Landfill Gas to Liquid Fuels

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Objective

Develop a competitive process for the conversion of Landfill Gas (LFG) into liquid hydrocarbon fuels.

Key Understandings

- Letting nature start the process
- Feedstock production from bacteria
- What you put into a landfill is what you get out of a landfill.
- Every Landfill is different
- Lower Greenhouse gas production
- Offset fossil fuel use
- Stop removal of currently sequestered carbon
- Converting waste gas into fuel
- Storable
- High energy density
- Domestic fuel source
- Carbon offset by use of biomass derived fuels
- Offset fossil fuel use
- Closed Loop Business Model
- Our customers are landfill operators
- High cost involved in fueling their equipment
- Satisfying federal emissions regulations
- Water 7.31
- Carbon Dioxide 38.18
- Methane 52.49
- Oxygen 0.41
- Nitrogen 1.54
- H2S 0.07
- Siloxanes 8.91E-05

Note: Phase duration time varies with landfill conditions
Source: EPA 1997
Motivation and Process

Hypothesis: Conversion of waste Landfill Gases into liquid hydrocarbons is a more feasible system than other proposed technologies.

Goals:
- Down scaling of Fischer Tropsch Synthesis Reactor (FTSR)
- Removing contaminants from LFG: Siloxanes, Sulfides, Halides, etc.
- Modeling a competitive large scale process
- Lab scale: 0.1 ft³/min (Kinetic data and reactor modeling)
- Industrial Scale: Using literature and industry data
- Process 2500 ft³/min

Pretreatment:
- Iron Solid Scavenger
- Activated Carbon/Silica Bed

Tri-Reforming:
- Convert LFG to Syngas
  - CO2 Reforming
  - Steam Reforming

Fischer Tropsch:
- Convert Syngas to Long chain hydrocarbons
  - POx of Methane

Separations:
- High Quality Diesel
- Low quality gasoline sold for upgrading
- Unused portions to combustion

Compressed Natural Gas
Liquid Hydrocarbon Fuels
The Product

<table>
<thead>
<tr>
<th>Product Composition</th>
<th>Diesel Properties</th>
<th>Sale Price ($/gallon)</th>
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</thead>
<tbody>
<tr>
<td><strong>Diesel</strong></td>
<td><strong>Flash Point (C)</strong></td>
<td>56.4</td>
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<tr>
<td></td>
<td><strong>Freezing Point (C)</strong></td>
<td>-36.2</td>
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<td></td>
<td><strong>Cetane Index</strong></td>
<td>71.35</td>
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<td><strong>Sale Price</strong></td>
<td><strong>Diesel</strong></td>
<td>4.00</td>
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<td></td>
<td><strong>Gasoline</strong></td>
<td>1.50</td>
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Gallons Produced:
- Diesel: 91%
- Gasoline: 9%
Conclusions

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<th>CNG</th>
<th>LFG to Liquids</th>
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### Financial Analysis

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<tr>
<td>Total Capital Investment</td>
<td>$12.3 MM</td>
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<td>Operating Cost (MM$/yr)</td>
<td>$0.06 MM</td>
<td>$2</td>
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<td>Net Present Worth (NPW) i=15%</td>
<td>$5.9 MM</td>
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<td>Discounted Rate of Return</td>
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### Capital Investment Breakdown

- **Total Capital Investment**: $12.3 Million
- **Revenue per year**: $9.2 Million
- **Operating Cost per year**: $5.2 Million
- **Plant Life**: 15 years
- **Operating Days/Year**: 350
- **Depreciation Method**: MACRS (9 years)
- **Net Present Worth (NPW) i=15%**: $5.9 Million
- **Discounted Rate of Return**: 26%
- **Discounted Payback Time**: 6.25 years