

# Cool GTL<sup>SM</sup> - A New Process for Direct Biogas Conversion To Liquid Fuels

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## 3CV.2.11 Subtopic 3.4 Oil-based and renewable hydrocarbon biofuels

### MOTIVATION

#### Why convert biogas to liquid fuels?

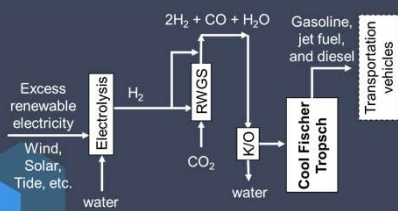
- Biogas contains large quantities of CO<sub>2</sub>
- Conversion of biogas to liquid fuels has previously required extensive methane purification by CO<sub>2</sub> removal
- Liquid fuels can be stored and transported cheaply and efficiently

#### Ethanol waste to energy

- Fermentation to produce ethanol creates large stoichiometric quantities of CO<sub>2</sub>



- Cool GTL<sup>®</sup> can be used to convert waste CO<sub>2</sub> and renewable H<sub>2</sub> to liquid fuels



### OBJECTIVE

Cool GTL<sup>®</sup> is a novel process to convert biogas or other CO<sub>2</sub> containing methane streams directly into liquid fuels without the need of prior CO<sub>2</sub> separation. Direct conversion of the feed gas including the CO<sub>2</sub> leads to a simplified process flow sheet and lower overall cost.

In the DOE project, "Cool GTL for the Production of Jet Fuel from Biogas", our goal is to make 100 gallons of high-quality jet fuel from biogas. This project will also demonstrate the Cool GTL catalyst and process stability through long term, 24-hour operation.

### COOL GTL PILOT PLANT



- Larger scale Cool GTL plant in operation
- Long term cool reforming process data (right)

### UNIQUE CATALYSIS

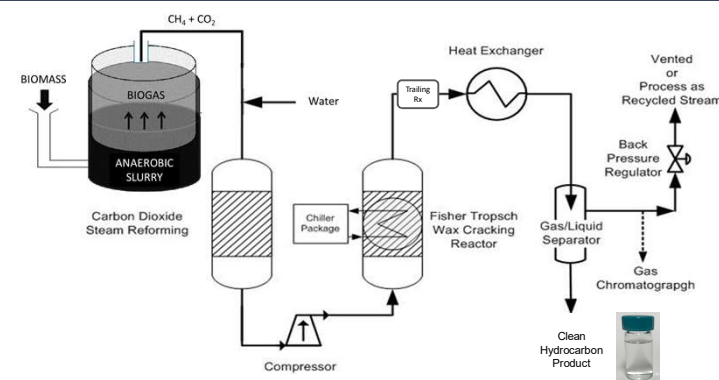
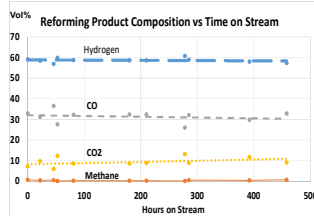
#### Cool Reforming

- Robust catalyst with long life
- Minimal coking
- Converts CO<sub>2</sub> and methane
- Directly makes 2:1 H<sub>2</sub>/CO synthesis gas by adjusting amount of steam added
- Simple and direct, mild temperatures, steady performance

#### Fischer-Tropsch

- No wax produced
- Drop in gasoline, diesel and jet
- Integrated trailing reactor to totally convert all wax
- High conversion per pass
- Excellent heat transfer –mixing

Low cost, simplified version of an old process with new catalysts



#### The Cool GTL<sup>®</sup> Process

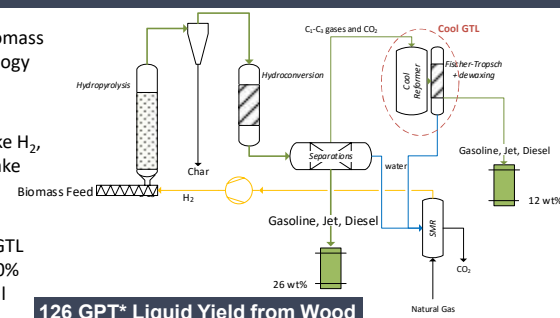
- Converts CO<sub>2</sub>-rich CH<sub>4</sub>, C<sub>2</sub>H<sub>6</sub> and C<sub>3</sub>H<sub>8</sub> to high-quality gasoline, diesel and jet fuel
- Works well for any gas containing CO<sub>2</sub> or CO
- Uses unique CO<sub>2</sub>/steam reforming catalyst to directly make 2:1 H<sub>2</sub>/CO synthesis gas
- Uses unique combined Fischer-Tropsch and wax-cracking reactor
- Simple and compact with unique catalysts in each stage

### INTEGRATED COOL GTL - IH<sup>2</sup><sup>®</sup>

- IH<sup>2</sup> is an integrated biomass hydrolysis technology invented by GTI

- Use natural gas to make H<sub>2</sub>, use biogenic gas to make more biogenic liquids

- LCA shows IH<sup>2</sup> + Cool GTL liquids still provide >60% GHG reduction vs fossil



126 GPT\* Liquid Yield from Wood