Perennial Grasses to Gasses to Liquid Fuels (GTL)

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Drivers and Resulting Fuels

Why are we here?
1. US Energy Independence = economic and military security
2. Jobs – Agricultural and Energy
3. Environment – Lower Greenhouse Gasses

What are the resulting products?
1. Green Fuels (ethanol, biodiesel, etc.)
2. Alternative Fuels, Grey Fuels (Marcellus Gas)

Biomass Based Fuels Overview
- Abundant, widespread availability.
  - Biomass in the form of grasses, energy crops, wood, consumer waste (MSW) and other carbon sources are widely available.
  - US Government has committed to second generation biofuels (cellulosic) beyond ethanol.
- Ultimately Fuels MUST be DROP IN and cost competitive without subsidies.
  - Equity investors and Lenders ignore subsidies, with election these may disappear.
- Mission critical fuels are of highest priority – airlines and US Military.
- Cleanest burning fuels from biomass.
  - Lowest GHG footprint, ecologically sound, no competition with food if cultivated/produced properly.
- Commercialization is taking time and money. Primus uses natural gas as its primary feedstock to produce a variety of fuels and chemicals. Over time, Primus will integrate the option to use biomass as a feedstock into its process, always producing fuels that are sustainable and petroleum-free.

Natural Gas Market & Pricing

The Case For Bio-Gasoline vs. Ethanol

- 3 times more gasoline than ethanol from same acreage – by volume
- 4.5 times more fuel energy from gasoline from same acreage
- The focus on drop-in Bio-Gasoline is clear
Primus Gasoline Comparison

- Primus gasoline is a highly competitive “drop-in” biofuel for gasoline

<table>
<thead>
<tr>
<th></th>
<th>Fossil Fuel Gasoline</th>
<th>Ethanol</th>
<th>Bio-Diesel</th>
<th>Primus Gasolines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependency on food-related crops</td>
<td>None</td>
<td>High</td>
<td>Medium</td>
<td>None</td>
</tr>
<tr>
<td>Energy density (MJ/gallon)</td>
<td>132</td>
<td>89</td>
<td>126</td>
<td>132</td>
</tr>
<tr>
<td>Cost per gallon</td>
<td>$3.10</td>
<td>$2.23</td>
<td>$3.00</td>
<td>$2.50 ($1.60**)</td>
</tr>
<tr>
<td>Uses</td>
<td>Drop-in</td>
<td>Fuel oxygenate</td>
<td>Substitute for diesel</td>
<td>Drop-in blend or substitute for gasoline</td>
</tr>
<tr>
<td>Lifecycle Carbon Dioxide Emissions</td>
<td>24.3 lbs/gallon</td>
<td>14.6 lbs/gallon</td>
<td>5.84 lbs/gallon</td>
<td>4.86 lbs/gallon</td>
</tr>
</tbody>
</table>

** Ethanol equivalent gallon based on 1.5x energy content ratio of gasoline vs. ethanol

Natural Gas Market & Pricing

Policy Maker & Market Reactions

“The United States now has, at current consumption rates, at least 75 years’ worth of recoverable natural gas. More important, the United States has become the world’s low-cost producer of natural gas...The rise of shale oil is shaping up to be the biggest shift in energy in generations. And its consequences—economic and political—are profoundly beneficial to the United States.”


“One trend we aim to invest behind is the shift in market interest from conventional to unconventional oil and natural gas assets....”

-KKR & Co. Inc., website

“We have a supply of natural gas that can last America nearly 100 years.”

- President Obama, 2012 State of the Union Address.

Introduction

- Primus Green Energy, Inc. has a proven system that converts biomass and/or natural gas to gasoline.

- This is a “drop-in” fuel, usable directly in gasoline engines without any modification or adjustment, for which infrastructure is already readily available.

- Bechtel design its first 25 million gallon per year commercial plant.

- Primus has raised $61 mm from IC-Green, a division of Israel Corporation.
Product Portfolio Strategy

- Single technology platform
- Multiple biofuel products

Bio/Grey-diesel
Bio/Grey-jet fuel
Bio/Grey-gasoline

Management Team

Robert Johnson CEO
- CEO of three biofuel companies: Mascoma (S-1 filed), BC International Corporation (acquired by BP) and Prometheus.
- Prior to 1998 he was a senior investment banker (Dain Rauscher Wessels, Lehman Brothers) where he completed over 100 transactions totaling over $3 billion in the private placements.

Eli Gal, Phd CTO
- Expert in coal and biomass gasification processes, air pollution control, cleantech, water treatment and chemical processes, 14 years with GE Power Systems, 16 years additional consulting.

Howard L. Fang, Phd, Vice President, R&D
- 30 years of experience with Exxon Mobil, BP and Cummins Engines

George Boyajian, Phd, Vice President, Business Development
- 18 years technology executive, built and sold last venture to GE Healthcare

Thermochemical Conversion Technology

Indirect Conversion Synthetic Fuels Manufacturing Processes

<table>
<thead>
<tr>
<th></th>
<th>Yield Jet</th>
<th>Yield (syngas %)</th>
<th>Cost Capex</th>
</tr>
</thead>
<tbody>
<tr>
<td>FT</td>
<td>20%</td>
<td>15%</td>
<td>100%</td>
</tr>
<tr>
<td>STG+</td>
<td>70%</td>
<td>32%</td>
<td>80%</td>
</tr>
</tbody>
</table>

Technology

Gasification

- Raw Syngas
- Clean Syngas
- Gas Scrubbing
- Compressor
- Makeup Water
- Heat Exchangers

Liquid Fuel Synthesis

- Steam Methane Reforming
- CO2
- Dry SynGas
- Compressor
- Heat

Technology

Bio-Gasoline (MTG)
Bio-DME (diesel)
Bio-Jet Fuel (MTO)
Bio-OME (lithium)
MeOH synthesis: \[ CO + 2H_2 \rightarrow CH_3OH \]

DME conversion: \[ 2CH_3OH \rightarrow CH_3OCH_3 + H_2O \]

Fuel conversion: \[ 6CH_3OCH_3 \rightarrow (CH_2)_n + n/2H_2O \]

Hydrogenation: \[ (HC=CH)_n \rightarrow 2(CH_2)_n + nH_2 \]

Advantages of the Primus STG+
- Cost competitive today using biomass feedstock with no gov’t subsidies.
- Lower GHG footprint than jet from crude.
- Four reactors in one recycle loop. No need for methanol condensation and evaporation.
- High product yield of 30% yield achieved to date, expected to reach 35%. (Yield is from syngas with \( H_2/CO \) ratio of 2.1).
- High quality premium 93 octane gasoline (with superior stability, lower corrosion and lower vapor pressure), toluene and xylene.

Advantages of the Primus STG+ (continued)
- Potential for low cost production at relatively small scale compared to other GTL technologies (MTG and FT). Cost optimization work is being conducted with support from Bechtel team.
- Process integration lowers operating costs.
- Process yields one or two products vs. Fischer-Tropsch’s 6 – 7.
### Primus GTL Technology

<table>
<thead>
<tr>
<th>Factor/Process</th>
<th>Primus</th>
<th>Haldor Topsoe</th>
<th>ExxonMobil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed Flexibility</td>
<td>Bio, coal, NG</td>
<td>NG, coal</td>
<td>Methanol</td>
</tr>
<tr>
<td>Product Flexibility</td>
<td>Gasoline, aromatics, jet fuel</td>
<td>Gasoline</td>
<td>Gasoline</td>
</tr>
<tr>
<td>Durene Reduction</td>
<td>Integrated</td>
<td>Separate</td>
<td>Separate</td>
</tr>
<tr>
<td>Complexity (Major Steps)</td>
<td>Syn Gas, STG+</td>
<td>Syn Gas, TIGAS, Durene reduction</td>
<td>Syn Gas, Methanol, MTG, Durene reduction</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Small to large</td>
<td>Small to large</td>
<td>Limited to Methanol plant size</td>
</tr>
<tr>
<td>Catalyst Sourcing</td>
<td>Multiple</td>
<td>In-house</td>
<td>Combined</td>
</tr>
<tr>
<td>Integration Economies</td>
<td>Highly integrated</td>
<td>Unknown</td>
<td>Low, separate plants</td>
</tr>
<tr>
<td>Footprint</td>
<td>Small</td>
<td>Medium</td>
<td>Large</td>
</tr>
</tbody>
</table>

### CAPEX / OPEX Ranking Outlook for “Drop-in” Gasoline

Primus < HT TIGAS < EM MTG < FT

### Demo Plant – Hillsborough, NJ, USA

- **Phase 1:** Natural gas to gasoline
  - 12.7 gal/hr (100,000 gallons/yr)
  - Expected Completion 1Q/13
- **Milestones for success (2 months)**
  - Production of gasoline that meets or exceeds product specifications
  - Confirmation of commercial plant design parameters including:
    - continuous nameplate production for 1 month
    - yield, carbon efficiency
    - reactor capability
    - catalyst behavior
    - composition control under various operating conditions
    - perform independently witnessed and verified tests for lenders/investors’ due diligence purposes
First Commercial Plant

- PGE will purchase an existing syngas plant, as basic for site; reduces capital cost and construction time
- Extensive infrastructure and pipelines, adjacent to refineries
- Production: 16-25 million gallons of fuel
- Jet fuel production will be for major US airline
- Will be able to switch between jet fuel and 93 octane gasoline production by changing catalysts, no equipment changes

Project Economics/Build-Out

Successfully Scaled for Commercial Production

- 2011
  - 0.36 gal/hr

- 2013
  - 12.7 gal/hr

- 2014
  - 1,826 gal/hr

- 2016
  - 11,416 gal/hr

Commercial Development Plan

- Pilot Plant
- Demo Plant
- 16 Million GPY Southern US Plant
- 100 Million GPY Commercial Plant

Primus GTL Technology

- 35X
- 144X
- 6.25X

Integrated Demonstration
- Biomass – 100 kg/hr
- Gasoline – 33 kg/hr
- Under construction – Q4 2012 thru Q1 2013

First Commercial Project
- Natural gas
- Jet fuel and/or gasoline
- 16-25 million gallons/year

Second Commercial Project
- Natural gas
- Jet fuel and/or gasoline
- 100 million gallons/year

Primus Green Energy

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Thank You