Modular Gasification for Syngas/Engine Combine Heat & Power Applications in Challenging Environments
This material is based upon work supported by the Department of Energy Award Number DE-FE0031601

MAKING COAL RELEVANT FOR SMALL SCALE APPLICATIONS

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WHERE IS FAIRBANKS?
PROJECT PARTNERS

HMI: Intellectual Property Decades Experience

Worley Group Inc.: Detailed Engineering Cost Estimating Service

Chena Power & Western Energy Services: Integration of Greenhouses with Engine Generators

Cost Share: Chena Power, Aurora Energy, City of North Pole, Sotacarbo, HMI, Hobbs Industries, Western Energy Services
PROJECT DESCRIPTION AND OBJECTIVE

Demonstrate small scale coal gasification to fuel reciprocating engine generators

- Cost effective coal generating capacity for small applications
- Provides load following services
- Ideal for islanding systems
- Local jobs and local food
ALIGNMENT WITH DOE GOALS

✓ Small—50-350 MW
  ✓ This project: 18 MWe
  ✓ First step toward “modularizing”

✓ Near Zero Emissions
  ✓ Built in a “Serious non-Attainment area for PM2.5”
  ✓ Purification of exhaust gas and supplied to greenhouses for CO2 enrichment

✓ Minimize water usage
  ✓ Water cleaned up for greenhouse use

✓ Capable of natural gas co-firing
  ✓ Engines are easily convertible to firing natural gas or propane

✓ Capable of high ramp rates
  ✓ Designed for wind regulation

Other noteworthy benefits:
✓ Deigned to co-fire biomass
✓ Repurposes contaminated refinery site
✓ Provides low-cost district heating, already attracting business interest in switching from fuel oil
Updraft Moving-bed Gasifier

- Feedstock In
- Pre-heated Air and Steam In
- Drying
- Pyrolysis
- Char Gasification
- Char Combustion
- Ash Out

Raw Syngas Out/Fly ash

Drying
Pyrolysis
Char Gasification
Char Combustion
Ash Out

FLARE

FLARE

GAS ENGINES

FUEL OIL STORAGE

DIESEL ENGINE

electrical energy
heat

electrical energy
heat

fuel oil
Coal/Biomass Input → Fuel Preparation / Feed Handling → Air Blower → Gasifier & Cyclone → Gas Cooling → Wet Electrostatic Precipitator → Acid Gas Removal → Oil/Tar Recovery → Blowdown → Pyrolysis Liquids → Ash for Disposal

Gasification System with pre-combustion sulfur capture

Reciprocating Engines Power Block

Jenbacher Engine Generator JMS620 X 4

Heat Recovery

To Greenhouse

Power Out

7.8 MWe

Total 9.4 MWe

3.0 MWe oils/tars

6.4 MWe naphtha

Ash for Disposal
THE EQUIPMENT
FOUND A HOME!

Now

Future
## WHY COAL GASIFICATION?

<table>
<thead>
<tr>
<th></th>
<th>Syngas Project (City of North Pole)</th>
<th>Diesel (GVEA)</th>
<th>Naphtha (GVEA)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capital Cost</strong></td>
<td>$94.3 million</td>
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</tr>
<tr>
<td><strong>Fuel Costs</strong> + variable O&amp;M</td>
<td>$10/MMBtu (at engine intake)</td>
<td>$17/MMBtu</td>
<td>$14/MMBtu</td>
</tr>
<tr>
<td><strong>Levelized Cost of Electricity</strong></td>
<td>$154/MWh</td>
<td>$269/MWh</td>
<td>$214/MWh</td>
</tr>
<tr>
<td><strong>Total Generation Capacity</strong></td>
<td>18MWe 10.0 MW avg 5 - 18 MW swing</td>
<td>180 MWe 10 MW avg 5 - 60 MW swing</td>
<td>60 MWe 43 MW avg 35 - 50 MW swing</td>
</tr>
<tr>
<td><strong>Electric Efficiency, LHV Eff. with heat recovery</strong></td>
<td>34% 53%-69%</td>
<td>&lt;15% (old, simple cycle turbines, part load)</td>
<td>42% (combined cycle turbine, used for wind regulation)</td>
</tr>
</tbody>
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Image Source: Innio
The EPA designated the Fairbanks vicinity as a “serious nonattainment area for PM2.5”

- PM2.5 and precursors (NOx, SO2, volatile organic compounds, and ammonia) will be regulated under the nonattainment New Source Performance Standard.
- Even with Best Available Control Technology, this project is economical.
GVEA CO$_2$e EMISSION RATES

GVEA Goal: Reduce CO2e emissions rate 26% by 2030 from 2012 levels with no adverse long-term increase in rates or adverse impacts on reliability

<table>
<thead>
<tr>
<th>CO$_2$ Tons/MWh</th>
<th>Fuel (Generating Plant Name)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.62-1.64</td>
<td>Coal (Healy 1, Healy 2, Aurora Energy (IPP))</td>
</tr>
<tr>
<td>1.11-2.53</td>
<td>Diesel (Zehnder 1, Zehnder 2, Delta (backup plant seldom used))</td>
</tr>
<tr>
<td>0.53-0.54</td>
<td>Naphtha (North Pole Expansion Plant)</td>
</tr>
<tr>
<td>0.42-0.56</td>
<td>Natural Gas (Purchased from Anchorage utilities.)</td>
</tr>
<tr>
<td>0.00 +</td>
<td>Wind (Eva Creek, Delta Wind (IPP))</td>
</tr>
<tr>
<td>0.00 +</td>
<td>Solar (Solar Farm)</td>
</tr>
<tr>
<td>0.00</td>
<td>Hydro (Bradley Lake. Delivered through the grid intertie.)</td>
</tr>
</tbody>
</table>

+ Wind and solar production must be paired with diesel or naphtha generation.

GVEA does not use energy storage for wind or solar regulation.

- Greenhouse CO2 uptake for our project has not yet been calculated. We are in the process determining the best mix of crops, and the optimal greenhouse acreage for our CHP plant. There is a variation between crops and conditions.
- Between 340 ppm – 700 ppm, CO2 can increase growth by 30-40%.
AK-DGGS IDENTIFIED 37 VILLAGES WITH COAL NEARBY
RADICALLY ENGINEERED SYSTEM

- Make it work at 10 to 18 MWe
  - Economies of Scale working against us
- Make it work at village scale <2MWe
- Integrate with diesel infrastructure
- Make it work with biomass & waste products
- Match greenhouse to CO2 + Heat availability + Power
USEFUL IN LOWER-48, TOO!

- Coal plants are best suited for baseload operation because it requires a long period to ramp up and to ramp down.

- Syngas/Engine combinations has the potential for making coal a cost competitive resource meeting flexible energy demand and fluctuating generation.
BUT MOST IMPORTANTLY
...POWER ALASKA’S INTERIOR
MEET THE TEAM

• Diane Revay Madden, NETL
• Brent J Sheets, UAF
• Rolf Maurer & David Thimsen, HMI
• Harvey Goldstein & Team, Worley Group Inc.
• Chilkoot Ward & David Fish, Aurora Energy
• Randy Hobbs, Hobbs Industries
• Bernie Karl, Chena Power
• Alberto Pettinau, Sotacarbo
• Mariana Hill, Western Energy Services
• Mayor Mike Welch, City of North Pole
• Bill Rogers, NETL
QUESTIONS?

Brent J Sheets
907-750-0650
bjsheets2@alaska.edu