Underground Coal Gasification

4th Annual Wyoming CO2 Conference
Casper Wyoming

29-30 June 2010

Don Schofield
General Manager - New Projects
About Linc Energy

• Linc Energy is leading the way in UCG

• ASX listed – 13,000 shareholders, also listed on OTCQX

• Over 120 staff (80 technical) - six offices

• Began UCG in 1999 (Chinchilla). Now operating 4th UCG generator

• Began making FT liquids in 2008 at Chinchilla Demonstration Facility

• Looking to commercialize UCG in coal rich countries around the world.
Coal Gasification Simplified

Coal + Water + Heat + Pressure = SYNGAS

C + H₂O → CO + H₂
Underground Coal Gasification
GTL - in simple terms

- **UCG GASIFICATION**: Raw Syngas
- **GAS TREATMENT**: H₂ + CO Syngas
- **FT REACTOR**: Cₓ+Hᵧ gases, liquids & waxes
- **COBALT CATALYST**: Tails gas & steam
- **PRODUCT WORK UP / REFINING**: Waxes, ultra-clean diesel, naphtha, jetfuel, LPG, water & oxygenates
- **ELECTRICITY GENERATION**: Water & oxygenates

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Carbon Capture

• Syngas needs ‘cleaning’ prior to further use

• The gas cleaning process often creates a clean CO₂ waste stream, ready for the sequestration process
Syngas is versatile

Syngas is a versatile feedstock for a wide range of processes and applications. Here is a summary of the possible downstream products:

1. **Ammonia**
   - Ammonia production is a key step in many chemical processes.
   - It can be used in fertilizer production and other applications.

2. **Urea and Formaldehyde**
   - Urea and formaldehyde are used in the manufacture of plastics, resins, and other products.

3. **Methanol**
   - Methanol is a versatile chemical that can be used in the production of fuels, solvents, and other products.

4. **Carbon Monoxide**
   - Carbon monoxide can be used in the production of other chemicals or as a feedstock for Fischer-Tropsch synthesis.

5. **Hydrogen**
   - Hydrogen is a valuable feedstock for many processes, including the production of ammonia, methanol, and other chemicals.

6. **Oxo Alcohols**
   - Oxo alcohols are used in the production of surfactants, plasticizers, and other products.

7. **SNG (Synthetic Natural Gas)**
   - SNG is a valuable feedstock for the production of transportation fuels or as a feedstock for Fischer-Tropsch synthesis.

8. **Town Gas**
   - Town gas is a mixture of gases that can be used as a fuel.

9. **Reduction Gas**
   - Reduction gas can be used in the production of metals.

10. **Gaso Turbines**
    - Gas turbines can be used to generate electricity.

11. **Electric Power**
    - Electric power is a direct result of using gas turbines.

12. **Resin**
    - Resin is a material used in adhesives, coatings, and other products.

13. **MTBE**
    - MTBE is a fuel additive.

14. **Acetic Acid**
    - Acetic acid is used in the production of plastics, detergents, and other products.

15. **Phosgene**
    - Phosgene is a toxic gas used in the production of pesticides and other products.

16. **Polyurethane**
    - Polyurethane is a material used in construction, automotive, and other applications.

17. **Detergents Plasticisers**
    - Detergents and plasticisers are used in a variety of end products.

18. **Fuels, Waxes, Others**
    - Fuels, waxes, and other products can be derived from syngas.

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UCG Operations - Chinchilla

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GTL Demonstration Plant - Chinchilla

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GTL Demonstration Plant
Chinchilla

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Angren, Uzbekistan

UCG: Smaller Footprint, Lower Impact
Soil Remains Intact
...for future (or co-incident) land use

Yerostigaz UCG, Uzbekistan
Environmental Aspects

Groundwater

- Linc’s UCG process relies upon in-situ moisture content of the coal seam
- Groundwater movement is minimized in Linc’s UCG operations because natural hydrostatic pressure is needed for UCG process

Groundwater Quality

- Quality maintained by limiting groundwater outflow
- Linc’s Chinchilla trials have experienced no groundwater contamination in over 10 years of operation

Subsidence

- Linc Energy targets no surface impact
Controlling UCG Impacts

- PREDICT
- CONTROL
- MONITOR
Understanding Geology

Site Selection –
One of the most critical factors in successful UCG

- Example acoustic borehole imaging log and mapping of geological joints/fractures
Understanding Overburden properties

- Comprehensive study of overburden characteristics is undertaken at all new prospective UCG targets.
- Overburden rock strength is characterized by laboratory measurements and mapping of joints/defects.
- Thermodynamic strength is analyzed.

Roof material from Chinchilla Generator 4 site
Cavity growth prediction

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Most Important Controls

• Site selection - many variables
• In operations - minimizing gas loss by controlling hydrostatic pressure
• Decommissioning - leave a clean cavity
• Monitoring
Hydrology Modeling

Chinchilla, Queensland
Dewatering Coal Seam is Undesirable for UCG

Linc Energy’s advanced UCG technology requires that normal groundwater levels be maintained.

This is opposite to all other forms of energy extraction from coal.
Controlling Groundwater Inflow

To manage groundwater inflow UCG takes advantage of a simple principle:

- By operating at or slightly below the hydrostatic pressure of the coal seam, water inflows can be maintained at the designed level.
Controlling Subsidence

- Linc Energy has developed advanced subsidence modeling techniques for UCG generator design
  - Targeting “no surface impact” design
  - Extraction width is designed to control fracturing in the roof materials
  - Pillars are designed to provide for UCG subsidence control.
- Modeling process similar to that used in underground coal mining
Decommissioning: Phase I

- Production Well: Reduced flow or shut in
- Maintained flow
- Injection Well

Drop in pressure, increased gradient, increased inflows
Decommissioning: Phase II

Production Well
Shut in, vented periodically

Injection Well
Shut in

Maintained low pressure. Cavity periodically vented to prevent gas pressure building and displacing water

Gasification extinguished, water recovering
Decommissioning: Phase III

Production Well → Shut in

Used to pump out cavity → Injection Well

Cavity purged and water treated

Cavity water recovered
Syngas Flare - Chinchilla
Commercial UCG Project Phase I

• A “stranded” coal seam of 30’ thickness:
  • contains over 34 million tons of coal per 640 ac. section

• A single UCG generator:
  • consumes approximately 80-90 tons/day
  • produces over 8.0 mmcfld of syngas

• An operating panel of 6 UCG generators:
  • produces over 50 mmcfld of syngas
  • could support a gas turbine plant of 100 MW
  • Could operate for well over 100 years in 34 mt resource
Commercial UCG Project
Phase II

- World Class UCG – GTL project:
  - producing 20,000 bbl/day of clean synthetic diesel, jet fuel and other liquids and valuable by-products
  - Producing all its own power requirements plus over 200 MW of exported power
  - consuming approximately 20,000 tons/day of coal
  - producing commercial quantities of pure CO2 ready for EOR sequestration or other purpose
  - Could operate for over 20 years in 3,200 acres of coal seam if 30’ thick (5 sections).
Social and Economic

- Safety – no people underground & no surface mining
- Contribution to Energy Security & Independence for America
  - Wyoming: In-state supply of FT diesel and jet fuel
  - Wyoming: In-state supply of CO2 for EOR projects
  - Wyoming: In-state utilization of coal-generated power.
- Creates major ‘new’ royalty stream for Wyoming
- Source of new jobs
- Less land use conflict
Social and Economic

- Significant value added from coal that is otherwise ‘valueless’

- Clean coal utilization

- Long term source of power, Clean liquid fuels, and CO2

- New types of support industries
Summary

• Linc Energy’s UCG technology is well developed and ready to be implemented commercially.

• Product quality can be controlled within specific limits dictated by site characteristics and can be manipulated above-ground to suit selected applications.

• Site characteristics are used to design and control underground processes.
Thank You

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