H Quest Vanguard, Inc

Creating petroleum

May 12th, 2015
Shale Gas Innovation Contest
Opportunity

Prevailing trends in the US energy markets:
- Shale revolution brought natural gas prices to historical lows.
- Environmental regulations are reducing demand for coal.
- Global trends expected to follow those of United States.

Global petroleum trends
- Crude oil demand continues to grow by 1.2% per year.
- New oil plays are increasingly difficult and costly: tight oil, oil sands, deep water drilling, etc.
- Despite short-term oil price volatility, the age of cheap oil is over.

An Energy Game Changer would:
- Provide a clean alternative to unconventional oil sources.
- Create an alternative market for coal and natural gas.
- Enable use of ‘stranded’ resources through simplified logistics.
- Use abundant coal and gas to produce the scarce, valuable oil.
Wave Liquefaction™ technology combines GTL and CTL in a novel synthetic crude oil process.

Natural gas and coal are converted into synthetic crude oil. The process is a single-stage continuous operation at atmospheric pressure, with virtually no CO$_2$ emissions and with low energy inputs.

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Wave Liquefaction™ process

Environmentally responsible, economically attractive natural gas and coal utilization pathway.

Transformational process originally developed with DARPA funding at a DOE national lab. Key advantages:

- virtually zero CO$_2$ emissions or process water consumption
- in-situ hydrogen production from natural gas without reforming
- low capital ($15K per bpd) and production (<$30/barrel) costs
- oil quality: 10+ API, 90% distillate, low asphaltene content
- oil yields: 3+ barrels per ton of coal (dry, ash-free)
- high feedstock flexibility (10 coals and coal/biomass blend tested)

H Quest holds an exclusive world-wide license to this breakthrough technology and is seeking strategic investors and partners for commercialization and scale-up.
Product: Synthetic Crude Oil (SCO)

- Low asphaltene and high distillate content, 10+ API
- Upgradable to high quality SCO (30+ API)
- Refinable, blendable with conventional oil streams
- Low cost of production: < $30/bbl with PRB coal
Wave Liquefaction™ technology

- Rapid, efficient, continuous process
- Compact footprint with a simple, modular design:
  - 2 barrel/day achievable with a 1 liter reactor
  - 100 barrel/day reactor capable of commercial operation
- Low environmental impact:
  - little to no CO₂ emissions or water consumption
- Built-in natural gas to hydrogen conversion:
  - eliminates steam-methane reforming units
- 3-4 barrels of oil from 1 ton of coal
- Electric energy input of only 250kWh per barrel
- Feedstock flexibility:
  - high yields with 9 coals and a biomass blend
Example input cost for 1 barrel: <$22

Assumptions: PRB coal @ $12 per ton | natural gas @ $4 per MMBTU | electricity @ $40 per MWh

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<th>POWER</th>
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<tr>
<td>1.46 MMBTU</td>
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The process has been tested with nine coals and biomass blend; methane, hydrogen and syngas confirmed as viable hydrogen donor gases.

$0.29$ ton on dry, ash-free basis correspond to $0.42$ tons as received.

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WL™ development to date

- **2009-2011**: DARPA funding\(^1\) to build a prototype reactor at a DOE National Laboratory ($1.2M) (achieved ~30 g/hr throughputs)
- **2011-2013**: H Quest funding to build laboratory-scale system and to test 9 different coals and biomass ($2.1M) (achieved ~1kg/hr throughputs)
- **2014**: H Quest Vanguard, Inc started commercialization in Pittsburgh: 5,000 sq ft high bay facility in Harmar, PA (achieved ~3kg/hr throughputs)

\(^1\)Contract no. HR0011-10-0088
Commercialization roadmap

Fast-track development sequence (2 years):
- by 2017 deploy a commercial pilot unit capable of up to 100 barrel/day production as part of an existing specialty chemical operation.

Primary development sequence (3 years):
- 2014-2016: Build a Process Demonstration Unit (PDU) capable of 2 barrel/day oil production (cost: $2M)
- 2016-2018: Build and deploy a pilot plant capable of 100 barrel/day oil production (capital cost: $5M-$10M, projected revenue: $2M/year)
- 2018-onward: Deploy and operate a commercial plant (based on replicated 100 bpd reactor units) with 10,000 barrel/day production (cost: $150M).

Plant EBITDA in 2021-onward: $50M+/year (@ $45/barrel)\(^1\)

\(^1\)Plant EBITDA on unconsolidated basis
Lean team of experienced technologists

George Skoptsov  
*President & CEO*

Engineering degrees from Carnegie Mellon University, 10+ years of experience in leading technology development from concept to commercialization in automation of natural gas and mining industries (tetherless pipeline inspection systems, autonomous mining haul trucks).

Dr. James Strohm  
*Chief Science Officer*

Lead inventor of the Wave Liquefaction™ technology
Formerly senior scientist at Battelle/Pacific Northwest National Lab
Expert in catalytic chemistry, fuel production and coal conversion.

Alan Johnson  
*Chairman, Advisor*

Executive and investor with extensive background in the international coal industry
Former Chair of Energy, Mines and Resources Committee, Parliament of Canada.
Former President of the Coal Association of Canada.

Excellent fit to the current focus on technology and IP development. In 2-3 years will need to be augmented with executives with expertise in petroleum refining, operations and distribution.
Select publications and contact info

Strohm JJ, Roberts BQ, Smurthwaite TD, Bays T, Johnson AA, Skoptsov G.

Strohm JJ, Bearden MD, Roberts BQ, Smurthwaite TD, Johnson AA, Skoptsov G.
Wave Liquefaction™ as an Alternative Approach to Direct Coal Liquefaction. International Conference on Coal Science & Technology; 2013

Strohm JJ, Bearden MD, Roberts BQ, Smurthwaite TD, Johnson AA, Skoptsov G.
Lowering the Cost and Environmental Impact of Direct Coal Liquefaction Through Wave Liquefaction™ Technology. 38th Annual Clearwater Clean Coal Conference. Clearwater, FL: Coal Technologies Associates; 2013

Multiple H Quest patents are pending.
Technical information and cash flow analysis available upon request.

For more information, please contact:

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