DG Update
News & views on distributed generation
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Performance of Microturbine-Based Cogeneration System Verified

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Verification performance testing of Mariah Energy Corporation's Heat PlusPower system has shown that the Capstone microturbine operated in the combined heat and power mode can achieve system efficiencies of 72 percent. Compared to emissions from the largely coal-fired, grid-supplied power at the Alberta, Canada test site, CO2 reductions of 55 percent and NOx reductions of 97 percent were achieved.

The U.S. Environmental Protection Agency's (EPA) Office of Research and Development operates the Environmental Technology Verification (ETV) program to facilitate the deployment of innovative technologies through performance verification and information dissemination. The Greenhouse Gas Technology Center (GHG Center), managed by EPA's partner verification organization, Southern Research Institute, is one of several verification organizations operating under the ETV program.

ESTIMATED ANNUAL CO_2 EMISSION REDUCTIONS FOR MODEL SITES

Model Site		Baseline System		Annual CO_2 Emission Reductions	
		Electricity Provided By:	Heat Provided By:	Lb	%
NC	Textile Plant	Utility Grid [a]	Natural Gas Boiler (60% efficiency)	5,418,735	27
Chicago	Large Office	Utility Grid [b]	Natural Gas Boiler (70% efficiency)	526,678	3
	Medium Hotel			557,608	12
	Large Hotel			884,276	9
	Hospital			3,924,710	16
Atlanta	Large Office	Utility Grid [a]	Electric Boiler [a] (95% efficiency)	1,048,338	6
	Medium Hotel			1,160,960	22
	Large Hotel			1,701,375	17
	Hospital			9,765,554	34

[a] EPA reported CO_2 emission factor for the Southeast region is 1.334 lb/kWh
[b] EPA reported CO_2 emission factor for the North Central region is 1.68 lb/kWh

(larger image is supplied at end of article)

Microturbines coupled with heat recovery systems for cogeneration are a relatively new technology, and the availability of performance data is limited and in demand.

Mariah Energy Corporation committed to participate in an independent verification of its Heat PlusPower system (Mariah CHP System) at the Walker Court condominium project in Calgary, Alberta, Canada, the first commercial installation of this system. The Mariah CHP System uses a Capstone Model 330 MicroTurbine (30 kWe) for electricity generation. It also includes: (1) a specially designed and insulated microturbine enclosure, (2) a turbine exhaust waste heat recovery unit, and (3) an integrated building energy management system. The heat recovery system consists of a fin-and-tube heat exchanger, which circulates a 15 to 17 percent propylene glycol mixture through the heat exchanger at approximately 20 gpm. The system can produce electric power in stand-alone or grid-connected applications. Most of the electricity generated is used on-site, and excess electrical energy is interconnected to the Alberta electric utility grid for sale. The facility uses the thermal energy generated by the system to heat domestic hot water and for comfort heating.

The GHG Center evaluated the performance of the Mariah CHP in collaboration with Natural Resources Canada and the Canada Center for Mineral and Energy Technology-Energy Technology Centre. In testing performed between April 2 and May 25, 2001, the team verified the Mariah CHP System's electricity generation and use rate, thermal energy recovery and use rate, electrical power quality, energy efficiency, emissions, and GHG emission reductions. GHG emission reductions for Mariah CHP System

installations at representative sites in the U.S. were also estimated. Verification testing occurred at an altitude of 3,370 ft above sea level. Ambient temperatures varied between 38 and 65 F. Turbine operation at higher elevations and ambient temperatures can result in lower efficiencies, unit derating, and the possibility of emissions profiles different from those reported here.

The results show that the quality of power generated by the Mariah CHP System is generally high, and that the unit is capable of operating in parallel with the utility grid. The unit produced between 23 and 28 kW of electrical power depending on ambient temperature. The maximum heat recovery rate measured was 195,000 Btu/hr. At full load, electrical efficiency was 24.6 percent and thermal efficiency was 47.2 percent. Total Mariah CHP System efficiency at full load was 71.7 percent, and total efficiencies as high as 80 percent were observed after Mariah modified an air inlet design. NOx and CO emissions at full load were less than 5 ppmvd (corrected to 15 percent O2). Maximum NOx and CO2 emission reductions are estimated to be 97 and 55 percent, respectively.

The table presents maximum estimated CO2 emissions reductions for the Mariah system at three model U.S. sites: commercial buildings in Chicago and Atlanta, and a textile plant in North Carolina. The annual reductions are lower than those estimated for Walker Court because the CO2 emission rate for the Atlanta, Chicago, and North Carolina electrical utility grids are significantly lower than the Alberta Power Pool. In most cases significant savings in emissions can be achieved in power systems drawing upon gas-fired plants.

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