



U.S. DEPARTMENT OF ENERGY

Mid-Atlantic Clean Energy Application Center

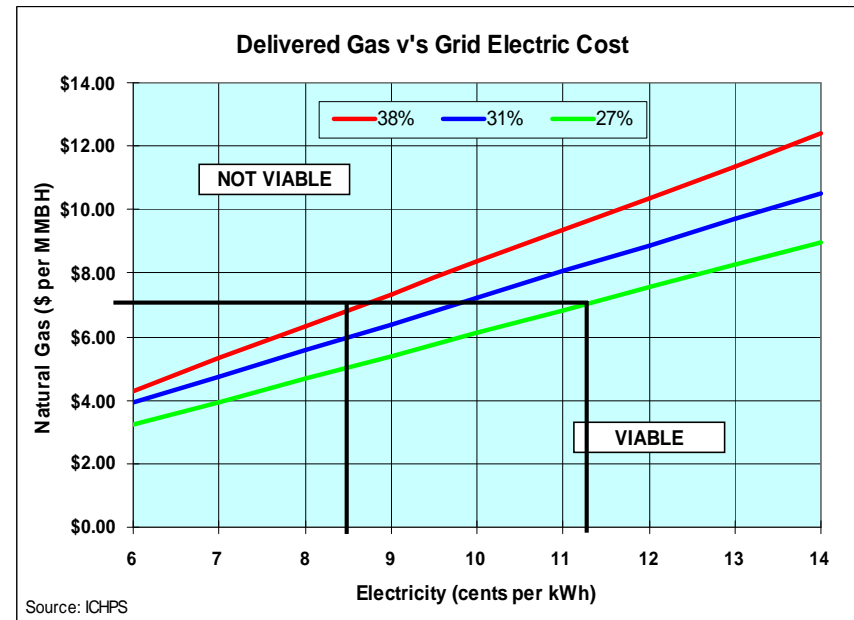
Promoting CHP, District Energy, and Waste Heat Recovery

CHP, Waste Heat & District Energy

Module 4: CHP Qualifiers & Considerations

CHP Project Goals

- Increase Energy Efficiency
- Reduce Energy Costs
 - High Thermal Load Factor
- Minimize Operational Risk
- Reduce Carbon Footprint
- Other Issues
 - Reliability, Expansion, etc.



At a natural gas cost of \$7/MMBH, on-site generators will produce power at between 8½ and 11½ cents/kWh*.

With high thermal load factor, CHP produces power at an effective 6½ to 9 cents/kWh*.

* Includes maintenance

Qualifiers

- **Substantial Energy Costs – Gas/Thermal & Electric**
 - > \$100K p.a. to Self Perform (small project)
 - > \$500K p.a. for 3rd Party Option (still small project)
 - > \$2M p.a. for medium projects
- **Substantial Operating Hours**
 - > 5,000 hours p.a. system operation at Full Load
- **Coincident Thermal & Electric Loads**
 - Thermal Distribution System required
 - Thermal Loads must be ‘Addressable’
- **Corporate Willingness & Desire for Benefits**

Qualifiers

- **Industrial Users**
 - > 1 MW peak demand with process thermal loads
- **Commercial Users**
 - Office Buildings over 50,000 SF
 - Enclosed Shopping Malls with central utilities
 - Hotels with over 100 rooms
- **Institutional Users**
 - Colleges over 5,000 full time students
 - Hospitals over 100 beds
 - Multifamily Residential over 100 units

** Thermal distribution system required for all applications*

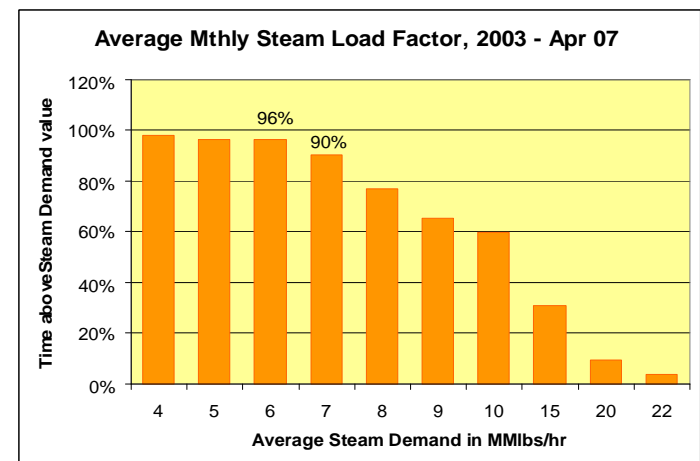


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Considerations

- **Physical Location & Space Availability**
 - Fit equipment with service access
 - Generation and Heat Recovery should be close
 - Easier transmit steam or water than exhaust
 - Proximity to Switchgear & Thermal Loads Cost issue
- **Thermal Distribution System**
 - Type and Quality
 - Tie-in point at return line
 - Maximize load for all 12 months
 - Thermal Use all Operating Hours



Considerations

- **Electric Distribution System**
 - Tie-in prior to distribution
 - Only 1 Meter – Cannot back feed
 - CHP output at 480 – 13,000 V
 - Grid Interconnection – Parallel or Island Mode
 - Parallel \Rightarrow No Power Export/Simpler Interconnection
- **Fuel Availability, Pressure & Quality**
 - Combustion Turbines require high pressure
 - Fuel quality can have significant impact



Considerations

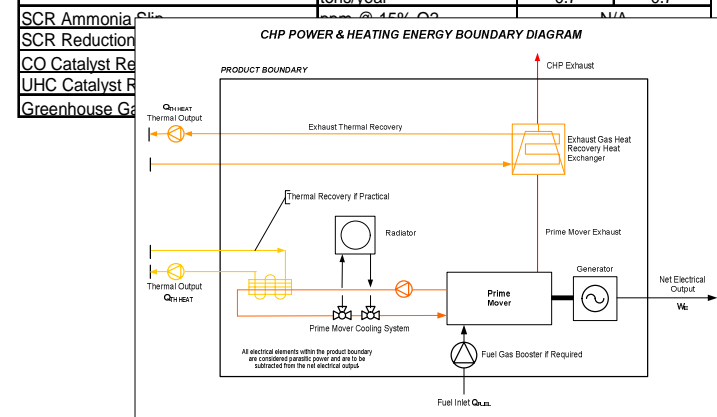
- **Electric Issues**
 - Facility Grid Reliability
 - ‘Black Start’ Capability – Emergency Circuits
 - Generator Block Loading Capability
 - CHP System Parasitics
- **Emissions**
 - EPA Title 5 or Local Authority
- **Noise**
 - Mitigated with Enclosures & Silencers
- **CHP System Control & Metering**
 - Integrate with component controls, utility meters & BAS

Generator Emissions				
Emissions		Rate g/bhp-hr	Annual Total	Monthly Average
NO _x	Tons	0.15	5.7	0.5
NH ₃	Tons	0.04	1.5	0.1
CO	Tons	0.5	19.0	1.6
O ₂	%	9.4		

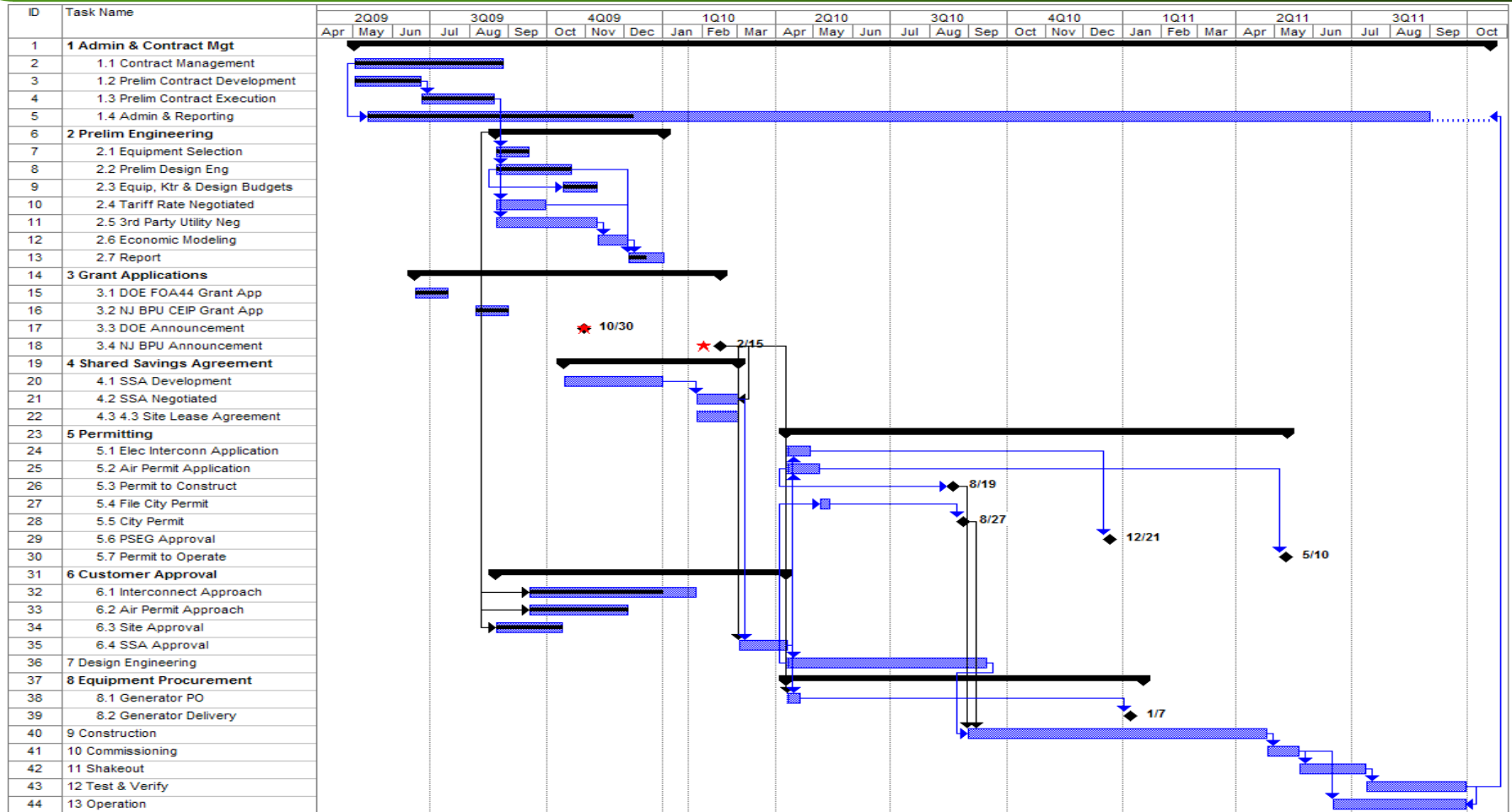
Permitting Issues

- Air Permits
- Electrical Interconnection
- City/State Construction Permits
 - Operating Personnel
- Grant Program Requirements
 - M&V

Exhaust Emissions At Stack			
NOx	ppm @ 15% O2	5	5
	lb/MMBtu, HHV	0.018	
	lb/hr	0.8	0.8
	tons/year	3.5	3.5
CO	ppm @ 15% O2	10	10
	lb/MMBtu, HHV	0.022	
	lb/hr	1.0	1.0
	tons/year	4.3	4.3
UHC	ppm @ 15% O2	10	10
	lb/MMBtu, HHV	0.013	
	lb/hr	0.6	0.6
	tons/year	2.5	2.5
VOC	ppm @ 15% O2	1	1
	lb/MMBtu, HHV	0.003	
	lb/hr	0.1	0.1
	tons/year	0.2	0.2
PM ₁₀	lb/hr	1.3	1.3
	lb/MMBtu, HHV	0.030	
	tons/year	5.8	5.8
	lb/hr	0.2	0.2
SO ₂	lb/MMBtu, HHV	0.003	
	tons/year	0.7	0.7



Project Schedule



Emissions

- In the same way that it saves fuel cost, CHP reduces pollution by using the fuel's energy twice, yielding half to a third of the emissions from separate applications.
- CHP is assumed to displace fossil fuel generated central power – not nuclear or renewable.

29. Displaced Electricity: Generation Profile


eGRID Average Fossil 2005

[Link to EPA's eGRID \(Emissions & Generation Resource Integrated Database\)](#)

Modify one of the Three User-Defined Generating Sources

30. Displaced Electricity: Select U.S. Average or individual state or NERC region/subregion for EGRID Data

RFC East



[NERC Region Definitions](#)

- Supported by US DOE & EPA with Caveat – No credit for power related emissions offset under Title 5

Emissions

- **2 MW Recip Engine w/ Cooling & Heating**

This reduction is equal to removing the carbon that would be absorbed by 2,289 acres of forest



This reduction is equal to removing the carbon emissions of 1,835 cars



Annual Emissions Analysis					
	CHP System	Displaced Electricity Production	Displaced Thermal Production	Emissions/Fuel Reduction	Percent Reduction
NOx (tons/year)	1.72	22.82	2.01	23.11	93%
SO2 (tons/year)	0.05	112.36	0.01	112.32	100%
CO2 (tons/year)	9,116	17,875	2,350	11,109	55%
Carbon (metric tons/year)	2,254	4,420	581	2,747	55%
Fuel Consumption (MMBtu/year)	156,232	187,583	40,282	71,633	31%
Acres of Forest Equivalent				2,289	
Number of Cars Removed				1,835	

This CHP project will reduce emissions of Carbon Dioxide (CO2) by 11,109 tons per year

This is equal to 2,747 metric tons of carbon equivalent (MTCE) per year



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Larry Burton
Pennsylvania and West Virginia
PENN STATE UNIVERSITY
UNIVERSITY PARK, PA 16802
TEL: 814.360.9868
E-MAIL: lcb2@psu.edu



Gearoid Foley
New Jersey
50 WASHINGTON ROAD
PRINCETON JUNCTION, NJ 08550
TEL: 609.799.2340
E-MAIL: gfoley@maceac.psu.edu

James Freihaut, Director
Mid-Atlantic Clean Energy Application
Center
104 ENGINEERING UNIT A
UNIVERSITY PARK, PA 16802
TEL: 814.863.0083
E-MAIL: jdf11@psu.edu

Richard Sweetser
Virginia, DC and Maryland
12020 MEADOWVILLE COURT
HERNDON, VIRGINIA 20170
TEL: 703.707.0293
E-MAIL: rsweetser@maceac.psu.edu

Bill Valentine
Delaware
THE PHILADELPHIA NAVY YARD
4801 SOUTH BROAD STREET
PHILADELPHIA, PA 19112
TEL: 609.799.2340
E-MAIL: wjv3@psu.edu