Underground Coal Gasification as a Clean Indigenous Energy Option

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The UCG Process

Key Variables:
1. The Coal – Nature, seam thickness, strata
2. Depth, - Hydrostatic Pressure
3. Oxidant – Oxygen content
100-DAY TRIAL FACILITY

- Production Well: syngas (H₂, CO, CH₄, CO₂)
- Injection well (O₂, steam)
- Retracting Injection
- Ignition well (+200m depth to coal)
- Surface plant
- 30m spacing
- <600m>

8-10m coal
World Coal Resource for UCG

World Resource 5-8000BT
• Proven Reserve (2005) 909BT
• Est. UCG addition 600BT
UCG - Energy Recovery Comparison

Energy extraction by method for a typical Australian 12km² coal deposit

- **UCG syngas**
  - **H₂**
  - **CO**
  - **CH₄**

- **Underground mining**
- **Coal**

![Energy Extraction Comparison](image)
CO₂ Capture Advantages of UCG-CCS

Capture Advantages of UCG (in deep seams)

• Gasification Process - amenable to pre-combustion capture (CHEAPER CO₂ SEPARATION)
• High Pressure Process - Smaller Plant & Pressure energy for power (up to 20%) available. (Cost Savings)
• Oxy-fuelled Process - burning gas produces only CO₂ and water (CHEAPER SEPARATION)
• H₂/methane mixtures can be produced - advantageous in gas turbines.
Pilot Plant:
Fischer Tropsch synthesis of clean diesel from UCG
Linc Energy, Chinchilla, Queensland, Australia
Efficiency and Capital Cost of Various Coal Combustion Technologies

- **Sub-critical**
  - £1150/kW
  - CO2 Emission: 1500 gram/kWh
  - Proposed limit of 500g/kWh

- **Supercritical**
  - £1200/kW
  - CO2 Emission: 1000 gram/kWh

- **Ultra-SC**
  - £1300/kW
  - CO2 Emission: 500 gram/kWh

- **IGCC**
  - £800/kW
  - Average Europe

Net efficiency (LHV) %:
- 30%
- 35%
- 40%
- 45%
- 50%
- 55%

- **150 MW UCG + CCGT**
  - £1150/kW
  - 20-25% energy cost for 90% post-combustion capture

- **150 MW UCG + Fuel Cells**
  - £1300/kW
  - 10% energy cost for 100% pre-combustion capture

**CAPEX**
- **without CCS**
  - £1150/kW
  - £1200/kW
  - £1300/kW

- **with CCS**
  - £1600/kW

**Proposed limit of 500g/kWh**

**Average Europe**

**Ultra-SC**

**IGCC**

**Sub-critical**

**Supercritical**

**Courtesy of BCG Energy**
Cost of Low Carbon Power Generation

![Cost of Low Carbon Power Generation Diagram](image)

**Figure 3. Cost of Low Carbon Power Generation**

- **Offshore Wind**: Effectively carbon-free.
- **New Nuclear (Base Load)**: Effectively carbon-free.
- **Existing Coal**: Including cost of removing or off-setting >90% of carbon.
- **New USC Coal**: Including cost of removing or off-setting >90% of carbon.
- **IGCC**: Including cost of removing or off-setting >90% of carbon.
- **CCGT (Natural Gas)**: Including cost of removing or off-setting >90% of carbon.
- **CCGT (UCG Gas)**: Including cost of removing or off-setting >90% of carbon.

2008/9 Price of Bulk Power £45/mw/h

Ditto rewarding 90% CCS £65/mw/h

Compiled by K. J. Fergusson, UCG Partnership
**Areas of the UK Suitable for Commercial UCG**

<table>
<thead>
<tr>
<th>Area of UK</th>
<th>&quot;Good&quot; UCG Resource M-tonnes</th>
<th>Power Output over 40 years MW</th>
<th>UCG as Nat Gas BCM</th>
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</thead>
<tbody>
<tr>
<td>Eastern/NE England</td>
<td>6,824</td>
<td>11,900</td>
<td>681</td>
</tr>
<tr>
<td>Lancs/Dee Wales</td>
<td>4,770</td>
<td>14,100</td>
<td>476</td>
</tr>
<tr>
<td>Wales</td>
<td>220</td>
<td>730</td>
<td>22</td>
</tr>
<tr>
<td>Scotland</td>
<td>171</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>16,784</strong></td>
<td><strong>26,730</strong></td>
<td><strong>1,676</strong></td>
</tr>
</tbody>
</table>

**Current Coal Power Capacity ~ 28,8550MW**

**UK Current Nat Gas Reserves 530BCM**

BGS study of coal resources for UCG, supported by DTI
Status of UCG Licensing in the UK

• First UCG licence application by:
  Thornton New Energy
  - for an area in the Firth of Forth
  - publicised in October 2008
  - conditional licence granted February 2009

• Second UCG licence application
  Clean Coal Limited
  - for five coastal areas of England and Wales
  - publicised December 2008
  - conditional licences granted November 2009
Concluding Remarks

- Despite 50 years of trials no commercial UCG project has been demonstrated
- Development of new technologies and the increase in the value of energy may change this
- Recent progress with pilot projects showing considerable promise
- Current pilots could result in commercial-scale operations within five to seven years, providing greatly increased confidence in the technology
- Sharing knowledge and keeping more of it in the public domain could greatly enhance the chances of UCG becoming an accepted and widely applicable technology
5th UCGP International Conference & Workshop
London 23rd – 24th March 2010

A global alliance of knowledge, expertise, training, networking & information for Underground Coal Gasification

www.ucgp.com
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