An Energy Efficiency Workshop & Exposition

Palm Springs, California

Please be courteous to our speakers

Turn off all cell phones

and

Set pagers to vibrate

Waste To Watts Introduction

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Typical 30 kW Microturbine

Turbine Exhaust Waste Heat Recovery

- Configurations available for 1- 4 Microturbines
- Extruded aluminum finned tubes with copper liners and steel headers
- Exhaust diverter valve to dispose excess heat

Waste Water Treatment Plant Application

(a) 2 – 30 Kw micro turbines

(b) Compressor and Heat Exchanger

(c) Fueled by anaerobic digester gas

Turbine Exhaust as Intake Air to Boiler

- Relatively constant thermal load
- Long run hours
- 1 MM Btu/hr (400 hp) boiler or greater
- Mission critical application
  - Process application such as food processing

Turbine Performance and Output

Net Output (%)	100	90	80	70
Efficiency (%)	27.7	25	22.2	17.4
Fuel Costs ($/mmBtu)	Cents per kWhr Conversion			
4.00	5.47	6.07	6.83	7.81
6.00	8.20	9.11	10.25	11.71
8.00	10.93	12.15	13.12	15.62

Turbine Performance and Inlet Air Temperature

Air Inlet Temp (F)	Efficiency (%)
59	28.0
68	26.5
77	25.0
86	23.5
Sea Level	

Combined Heat and Power Costs

	Sensible	S&L adder
Turbines (*)	105,503	
Heat Ex	9,333	-9,333
Compressor	5,610	
Site Prep	2,500	
Electrical Connections	3,000	
Gas Connections	2,000	
Permits	500	
Ducting & Insulatio	754	2,133
Shipping and Handling	----	----
Total	$ 1538 / kW(**)	$ 1452 / kW(**)

(*) Master Turbine - 25,960; 3 Slave Turbines – 77,220; Remote Monitoring – 1,540; Natural Gas Kit – 462; Emergency Stop – 198; and MultiPac Cable – 123

(**) 30 kW units derated to 28 kW to supply compressor

"Free" Fuel Assumptions

There are applications where microturbine fuel is available at little or no costs. Some examples include Flare Gas, Coal Bed Methane, Municipal, Industrial, and Agricultural Sewage Treatment Plants, and Landfills. Heat recovery may or may not be practical in these applications.

CHP Bottom Line

Application	Sensible	Sens&Lat
Capital Recovery	2.02	1.91
O&M	1.50	1.50
Fuel	8.78	8.78
Heat Rec. Adjustment	(1.97)	(4.28)
Total	10.33 c/kWhr	7.91 c/kWhr

Assumption: Sea Level, 75 F inlet temp, 100% output, 60 cents per therm, 95% availability, 8% interest and 10 year capital recovery

Free Fuel Bottom Line

	Sensible	Sens&Lat	w/o Heat Rec
Capital Recovery	2.02	1.91	1.86
O&M	1.50	1.50	1.50
Fuel	--	--	--
Heat Rec. Adj.	(1.97)	(4.28)	--
Total	1.55 c/kWh	-0.87 c/kWh	3.36 c/kWh

Q and A