Modular Gasification for Syngas/Engine Combine Heat and Power Applications in Challenging Environments
(Funding by DOE/NETL Contract DE-FE0031446)

MAKING COAL RELEVANT FOR SMALL SCALE APPLICATIONS

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WHERE IS FAIRBANKS?
PROJECT PARTNERS

SLR & PDC: Permitting and Environmental Assessments

HMI: Intellectual Property Decades Experience

WorleyParsons: Detailed Engineering Cost Estimating Service

Cost Share: Chena Power, Aurora Energy, UAF, Sotacarbo, HMI, GVEA, Innio, Western Energy Services
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
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”
✓ 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

Not specifically part of DOE’s stated goals, but noteworthy:
✓ Pyrolysis tars/oils can be used in diesel engines
✓ Designed to co-fire biomass
UAF’S MODIFIED DESIGN

HMI Gasifier
Fisher Klosterman Cyclone
Alfa Laval Syngas Cooler
Bellini Wet ESP and Final Condenser
Bellini Caustic Scrubber
GE Jenbacher Engines
UAF’S MODIFIED DESIGN

COAL

GASIFIER

GAS COOLING

CAUSTIC SCRUBBER

RECIP on SYNGAS

HRSG and SCR

ASH

TARS & OILS

DEG on FUEL

HRSG and SCR

ULSD
THE EQUIPMENT
FOUND A HOME!
## WHY COAL GASIFICATION?
COSTS FOR REGULATING 10 MWe OF WIND POWER

<table>
<thead>
<tr>
<th></th>
<th>Syngas Project (UAF)</th>
<th>Diesel (GVEA)</th>
<th>Natural Gas (not an option)</th>
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</thead>
<tbody>
<tr>
<td>Capital Cost (option 3)</td>
<td>$85 million</td>
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</tr>
<tr>
<td>Fuel Costs + other O&amp;M</td>
<td>$76.6/MWh ($10/mmbtu)</td>
<td>$147.2/MWh ($15/mmbtu)</td>
<td>$200/MWh ($20/mmbtu)</td>
</tr>
<tr>
<td>Wind Regulation Costs (10 MWe regulating capacity)</td>
<td>$3.1 M/yr (GVEA’s cost to regulate wind with syngas)</td>
<td>$6.5 M/yr (avoidable costs)</td>
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<tr>
<td>Total Generation (syngas and liquid fuels)</td>
<td>18 MW 10.0 MW avg 5 to 18 MW swing</td>
<td>240 MW 43.2 MW avg 35 to 48 MW swing</td>
<td>--</td>
</tr>
<tr>
<td>Efficiency, HHV</td>
<td>39%</td>
<td>&lt;15% (turbines)</td>
<td>--</td>
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</table>
THE PROBLEM: INTERMITTENT GENERATION

Eva Creek

Combustion Turbine

Coal

“Free” Energy

Expensive Energy

Curtailed Cheapest Energy
THE SOLUTION: COAL ENABLING WIND

Eva Creek + Recip. Generator = Coal + Combustion Turbine

“Free” Energy + Cheapest Energy = Cheapest Energy + Expensive Energy
EFFICIENCY vs. LOAD

COMBINED CYCLE LM6000 GAS TURBINE PLANT – NPEP
EFFICIENCY CURVE – COMPARED TO DIESEL RECIP UNITS
IN WIND LOAD FOLLOWING APPLICATION

- PEAK EFFICIENCY 52% @ -30F ~68 MW, 72 GPM
- TYPICAL AVERAGE LOAD
- REDUCTION IN GAS TURBINE EFFICIENCY TO LOAD FOLLOW WIND ~ 18%
- 34% Eff, 128.4 gallons per MWh
- 50% Eff, 83.8 gallons per MWh
- Higher loads cannot be achieved at high ambient temps (summer time)
- 24.6 MW REDUCTION IN OUTPUT AS WIND OUTPUT INCREASES
- Lower Cost Naphtha Fuel 17 MW and up >>
- Steam Turbine Risks Tripping Below ~20 MW
- Jet A Fuel Below 17 MW

FUEL %

STARTING

50%

40%

30%

20%

10%

0%

EFFICIENCY %

50%

40%

30%

20%

10%

0%

10 MW 20 MW 30 MW 40 MW 50 MW 60 MW

GENERATOR OUTPUT MW
EFFICIENCY vs. LOAD

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34% Eff, 128.4 gallons per MWh

Fuel Savings & Reduced Emissions

24.6 MW REDUCTION IN OUTPUT AS WIND OUTPUT INCREASES

GENERATOR OUTPUT MW

Jet A Fuel Below 17 MW
Lower Cost Naphtha Fuel 17 MW and up >> Steam Turbine Risks Tripping Below ~20 MW

Higher loads cannot be achieved at high ambient temps (summer time)
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
Multiple gasifier trains and engines can create powerplants from 1 MWe to 30 MWe+.
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 <2 MWe
- Integrate with diesel infrastructure
- Make it work with biomass and waste products
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
RISK FACTORS

• Except for the HMI Gasifier, all components are available commercially
  – HMI gasifier components are well understood and documented

• Emission controls could be *the* key factor to be addressed
  – Fairbanks is in an EPA designated “Serious non-attainment area for PM 2.5”
MEET THE TEAM

- Diane Revay Madden, NETL
- Brent J Sheets, UAF
- Rolf Maurer & Team, HMI
- Harvey Goldstein & Team, WorleyParsons
- Chilkoot Ward & David Fish, Aurora Energy
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- Alberto Pettinau, Sotacarbo
- Isaac Bertschi & Courtney Kimball, SLR
- Erica Betts, PDC
QUESTIONS?

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