

WWTP CHP

The ABC of CHP Economics & Design

NJ WEA 2013, Atlantic City, NJ

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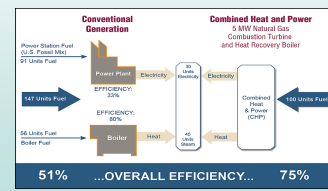


What is CHP

Combined Heat & Power or Cogeneration

ASHRAE Handbook: "Combined heat and power (CHP) is the simultaneous production of electrical or mechanical energy and useful thermal energy from a single energy stream."

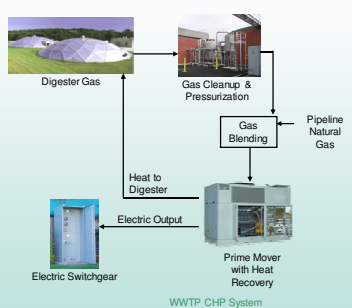
CHP uses 32% less primary energy versus grid power and fossil fueled boilers. (source US EPA)



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System Components

- Anaerobic Digester
- Fuel Treatment
- Prime Mover
- Heat Recovery
- Thermal Technology
- Accessory Devices
- Switchgear
- Controls/M&V




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Fuel Treatment

WWTP Digester Gas contains many contaminants including moisture, particulates, sulfur and siloxanes to varying degrees which can cause significant damage to CHP system components if not removed. The DG pressure also needs to be boosted to meet prime mover requirements.

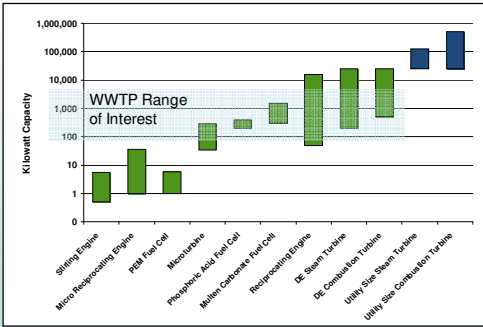
Fuel Treatment Methods:

- Gas Compressors
- Chillers for Moisture Removal
- Iron Sponge for Sulfur removal
- Filter for Particulate & Moisture removal
- Carbon Filters or Membranes for Siloxanes removal



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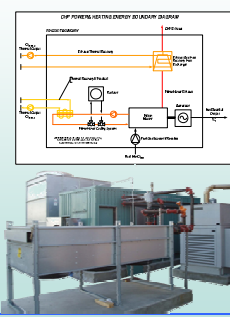
Prime Movers



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CHP Project Goals

- Increase Energy Efficiency
- Reduce Energy Costs
- Minimize Operational Risk
- Reduce Carbon Footprint
- Other Issues: Reliability, Expansion, etc.



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WWTP CHP Economics

WWTP Digester Gas holds significant potential to provide electric power generation

1,000 CF of DG at 600 Btu/CF = 600,000 Btu

Typical Engine Generator Electric Efficiency = 30%

Typical Engine Generator Thermal Efficiency = 40%

With CHP = 52.7 kW Electricity + 240 MBH Heating

With an 80% Efficient Boiler = 480 MBH

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Basic Operating Value

Grid Electric = 12 ¢/kWh Nat Gas = 80 ¢/Therm
 CHP System O&M = 3 ¢/kWh

50% Higher Value

Value per 1,000 CF	CHP Plant	Boiler
Electric Offset	\$6.32	-
Thermal Offset	\$2.40	\$4.80
O&M Cost	\$1.58	-
Net Output Value	\$7.14	\$4.80

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WWTP CHP Economics

Load Factors (LF) are critical to evaluation of the economics when using Digester Gas (Boiler's higher thermal output has lower LF than CHP)

CHP Electric LF = 90%, CHP Thermal LF = 80%

Boiler Load Factor = 60%

Adj Value per 1,000 CF	CHP Plant	Boiler
Electric Offset	\$5.22	-
Thermal Offset	\$1.68	\$2.52
O&M Cost	\$1.42	-
Net Output Value	\$5.48	\$2.52

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WWTP CHP Economics

CHP System CapX at \$4,000 per kW = \$1,320,000


Net CHP Benefit against existing DG Boiler = \$162,060
 Simple Payback = 8.1 years without Rebates
 Rebate Cap = 40% of project ⇒ 4.9 year Simple Payback

Net CHP Benefit against Flaring = \$300,030
 Simple Payback = 4.4 years without Rebates
 Rebate Cap = 40% of project ⇒ 2.6 year Simple Payback

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Considerations

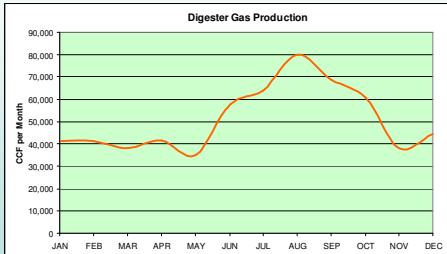
- WWTP Process Integration
 - Aeration system operation – considerable electric load
 - Existing equipment operating schedule & efficiency
- Compatibility with existing Electric Infrastructure
- Control & Controls Integration
- DG Production & Management
- Environmental Air Permit Reporting
- Facility Operations Integration
- Maintenance – Electric, Thermal & Gas Cleanup Equipment
- 3rd Party Involvement



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WWTP DG Production

DG Production can vary considerably by month



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Thermal Loads

Digester heating provides a good thermal load

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Considerations

To optimize the economic advantage provided by CHP, the plant must have a high electric and thermal load factor.

Natural Gas can be blended with DG to increase plant capacity

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Considerations

High Thermal & Electric Load Factor Required (LF = Use/Capacity)

The 'Thermal Credit' is critically important to the economics of CHP.

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Considerations

Physical Location & Space Availability
Fit equipment including gas clean-up 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 all Operating Hrs

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Considerations

Electric Distribution System
Tie-in prior to distribution
Only 1 Meter – Cannot back feed
CHP output at 480 – 13,000 V
Emergency Power Circuits
Grid Interconnection – Parallel or/and Island Mode
Parallel => No Power Export/Simpler Interconnection

Fuel Availability, Pressure & Quality
Combustion Turbines require high pressure
Fuel quality can have significant impact

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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	Annual Total	Monthly Average	
NOx	lb/hr	0.15	5.7	0.5
SOx	lb/hr	0.04	1.5	0.1
CO	lb/hr	0.5	18.0	1.6
O ₂	%	9.4		

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Considerations

- Prime movers require expert maintenance to meet reliability expectations**
 - 3rd Party for routine maintenance + rebuilds or self perform routine maintenance and contract rebuilds
- Engine maintenance higher than NG engine**
- Gas Cleanup cost typically 25% of maintenance**
- Thermal equipment often merged with existing facility O&M activities**
- Continuous monitoring improves reliability and allows for predictive maintenance**

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Considerations

- Operating Air Permit**
 - Size may Dictate Requirements
 - Exhaust Treatment Options
- Electrical Interconnection**
 - Distribution Utility Issue
- City/State Construction Permits**
- Operating Personnel**
- Incentive Program Requirements**
 - Efficiency/Emissions
 - M&V

City/State	Permitting Agency	Permitting Process	Permitting Fee
NY	DEC
PA
MD
VA
NC
SC
GA
FL
LA
TX
OK
KS
MO
IL
IN
OH
MI
WI
ND
SD
NE
WV
DC

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Considerations

- County/City Planning Boards: Land use and noise ordinances.**
- Building & Fire Code Departments: Exhaust temperatures, venting, gas pressure, fuel storage, space limitations, vibration, steam piping and structural issues.**
- Environmental/Public Health Department: Public health and safety issues, hazardous materials and waste management.**
- Water/Sewer & Public Works Authorities: Water supply and discharge issues.**

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Project Schedule

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Q&A

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