LucaGas: New Energy from a Depleted Resource

2nd International Advanced Coal Technologies Conference

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Luca Technologies Inc.

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Luca Technologies Inc.

- Business: Create real-time microbial methane gas in place at economic rates and volumes
- Opened laboratory in August, 2003
- Headquartered in Golden, Colorado
- Field Office and Mixing Plant in Gillette, Wyoming
- 98 current employees
- Own and operate over 1,300 wells in the Powder River Basin, Wyoming
- Patriot Energy Resources LLC is a wholly owned subsidiary of Luca
Who Is Luca?

$100+ million to date

Luca technologies

Founders, Employees and Stockholders

One Equity Partners

Oxford Bioscience Partners

BASF The Chemical Company

Proprietary & Confidential
Two Fundamental Principles

1. Many hydrocarbon reservoirs are alive with microbes

2. Small conversion of immense hydrocarbon reservoirs yields large amounts of new natural gas in real time

Covered wellhead & temporary well treatment skid in Powder River Basin
Proved Coal Reserves

in thousand million tons
(anthracite and bituminous in brackets)

~ 1 Trillion tons
- But only a fraction of the total coal deposits
Resource Size

Powder River Basin, Wyoming - 100 by 150 Miles
Loy Yang Mine, Latrobe Valley, Australia

Largest in Southern Hemisphere
> 30 Million Tons/Year
A Grand Energy Transition

• How can we continue to utilize our vast deposits of coal in a more environmentally benign manner and thereby participate in this event and reap its economic benefits?

➤ Expanding from a coal mining industry to a coal energy industry
  o Leveraging surface, minerals, knowledge into CBM and new coal technologies
## Sampling of North American Hydrocarbon Deposits and Related Biogenic Methane Potential

<table>
<thead>
<tr>
<th>Name of Substrate</th>
<th>Microbial Substrate in Place</th>
<th>“Bio-resource in Place” (100% bio-conversion)</th>
<th>“Technically Recovery Bio-resource “ (3.1% Bio-conversion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powder River Basin Coals in Montana and Wyoming (No Minimum Thickness Cutoff)</td>
<td>1,300 Billion Short Tons (BST)</td>
<td>8,638 Trillion Cubic Feet (TCF)</td>
<td>267 TCF (US consumption, 2007: 23 TCF/year)</td>
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<tr>
<td>Antrim Shale</td>
<td>12,528 BST</td>
<td>18,429 TCF</td>
<td>570 TCF</td>
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<tr>
<td>Green River Shale</td>
<td>54,000 BST</td>
<td>3,500 TCF</td>
<td>108 TCF</td>
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<tr>
<td>U.S. Residual Crude Oil</td>
<td>262 Billion Barrels</td>
<td>925 TCF</td>
<td>28 TCF</td>
</tr>
<tr>
<td>Canadian Tar Sand Bitumen</td>
<td>1,425 Billion Barrels</td>
<td>3,769 TCF</td>
<td>115 TCF</td>
</tr>
<tr>
<td>Forestry and Agriculture Feedstock for bioenergy</td>
<td>1,366 Million Dry Tons/Year in 2050</td>
<td></td>
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</tbody>
</table>
In situ Microbes: SEM - Monarch Coal - 7000X
Direct Stain of Sediment 570 m Below the Ground
Microbial Population of a Low-Methane Producing Region of the PRB (Lake DeSmet)
Microbial Population of a High-Methane Producing Region of the PRB (Monarch)
Dietz Coal – NW Basin Amendments

Percentage of Methane in Headspace

Days

[ a. Amendment 1 ]
[ b. Amendment 2 ]
[ c. Unamended Control ]
[ d. BESA ]
Luca Lab Research Progress

Generation I - 5% methane in headspace in 681 days
17 mcfd (extrapolated)

Generation II - 7% methane in headspace in 251 days
94 mcfd

Generation III - 19% methane in headspace in 251 days
176 mcfd

Generation IV - 24% methane in headspace in 61 days
3,969 mcfd

Generation V - ??
Laboratory Coal Bioconversion to Methane

3.1% conversion of hydrogen in coal to methane (and still rising)

- 560 days
- 291 umole/g
- 15 grams

Scale up: 180 scf/ton
Biogenic Process Strategies

1. Stimulate the activity of the microbes
2. Grow microbial biomass
3. Modify the microbial community structure
   • Make those microbes actively involved in producing methane numerically dominant

➢ Goal is to know who is there, what they can and do eat, how to stimulate, and when to stimulate
Geobioreactor™

The combination of a hydrogen/carbon bearing geologic formation with naturally occurring microorganisms capable of making methane gas real-time.
Luca Process - Biogenic Gas Creation

"Push" Stage

Proprietary mixture of amendments gravity fed into coal seam

Mobile Nutrient Delivery System

Surface

"Dewatered"

"Watered" Coal Seam
Original Field Tests

- Tongue River – Project Area totals 260 Wells
  - 2006 Program
    - 102 Restorations
    - Goal – Obtain proof-of-concept
    - Three Coals, 6 amendments, 4 water types, various concentrations, mixes and job sizes
  - 2007 Program
    - 32 Restorations
    - Goal – Confirm and improve best treatment from 2006
CBM Field Trial Gas Production

Date
Jan-05 May-05 Aug-05 Dec-05 Apr-06 Aug-06 Dec-07 Apr-08 Aug-08

Natural Gas (mcf/day)

Begin Treatment

0 1 2 3 4 5 6 7

0 1000 2000 3000 4000 5000 6000 7000

10000
CBM Field Trial Gas Production

Natural Gas (mcf/day)

DNA Concentration (ng/mL)

Nutrient Concentration (mM)

Date

Jan-05 May-05 Aug-05 Dec-05 Apr-06 Aug-06 Dec-06 Apr-07 Aug-07 Dec-07 Apr-08 Aug-08

Biomass

Begin Treatment

Begin Treatment
815,000 mcf of newly created biogenic gas!

Date

Jan-05 May-05 Aug-05 Dec-05 Apr-06 Aug-06 Dec-07 Apr-08 Aug-08

Natural Gas (mcf/day)

815,000 mcf of newly created biogenic gas!

DNA Concentration (ng/mL)

Nutrient Concentration (mM)

Existing Decline Trend

Begin Treatment
Wells in Powder River CBM Field - Similarity of DNA Fingerprints
Restoration Success

• Nutrients differ by substrate, reservoir conditions, and community activity
• Nutrient concentrations are determined by dilution (down hole mixing)
  – Too much is detrimental
  – Not enough has no impact
• Volume of treatment is dependent upon a number of variables
• Cell growth is affected by community in the reservoir
• Sampling vision drives the process (chemical and biological information)
Comparison of Methane Yields

Summary of unamended yields of methanogenesis

Unamended yields (umols CH4/g)

- coal
- shale
- oil
LUCA Value Proposition

Luca = C&P Industry = Top of Clean Tech Class

- **Big** – Organic matter “behind pipe” is enormous untapped resource
- **Simple** – No change in the energy infrastructure is needed.
- **Green** – Every MCF cultivated is a portion of coal not mined and burned, CO₂ is prequestered.
- **Profitable** – Technology is currently profitable @ $5.00 mcf without subsidy (paying full taxes on production)
- **Transformational** – Game changing technology not yet signaled to the markets
Bioconversion Technology
- Applications for Coal

• Extending the life of CBM gas wells
• Enhancing the economics of CBM gas wells
  – Making a non-economic project, economic
• Extracting value from the remnants of mining
  – Abandoned mine walls, pillars & gobs
• Accessing economically unmineable seams
  – Poor overburden to coal ratios
  – Lack of mine mouth power demand for high moisture content coals
Summary

• Tomorrow’s clean coal technology is here today
• Energy produced by life, for life and by necessity, environmentally friendly
• If you own coal you will definitely be able to participate in the “Grand Energy Transition” to cleaner fuels.
Biotech Industry

Oil & Gas Industry

Transforming Traditional Coal and Oil & Gas Assets Into a Clean Sustainable Energy Source