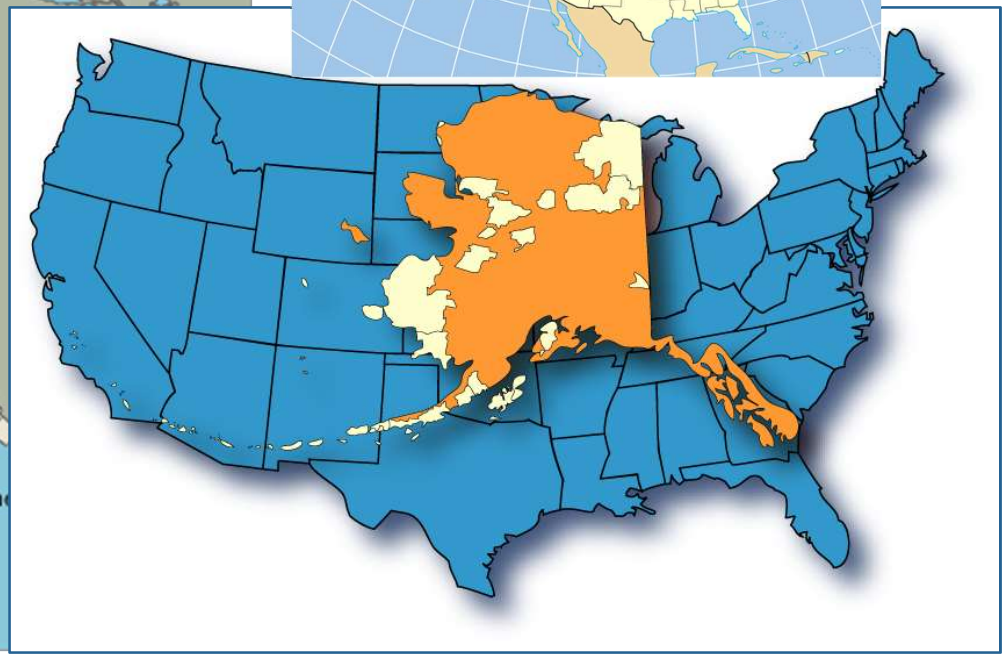
Modular Gasification for Syngas/Engine Combine Heat & Power Applications in Challenging Environments

This material is based upon work supported by the Department of Energy Award Number DE-FE0031601

MAKING COAL RELEVANT FOR SMALL SCALE APPLICATIONS

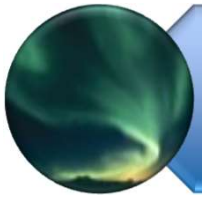
WHERE IS FAIRBANKS?



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

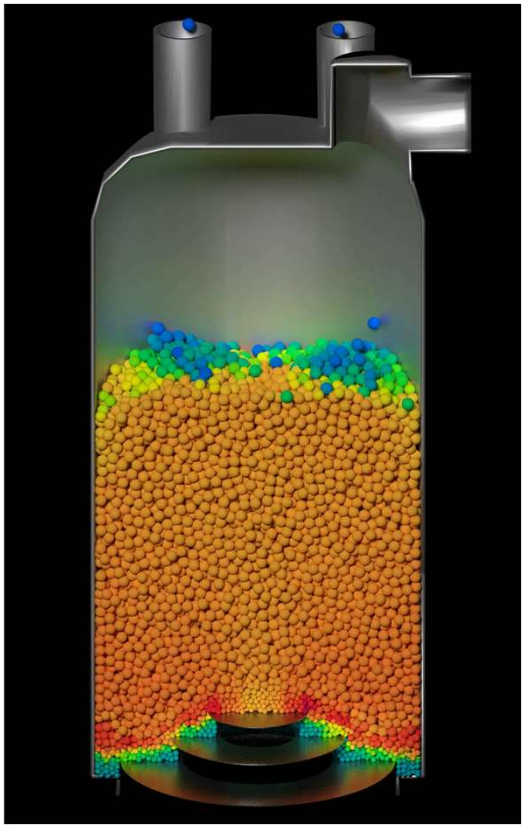
ALIGNMENT WITH DOE GOALS

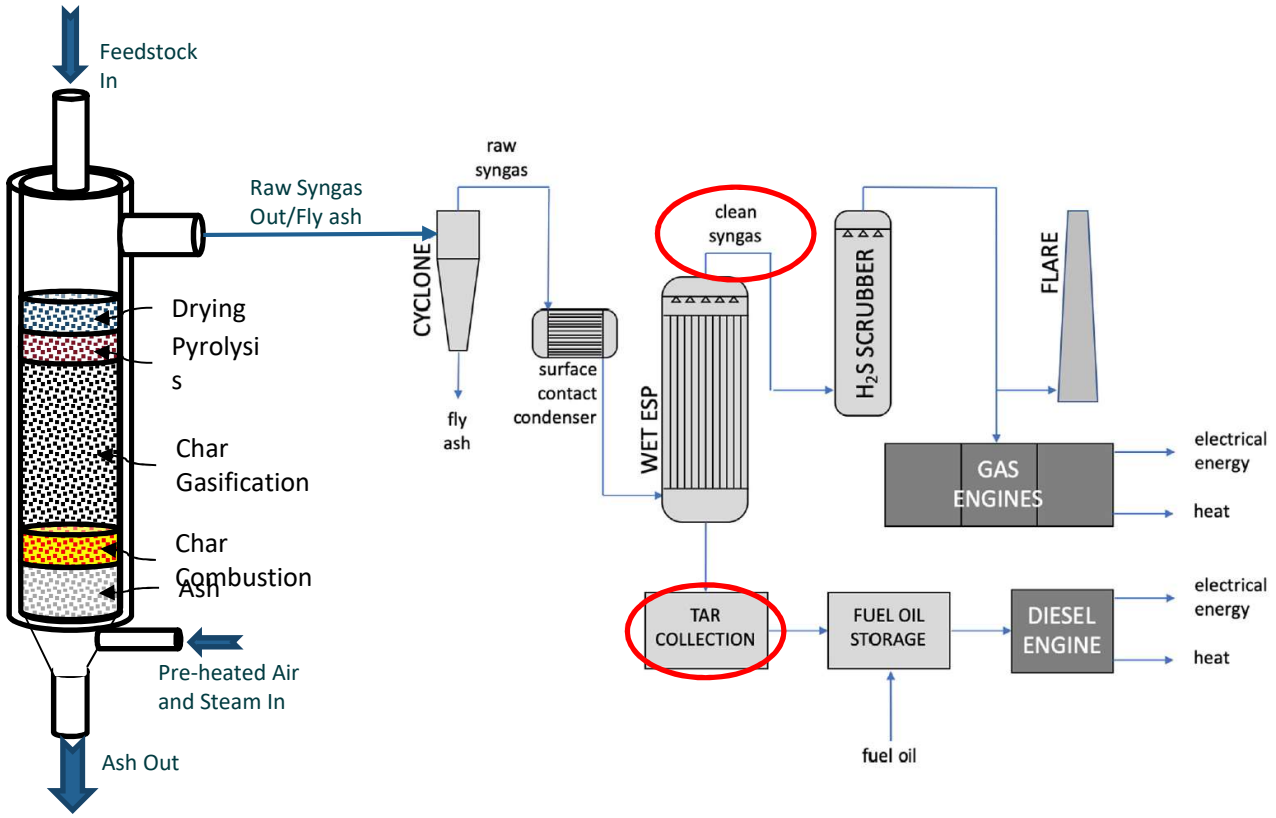
- ✓ Small—50-350 MW
  - ✓ This project: 18 MWe
  - ✓ First step toward "modularizing"
- ✓ Near Zero Emissions
  - ✓ Built in a "Serious non-Attainment area for PM2.5"
  - ✓ Purification of exhaust gas and supplied to greenhouses for CO_2 enrichment
- ✓ Minimize water usage
  - ✓ Water cleaned up for 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

Not specifically part of DOE's stated goals, but noteworthy:

- ✓ Pyrolysis tars/oils can be used in diesel engines
- ✓ Deigned to co-fire biomass

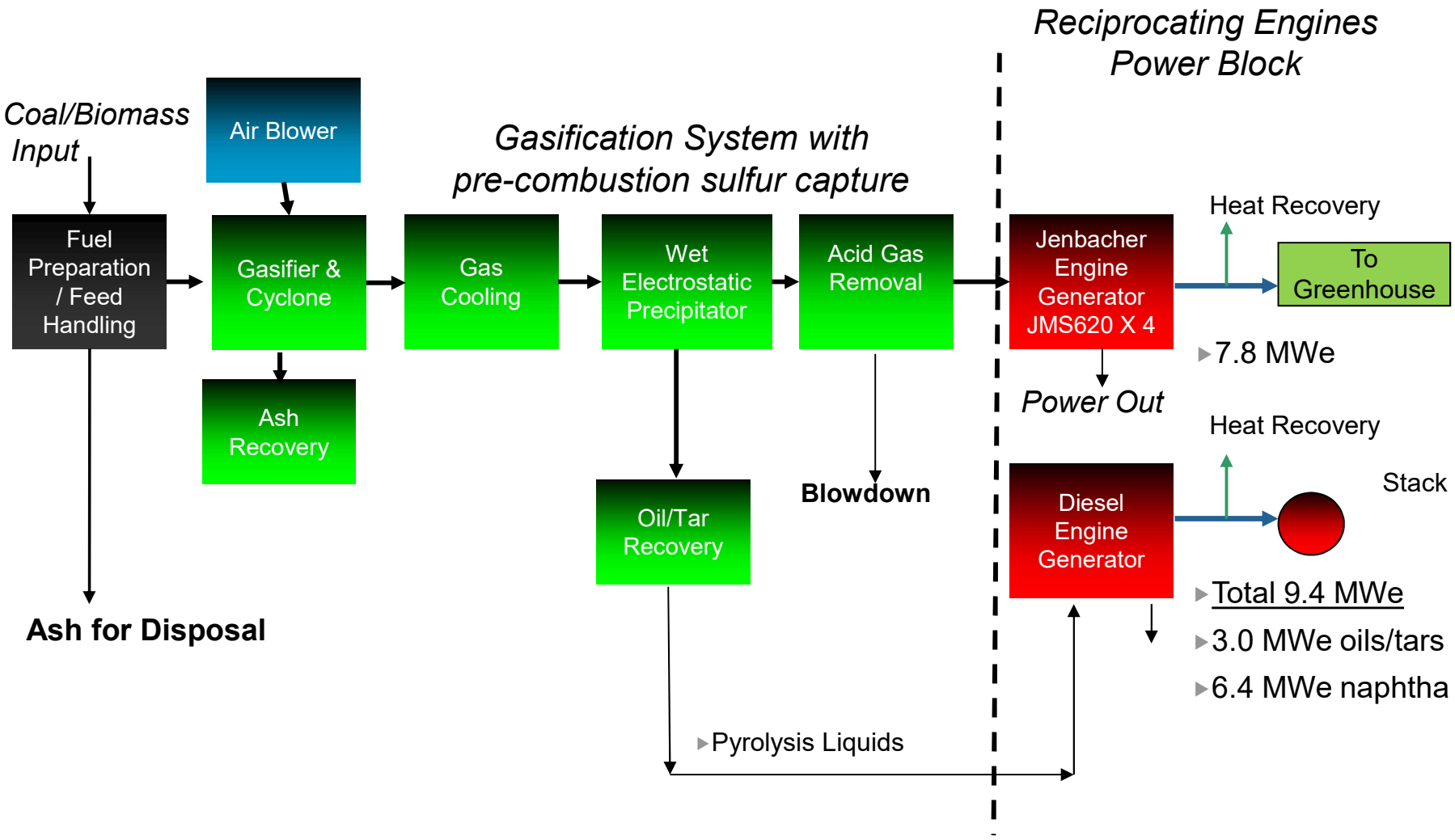
Updraft Moving-bed Gasifier



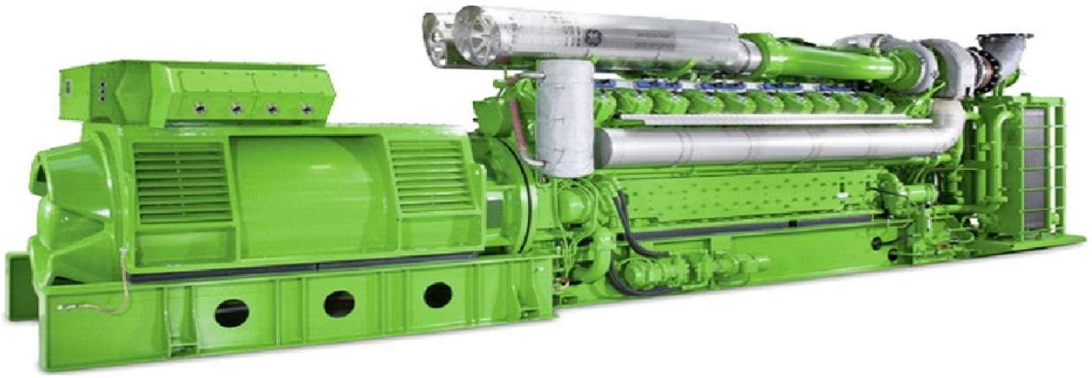


Fuel 267 (2020) 1173

BLOCK FLOW DIAGRAM



THE EQUIPMENT



FOUND A HOME!

WHY COAL GASIFICATION?

	Syngas Project (City of North Pole)	Diesel (GVEA)	Naphtha (GVEA)
Capital Cost	$94.3 million	--	--
Fuel Costs + variable O&M	$10/MMBtu (at engine intake)	$17/MMBtu	$14/MMBtu
Levelized Cost of Electricity	$154/MWh	$269/MWh	$214/MWh
Total Generation Capacity	18 MW 10.0 MW avg 5 - 18 MW swing	180 MW 10 MW avg 5 - 60 MW swing	60 MW 43 MW avg 35 - 50 MW swing
Electric Efficiency, LHV Eff. with heat recovery	34% 53%-69%	<15% (old, simple cycle turbines, part load)	42% (combined cycle turbine, used for wind regulation)

HORTICULTURE

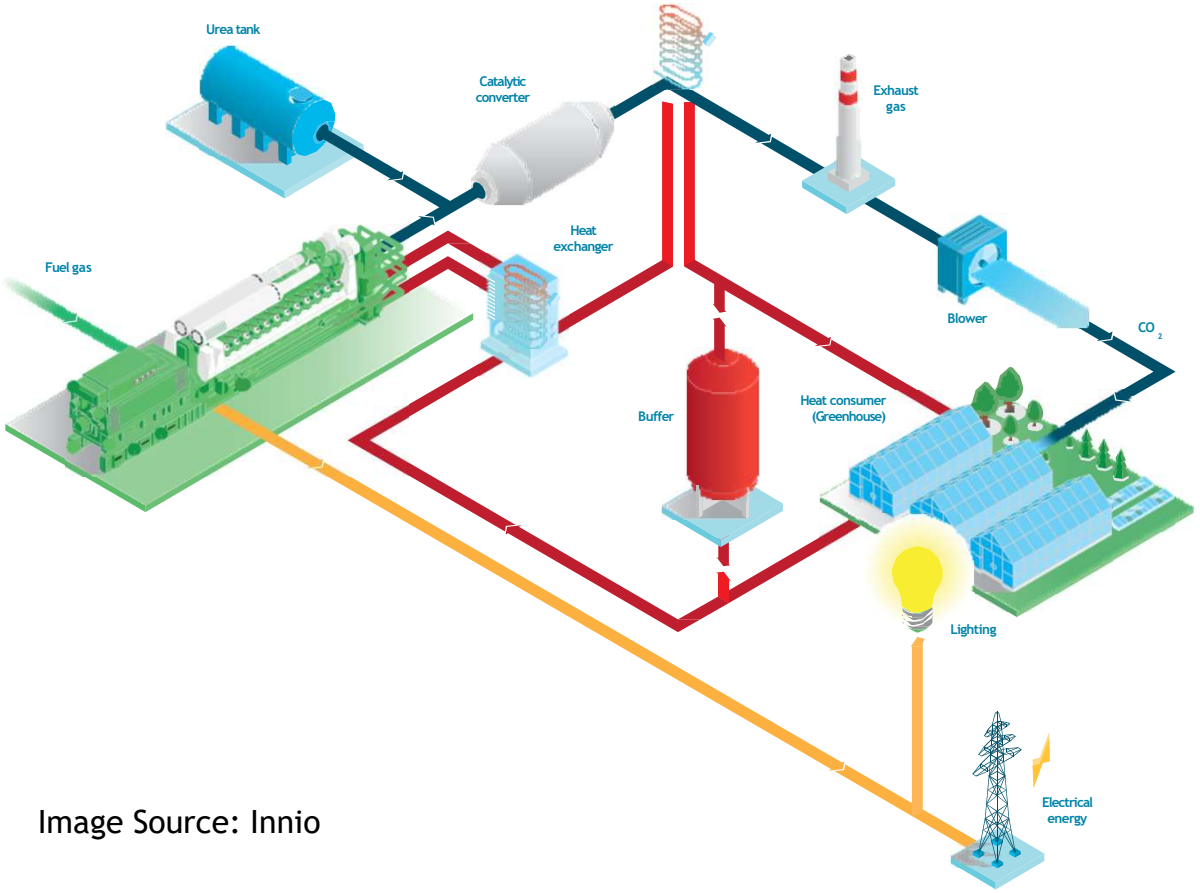
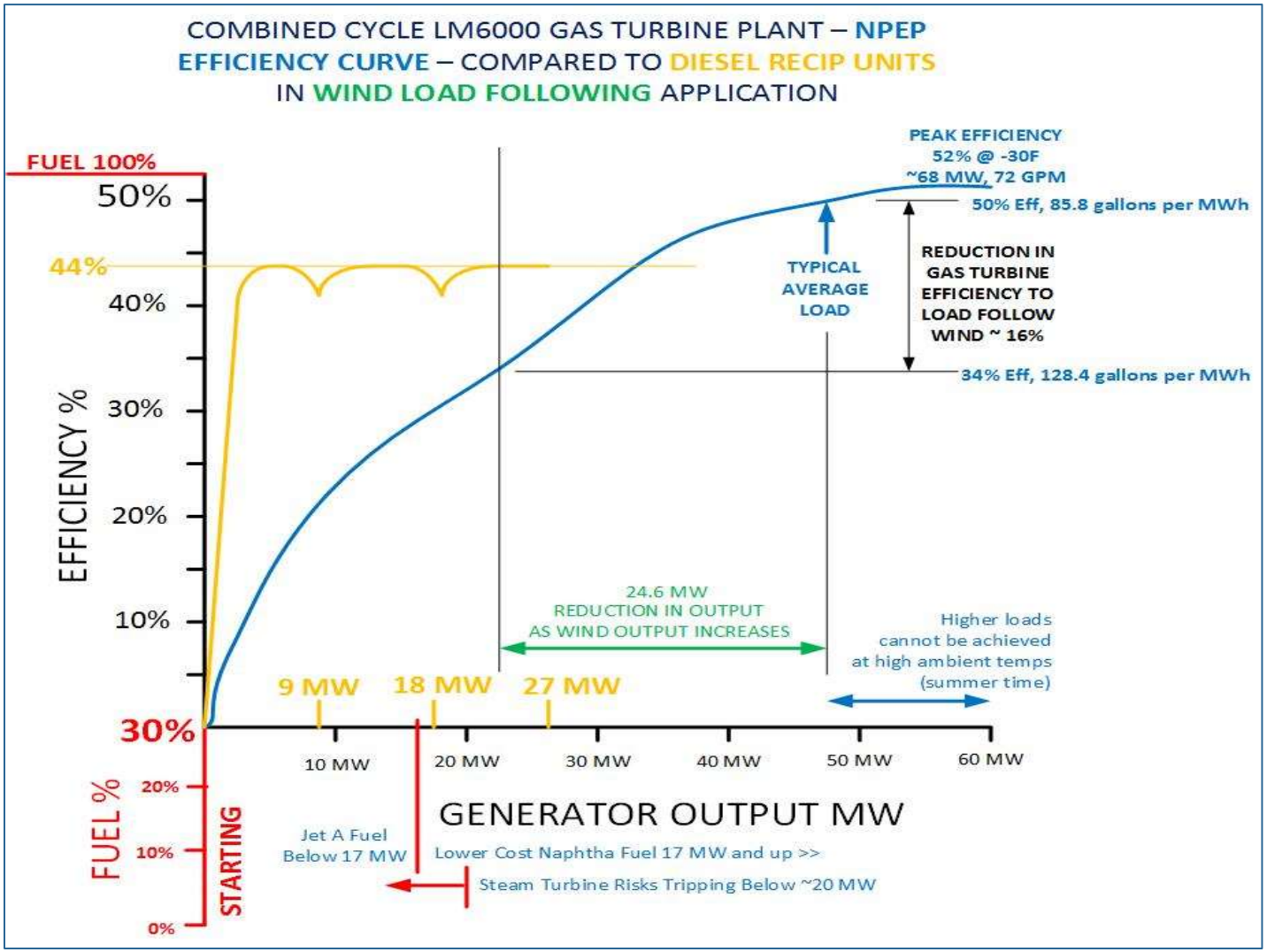


Image Source: Innio

EFFICIENCY vs. LOAD



REGULATORY/PERMITTING

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

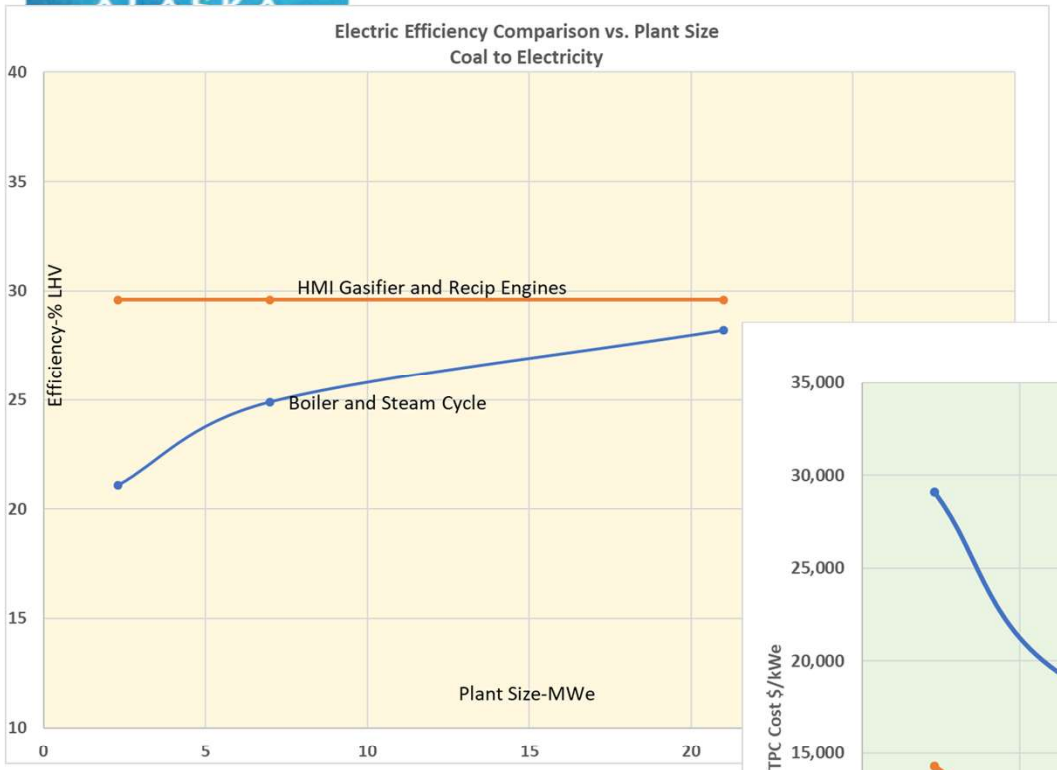
GVEA CO_2e EMISSION RATES

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

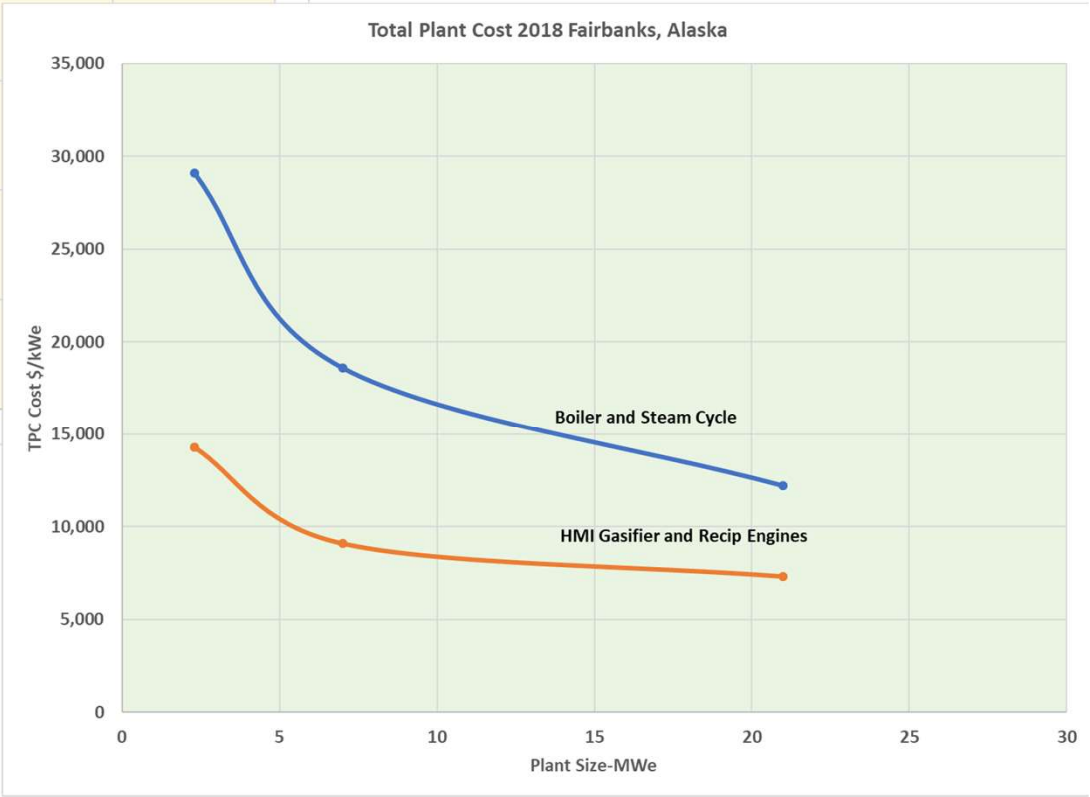
CO_2 Tons/MWh	Fuel (Generating Plant Name)
1.62-1.64	Coal (Healy 1, Healy 2, Aurora Energy (IPP))
1.11-2.53	Diesel (Zehnder 1, Zehnder 2, Delta (backup plant seldom used))
0.53-0.54	Naphtha (North Pole Expansion Plant)
0.42-0.56	Natural Gas (Purchased from Anchorage utilities.)
0.00 +	Wind (Eva Creek, Delta Wind (IPP))
0.00 +	Solar (Solar Farm)
0.00	Hydro (Bradley Lake. Delivered through the grid intertie.)
+ 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%.

MODULARITY and SCALING

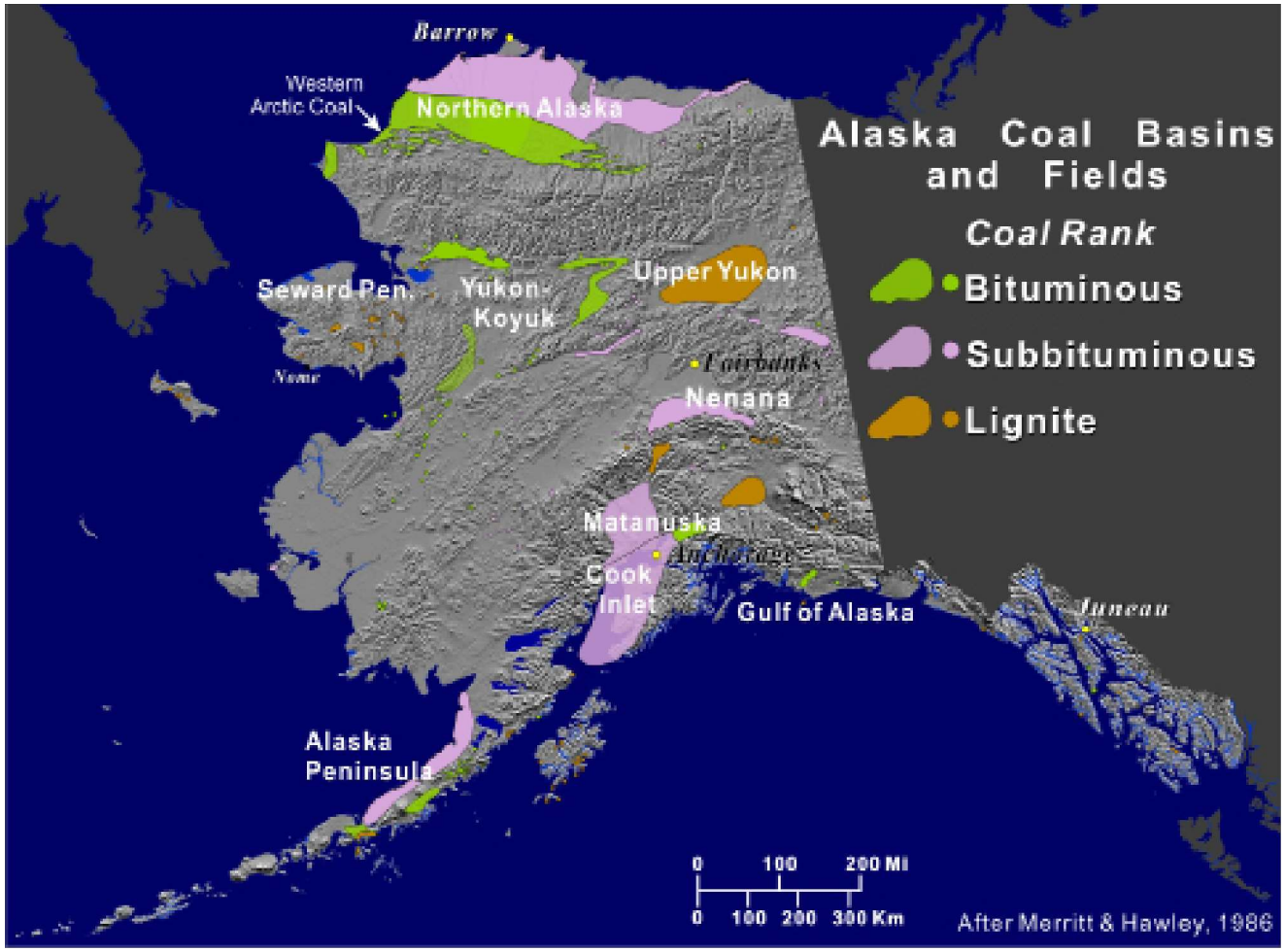


Gasifier/Engine System is Modular and Scalable



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 <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

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 &
  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