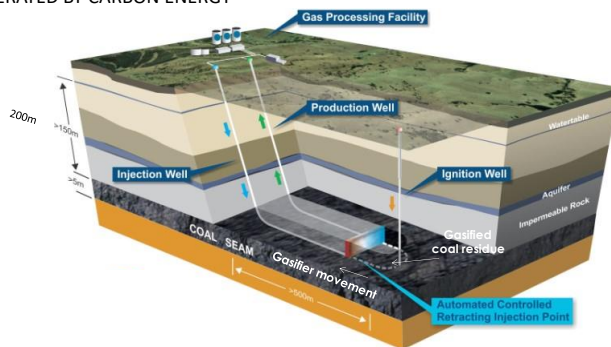
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Proven UCG technology and gasifier design

UCG gasifier design has steadily advanced, and in recent years stable production at commercial scale has been demonstrated. A number of designs have been used, but one of the most successful is the Parallel CRIP design pioneered in Australia and published by Carbon Energy. This uses two long, parallel, in-seam wells, one to inject oxidant and the second to remove product syngas. A gasification face lies between these two wells, and a panel of coal is extracted (gasified) as the gasification face advances, in a similar way to a traditional longwall coal mine. The extraction panels can be more than a kilometer long, and 30+m wide, and take 2-10 years to fully extract.

PARALLEL CRIP UCG DESIGN

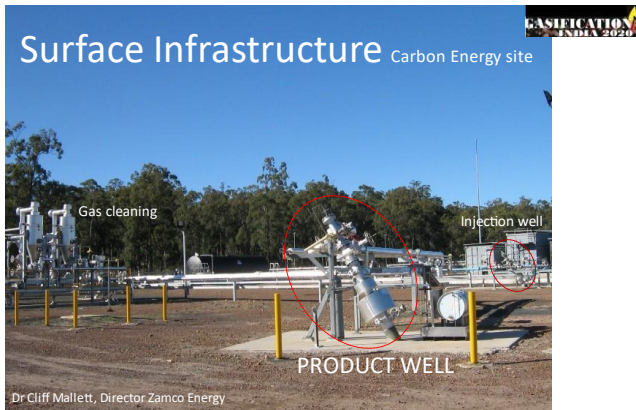
OPERATED BY CARBON ENERGY



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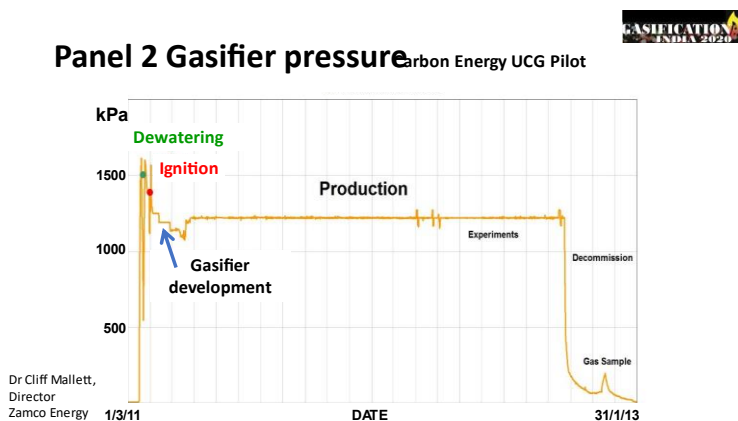
Surface facilities

Surface facilities are concentrated where the long in-seam wells come to the surface, and consist of compressors and supply of oxidant gas around the injection well, a production well where the syngas product emerges, and a syngas gas processing plant that removes water and any contaminants before the gas passes to its designated use (published by Carbon Energy). A significant advantage of UCG is that residual 'ash' left after gasification of the coal remains underground.



Long term consistent syngas production

When the geology of a site is suitable, and appropriate operating protocols are used, stable, long term syngas production is maintained. The plot below shows the gas pressure published by Carbon Energy for their Panel 2 over almost 2 years. Following de-watering and initial gasifier development, the gasifier was maintained at constant pressure until it was decommissioned after 20 months operation.

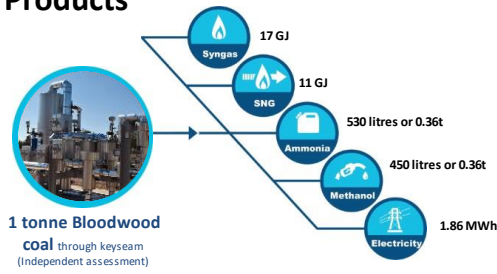


Products from UCG Syngas

An example of the potential products from UCG syngas is the independent studies published by Carbon Energy for their site in Australia. This indicated that for each tonne of their coal gasified they could obtain 17GJ energy, 11GJ synthetic natural gas (methane), 0.36 tonnes ammonia, 450 litres of methanol, and 1.86MWh of electricity. Production costs are competitive, for example SNG in a 25PJpa plant was predicted to cost around \$3.5.



UCG Products



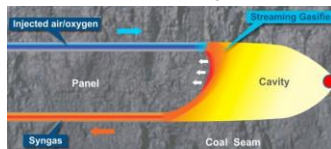
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UCG Gasifier production capacity

A UCG gasifier has an optimum production rate depending on the coal deposit, gasifier design, oxidant used, and most significantly, the depth and related gas pressure used. A single gasifier ranges 0.5 – 8PJ per year. The gasification face must maintain gasification temperature to support gas/coal reactions to give stable, continuous operation for the life of the extraction panel.



A UCG Gasifier has an optimal Production rate



One gasifier ranges 0.5-8PJpa – depends on depth/pressure

200m depth – 0.5 PJ Syngas per year

~1000m depth - 8PJ Syngas per year

Multiple modules will achieve required production

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Commercial scale production

UCG Gasifiers are duplicated to achieve the scale of production required for commercial plant using the UCG syngas. Coal consumed and products produced depending on the depth (gas pressure) of the gasifiers, and the number of gasifiers. One gasifier can convert 0.05-0.4Mt of coal per year into 0.55-4.4GJ SNG per year or 18-144 tonnes of ammonia. Fifty gasifiers will convert 2.5-20Mt of coal per year into 27.5-220GJ per year SNG or 900-7200 tonnes ammonia.



Commercial Scale UCG

Multiple gasifier units

Number of Modules	Depth m	Tonnes coal/pa	Syngas PJ/pa	SNG GJ/pa	Ammonia t/pa
1	200	0.05Mt	1	0.55M	18
	~1000	0.4Mt	8	4.4M	144
10	200	0.5Mt	10	5.5M	180
	~1000	4Mt	80	44M	1440
50	200	2.5M	50	27.5M	900
	~1000	20M	400	220M	7200

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