The future of clean coal - where can UCG fit in the mix?

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Underground coal gasification

Gordon R Couch
CCC/151
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The future of clean coal - where can UCG fit in the mix?

This presentation will cover:

• Current and future energy paths
• The drivers for cleaner coal
• UCG – where does it fit?
World energy demand continues to rise

Source: IEA WEO, 2013
Electricity generation in non-OECD countries is rising at an incredible rate.

Electricity generation by source

Source: IEA WEO, 2013
Global energy is changing

Challenge:

• Developed regions are focusing on energy efficiency and CO₂ reduction

... but

• 1.3 billion people lack electricity, 2.6 billion lack clean cooking facilities whilst having access potential access to coal

Investment is needed in clean and affordable energy in emerging regions
Fossil energy resources by type

- **Coal**: 3050 years total, 142 years proven reserves, 61 years cumulative production to date.
- **Natural gas**: 233 years total, 61 years proven reserves, 54 years cumulative production to date.
- **Oil**: 178 years total, 54 years proven reserves, 54 years cumulative production to date.
The drivers for cleaner coal
World energy demand & related CO₂ emissions by scenario

Primary energy demand:
- Current Policies Scenario
- New Policies Scenario
- 450 Scenario

CO₂ emissions (right axis):
- Current Policies Scenario
- New Policies Scenario
- 450 Scenario
HELE future for coal

HELE is the means by which coal can remain in the energy mix in a carbon-constrained future

HELE = High efficiency low emission technology

- High efficiency combustion (super and ultra-supercritical and gasification options)
- State of the art flue gas cleaning
- Carbon capture and storage (CCS)
Legislation is evolving at different rates

Permit based limits and caps for major pollutants, GHG trading

Relatively lenient GHG but not SO2/NOx

Japan, China and some of SE Asia have emission limits

New SO2/NOx limits

Permits - combination of trading and emission limits

Combination of caps and emission limits

Relatively lenient

Relatively lenient

Relatively lenient

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GHG but not SO2/NOx
But some areas use less energy

Combination of caps and emission limits
Permit based limits and caps for major pollutants, GHG trading
Relatively lenient
Japan, China and some of SE Asia have emission limits
Permits - combination of trading and emission limits
Relatively lenient
New SO2/NOx limits
Relatively lenient
Relatively lenient
GHG but not SO2/NOx
What is legislation doing to the coal sector?

The trend in OECD regions is towards:

- efficient particulate control systems
- >90% sulphur control
- >80% nitrogen oxide control

Coal plants must either meet new emission limit values, must trade within bubbles, must switch fuels or must close.
Many coal plants in Europe are being phased out
Coal plant closures, USA
China taking HUGE steps to clean up

Beijing to Shut All Major Coal Power Plants to Cut Pollution
What effect is legislation having on the coal industry?

In the EU, North America, Japan and China, plants which wish to continue operating into the next decade must be clean and efficient.

Despite coal being “cheap”, maintaining a compliant coal plant is becoming expensive and some older plants do not merit the investment to remain open.

New plants – must meet even stricter emission limits including, in some regions, either efficiency standards or CO$_2$ limits.
# Proposed CO\textsubscript{2} limits for new build coal plants

<table>
<thead>
<tr>
<th>Country</th>
<th>Proposed CO\textsubscript{2} limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>EIB target*</td>
<td>550 kg/MWh</td>
</tr>
<tr>
<td>USA</td>
<td>500 kg/MWh (1,100 lbs/MWh)</td>
</tr>
<tr>
<td>Europe</td>
<td>500/450 kg/MWh</td>
</tr>
<tr>
<td>Canada</td>
<td>420 kg/MWh</td>
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</tbody>
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**Current average for coal plant**: >900 kg/MWh

* Proposed target by the European Investment bank above which funding will not be given
LOW-COST

UCG emerges as the cheapest energy option for power generation when combined with “Carbon Capture and Storage”

Last year the World Bank announced a new directive to limit financing of coal-fired power plants to “rare circumstances” (although this may be reviewed)

Similar policies issued by the Obama Administration have sought to prevent investments into coal-fired power plants by the Treasury Department and the Export-Import Bank

But ... South Africa alone has some 30 billion t of coal reserves. Zimbabwe has another 500 Mt. Tanzania and other countries also have plentiful coal resources
The future for coal?

In the developed world, the challenge is compliance - methods of coal combustion will need to change to meet HELE requirements to remain part of the future energy mix.

In the emerging world, the challenge is more often funding and accessibility.
Can UCG be a means of moving coal into the “healthier” gas market?

Majuba
“Setting fire to coal underground could answer our energy prayers, or start an environmental disaster on a bigger scale than ever before.

If you thought shale gas was a nightmare, you ain't seen nothing yet .... To the horror of anyone concerned about climate change, modern miners want to set fire to these deep coal seams and capture the gases this creates for industry and power generation. Some say this will provide energy security for generations to come. Others warn that it is a whole new way to fry the planet.”

New Scientist, March 2014
But UCG can be cleaner than conventional coal
IEA comments:

- **UCG using state of the art gas turbines could approach the efficiencies achieved by IGCC (up to 45% or more)**

- **UCG might offer a relatively simple and low-cost way of storing CO_2_; given favourable geological conditions, CO_2_ from reacted syngas could be stored underground in the cavities created by the UCG process**
Significant work on UCG continues

Courtesy of CNR
New developments being announced

- Linc Energy (MoU) for a 400 MW UCG project in Tanzania to provide power to the Tanzanian electricity grid by 2017 (announced 6th Aug 2014)

- On the 4th August 2014, it was announced that the Indian Government are preparing a draft policy on UCG. Several coal blocks have been identified for UCG purpose for government companies in the state and the applications for the same have been invited

  http://coal.steelguru.com/india/16921/india_govt_preparing_draft_policy_on_underground_coal_gasification
Cluff Natural Resources currently has 100% working interest in 9 UCG licences in the UK covering a total of 690 km². This includes sites in the Dee Estuary, Kincardine, Durham and Maryport.

5Quarters also investing in a UCG portfolio
Potential markets for UCG in the UK

- Feedstock for petrochemical industry
- Primary electricity generation (CCGT)
- Fuel gas for energy intensive industry
- Gas-to-liquids processes
- Fuel for the Hydrogen economy
- Fertilizer (ammonia) & methanol production

... offsetting natural gas use
Challenges for UCG

- funding towards commercialisation
- prove potential as an unconventional gas source
- improved media and public perception
- proof of CCS potential and inclusion as a HELE option
Thank you for listening

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