Global Development of Underground Coal Gasification

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UCG ASSOCIATION
Outline of Presentation

• Introduction to UCG Association
• Benefits of UCG
• The Global Growth of the UCG Industry
• Conclusions
Underground Coal gasification

- The process of gasifying coal whilst in situ
- Best suited to deep, inaccessible coal, UCG has the potential to significantly increase global coal stocks and turn these into a high value synthetic gas, cleanly, safely, cheaply
- In recent years it has undergone a transformation due to technical advances, specific research, open exchange of knowledge and information.
- Much of the recent development and industry growth has been spearheaded by the UCG Association
The UCG Association

• The professional body for the Underground Coal Gasification Industry
• Not for Profit – Member Subscriptions
• Promote, Educate and Inform all of the commercial, social and environmental benefits of UCG technology
• Engage with Governments, Decision makers, Environmental Groups and the Media
• Work closely with Licensing, Regulatory Bodies
• Over 280 members, representing more than 70 organisations and 29 nations: Argentina, Australia, Belgium, Botswana, Brazil, Bulgaria, Canada, Chile, China, Colombia, Germany, Hungary, India, Indonesia, Ireland, Italy, Japan, Kazakhstan, Netherlands, Norway, Poland, Russia, Slovakia, South Africa, Ukraine, UK, USA, Vietnam.
• UCGA is globally recognised as the centre of excellence and information for all
Some of our Members

Deloitte
NABARRO
Future Energy Yorkshire
American Coal Council
Skadden
Wardell Armstrong
Engineering & Environmental Solutions
Keele University
The Coal Authority
MEGCHEN
IN SITU ENERGY, LLC
WESTRALIAN GAS & POWER LIMITED
Reliance Industries Limited
Carbon Energy
ABN-AMRO
China YINFA Group
STATOIL
eenergy Institute
Newcastle University
Imperial College London
IMC
Durham University
clean coal
新奥集团
PetroSA
Liberty Resources
CAPE BRETON UNIVERSITY
UCG ASSOCIATION
More of our Members
We are Members of

- World Coal Association
- Energy Institute
- American Coal Council
- Brazilian Coal Association
- Westminster Energy Forum
- Fossil Fuel Foundation of Africa
- Global Round Table on Climate Change (GROCC)
- Global Carbon Capture and Storage Institute (GCCSI)
- European Union – Coal Working Groups – India, China, South Africa
- UN Expert Group on Resource Classification (UNERC)
Why UCG Now?
To fully appreciate the benefits of any new technology one needs to discuss this in the context of the global energy and environmental challenge

Global Energy Challenge

• Energy Security
• Sustainable Supply
• Energy Poverty
• Climate Change

UCG addresses all of these issues
Benefits of UCG

As the gasification of coal takes place underground many of the advantages of UCG are obvious:

• No one works underground
• Less Surface Impact - No coal is brought to the surface
• Lower Fugitive Dust - Noise - Visual Impact
• Syngas can be piped directly to the end-user, reducing rail / road infrastructure
• Cheaper and easier site remediation on project completion
UCG – Lower emissions

- Particulates – 50% lower than surface equivalents and stay underground **where they belong**
- Harmful chemical vapours such as NOx, SOx, are captured and do not enter the atmosphere
- Mercury, Sulphur greatly reduced and easier to handle
- Reduced methane emissions - gas recovered, rather than lost in the atmosphere
- Leaves coal ash and other process wastes deep underground,
- Offers reduced environmental management and costs
- The whole process affords opportunities to use coal more effectively
UCG – CCUS Advantages

Operating a UCG power plant system at high pressure allows the full, higher-heating value of coal to be utilized, recovering the latent heat of vaporisation. UCG operates at up to 80-85% efficiency - the amount of the syngas recovered at the surface is about 80 - 85% of the original heating value of the coal feedstock.

Enables the CO2 in the flue gas to be captured in a supercritical state available for Enhanced Oil Recovery (EOR) Enhanced Coal Bed Methane (ECBM) - Carbon Capture Utilisation and Storage (CCUS) opportunities.
UCG – Water Stress

UCG may not require an external water source to operate. A major environmental advantage.

**Concept Water Stress** - an imbalance between water use and water resources.

The water stress indicator in this map measures the proportion of water withdrawal with respect to total renewable resources.

www.worldwatercouncil.org
UCG – Water Supply

- World population tripled in the 20th century
- But use of renewable water resources grew six-fold.
- As the resource becomes scarce, tensions among different users intensifies, at both national and international level.
- Over 260 river basins are shared by two or more countries.
- One of the Millenium Development Goals is to halve, by 2015, the proportion of people without sustainable access to safe drinking water and sanitation
- Expected 40% -50% increase in population by 2050 - coupled with industrialisation and urbanisation - demand for water will have serious environmental consequences.
- www.worldwatercouncil.org
UCG – Sustainable development

The total number of individuals without electric power is about 1.5 billion - a quarter of the world's population. Nearly 80% of known coal reserves are deemed unmineable. The poorest nations - least choices of indigenous energy sources.

Direct Link:
Access to Energy
Human Development
Life Expectancy

Clean Conversion of coal - too deep - poor quality, or simply uneconomical to access - into energy and products has huge environmental and social benefits.
UCG – Sustainable development

Applying UCG technology to, stranded, low grade coal seams vastly increases the amount of exploitable global reserves

- Estimates suggest UCG could increase recoverable coal reserves by 300%-400%*
- Coal when applied to UCG becomes the largest sustainable resource base in the world

*Accelerating Development of Underground Coal Gasification, Dr. S Julio Friedmann, Lawrence Livermore National Laboratory, 2007)
What is Alberta’s Estimate of Coal Reserves?

The ERCB estimates the established remaining reserves of raw coal in Alberta as of Dec. 31, 2008 is 33.4 Gt - as compared to the WEC estimate of 6.6 Gt which would place it about the same as the Ukraine.

<table>
<thead>
<tr>
<th>Rank Classification</th>
<th>Initial in-place resources</th>
<th>Initial reserves</th>
<th>Cumulative production</th>
<th>Remaining reserves</th>
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<tbody>
<tr>
<td>Low- and medium-volatile bituminous*</td>
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<td></td>
<td></td>
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<tr>
<td>Surface</td>
<td>1.74</td>
<td>0.811</td>
<td>0.235</td>
<td>0.576</td>
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<tr>
<td>Underground</td>
<td>5.06</td>
<td>0.738</td>
<td>0.108</td>
<td>0.630</td>
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<td>0.343^d</td>
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<tr>
<td>High-volatile bituminous</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface</td>
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<td>1.89</td>
<td>0.166</td>
<td>1.724</td>
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<tr>
<td>Underground</td>
<td>3.30</td>
<td>0.962</td>
<td>0.047</td>
<td>0.915</td>
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<tr>
<td>Subtotal</td>
<td>5.90^c</td>
<td>2.88^c</td>
<td>0.213^d</td>
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<tr>
<td>Subbituminous*</td>
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<td></td>
<td></td>
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<tr>
<td>Surface</td>
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<td>8.99</td>
<td>0.754</td>
<td>8.236</td>
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<tr>
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<td>21.132</td>
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<td>34.8^c</td>
<td>1.379</td>
<td>33.421^c</td>
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</tbody>
</table>

^a Tonnages have been rounded to three significant figures.
^b Includes minor amounts of semi-anthracite.
^c Totals for resources and reserves are not arithmetic sums but are the result of separate determinations.
^d Difference due to rounding.
^e Includes minor lignite.

Slide courtesy of Rick Richardson, Alberta Innovates.
Flexible Product Uses

SYNGAS

- Syngas Product
- Iron Reduction
- Synthetic Natural Gas
- Naphtha
- Petrol
- Diesel
- Wax
- Fischer-Tropsch
- Petrol
- Polyolefins
- Methyl Acetate
- DME
- Formaldehyde
- Acetic Acid
- Ethylene
- Steam & Power
- IGCC
- Power Gen
- Hydrogen
- Ammonia
- Chemicals
- Fuel Cells
How fast is the industry growing?

- **UK:** 13 UCG licences awarded (BCG Energy, CCL, Riverside, Europa Oil & Gas. B9 Coal and others promoting a demonstration UCG-CCS project onshore and 500MW power station.

- **Ireland:** 1 UCG licence awarded in Dublin Bay - VP Power.

- **Belgium:** EU trial at Thulin.

- **Canada:** UCG Projects announced in Alberta, Nova Scotia - Nordic, Swan Hills, CCL & Laurus.

- **USA:** Major trials in the 1950s. Substantial interest & new project activity planned in Wyoming, Montana, North Dakota, Cook Inlet, Alaska & other states. Linc, CCL & Laurus.

- **Spain:** EU trial at El Tremedal.

- **Colombia:** UCG project planned.

- **Chile:** UCG project announced by Carbon Energy.

- **Brazil:** Demonstration project planned.

- **Slovenia:** UCG under review.

- **Czech Republic:** UCG under review.

- **Slovak Republic:** MOU signed by CCL.

- **Hungary:** White Coal & Wildhorse Energy project.

- **Romania:** UCG activity under review.

- **Bulgaria:** 2 projects under review.

- **Turkey:** CCL project in Amasra with Hema.

- **Kazakhstan:** UCG trial site identified.

- **Russia:** Long history of UCG activity. Promgaz-Gasprom active.

- **Japan:** Research activity.

- **China:** History of Pilots. Academic training of many UCG PhDs. New projects planned- Cougar & CCL. The Ulanchap, Inner Mongolia project is in its 3rd year. Other projects in this region in planning stage with other operators including CGE, Cougar & Gulfside.

- **Bangladesh:** UCG activity planned.

- **Vietnam:** 2 projects Red River Delta in planning stage- Linc & CCL.

- **Indonesia:** MOU signed by CCL.


- **New Zealand:** Solid Energy UCG project.

- **India:** Substantial activity planned with 13 companies bidding for leases.
Global UCG Development

- **Australia** - Bloodwood Creek site, Carbon Energy
  Chinchilla - Linc, Western Australia - 3 potential sites, Pekira Basin,
- **Bulgaria** – EU funded joint research project – Overgas,
  Aachen University, Leeds University, UCG Engineering
- **Canada**, Swan Hills Synfuels, deepest ever, 1,400 meters, CC for EOR,
  Laurus Energy Project, others Liberty, Linc, Nordic
  **Canada ahead on legislation, environmental frameworks, licensing**
- **China** – recent announcement of Inner Mongolia Project, joint
  UK/China initiative, ENN syngas from pilot project in Walanchabi
  City, Inner Mongolia, 26 months, gasifying more than 100,000 tons of
  coal.
- **Chile** - Carbon Energy
- **Colombia** – lack of legislation
Global UCG Development

- **Hungary** - WildHorse Energy, Mecsek Hills project, plus two other sites earmarked
- **India** – announcement soon of UCG projects
- **New Zealand** – Solid Energy project at Huntly
- **Pakistan** - Thar Project, Sindh Province
- **South Africa** – Eskom, Majuba UCG project
- **Turkey** – Carbon Energy
- **UK** - 18 licenses to explore UCG off shore
- **USA**, Colorado, Wyoming, Montana, Alaska – Linc, Carbon, Laurus, Ergo and others

**State level** - Montana, Colorado, Indiana,

**University of Utah, University of Colorado, LLNL, NETL** - UCG research, **Clean Air Task Force Report** - recommends 3 UCG pilots
Global UCG Development - UK

- 1 in 3 homes in Britain rely on coal for electricity.
- Indigenous production currently represents approximately 33% of the total amount.
- 10% of UK’s electricity is being created from indigenously produced coal *

  *The UK remains reliant on vast quantities of expensive coal and gas imports*

*Source - the UK Coal Authority*
Global UCG Development - UK

- 18 conditional UCG licenses issued – more than elsewhere
- No one doubts that operating UCG off shore will not offer challenges
- Enables access to huge untapped coal resources under the North Sea
- Long history of UK offshore operations, drilling techniques, legislation, processes
- All UCG licenses are near regions that once thrived on coal
- Have existing on-shore industrial infrastructure
- Have local support – Local authority, all stakeholders, media and residents – all positive towards UCG
- See the advantages of UCG - employment, regional and financial growth
Licensing and Regulation

- Regulators may need to deal with competing bids and other users of coal.
- Sometimes difficult for a new industry since others are already licensed.
- In countries such as Australia, Colombia, issues over overlapping tenements CBM/UCG, though both can be done in the same site!
- UCGA believe such disputes be resolved with the objective of the optimisation of overall national resource.
Summary - UCG has so much to offer

- UCG – CCUS - can meet emissions reductions sought globally
- Enables the use of stranded coal, on and off shore, vastly increasing global feedstock
- Indigenous resource – secure, sustainable supply
- Higher yield - at lower cost
- Countries with green credentials - New Zealand and Canada are actively engaged in UCG
- Site Selection is vital - not all coal is suitable
- All coal rich nations have engaged in dialogue and investigation –commercially - before Licensing, Regulatory.
- Need for Trained and skilled Operatives and those with knowledge or services in UCG technology.
Conclusion

• UCG is now being recognised globally as a viable and economic method for accessing deep otherwise unrecoverable coal reserves, on and offshore

• To become more widespread, we need to convince governments across the world of the environmental, financial and social benefits of UCG - Key to the commercialisation and growth - collaboration

UCGA strive to ensure all who operate at a commercial level do so responsibly and with the highest regard to safety and environment

Join UCGA. Strength in unity
Presentation Ends
Thank you for your attention

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