CHG:
Today's Lowest-Cost Biofuel Process

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Overview of Gasification Process

- **Catalytic Hydrothermal Gasification (CHG) is a wet process (up to 90% water) which produces methane in a single step**
- **Feedstock is any organic material made into slurry**
- **Reactions are fast (< 1 hour) and complete (>99%)**
- **Process developed over 30-year period at Pacific Northwest National Laboratory (PNNL), a DOE National Lab, by Doug Elliott and others**
- **Genifuel is licensed for commercialization**

Energy from CHG Gas Production

- **Gas produced is mostly methane and carbon dioxide in 60/40 mix; no sulfur or silanes**
- **Gas can be burned directly as medium-heat fuel**
  - App. 24 MJ/m^3 (620 BTU/ft^3)
  - Engines, turbines, and fuel cells can accept this gas
- **Alternatively, can remove CO_2 to get pure methane (renewable natural gas)**
  - App. 38 MJ/m^3 energy content (1020 BTU/ft^3)
- **Gasifier is compact and is co-located at the feedstock source to reduce transport of wet stock**

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Feedstocks

- **In the wet slurry, water carries the solids and is also a reactant**
- **Operation at 21 MPa (3,000 psi) and 350ºC (660ºF)**
- **Solids in slurry can be between 1% and 40%, but optimum range is between 10% and 20%**
  - Feedstocks in this range flow well, can be pumped easily, and allow for better sizing of machinery
- **Algae is an ideal feedstock material—easy to make into slurry**
  - Lipid-extracted algae (LEA) can be used, giving a second fuel stream in addition to lipid-based fuels

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Typical Feedstocks

- **Algae fuel residuals (lipid-extracted algae)**
- **Beer fermentation bottoms**
- **Corn ethanol fermentation bottoms**
- **Food processing plant wastes**
- **Water weeds from remediation programs**
- **Dairy manure**
- **Wastewater solids**
- **Many others**

Other Gasification Technologies

- **Two existing technologies also provide alternate forms of gasification**
  - Anaerobic Digestion (Biogas)
  - Thermal Gasification to Synthesis Gas (Syngas)
- **Both differ in significant ways from CHG, with CHG offering a number of process advantages**
- **Additional advantage of CHG is that plant nutrients in the feedstock are recovered and can be recycled for new growth (i.e. fertilizer)**

Skid-Mounted Gasifier Test Unit

CHG Pilot Design

- **Design for Pilot Plant will gasify 10 metric tons of wet biomass/day at 15% solids (1,500 kg/d dry)**
  - Follow-on designs will be 5x and 10x larger
- **This size will produce 500 m^3 (18,000 ft^3) of net methane (after internal use) per day**
  - This amount of methane will power a 100 kWe generator 24 hours/day
  - Or could store gas and generate 200 kWe for 12 h/d
- **At 30 $g/m^2/d$ productivity, 10 t/d wet 15% algae would require 4.5 ha (11 acres) of ponds**

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CHG in the Algae Biofuels Process

- **If harvest 2 t/d dry algae with 25% lipids, then:**
  - Lipid production is 500 kg/d, or 143 gal/d
  - Lipid-Extracted Algae (LEA) is 1.5 t/d dry mass
- **CHG will yield 500 m^3/d net product methane from 1.5 t/d dry LEA mass**
- **Value of the products:**
  - Lipid value @ $3.00/gal = $429/d
  - Methane generates electricity worth $261/d
- **Therefore, CHG increases biofuel value by 60%**

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Conclusion

- **CHG can make substantial contribution to algae fuel economics**
- **CHG Pilot Plant is funded by DOE grant as part of the NAABB consortium**
- **Design and engineering is being performed now, with construction in 2011**
- **Demonstration will take place at location of algae production which yields adequate feedstock**