

**AT A GLANCE**

- Microturbines derived from other small combustion turbine designs
- Waste heat recovery the key to economic feasibility
- Units are easily installed in modules
- Continuing research extends life, improves efficiency

# Small Packaged Generation Systems

## THIS ISSUE: Microturbine Use on the Rise

Recognition is growing that small packaged generation systems can increase the energy security of a facility, and allow the owner to make independent energy decisions. Being "off the grid" was at one time considered a costly and risky business decision. That has changed.

### MICROTURBINES GROWING IN POPULARITY

Last issue we discussed the important role played by generator sets driven by natural gas-fired reciprocating engines. A second major class of small gas-fired generators is also in widespread and growing use — microturbines.

Microturbines are combustion turbines, typically the size of a refrigerator, with outputs of 25 kWe to 500 kWe.

These machines are true "technology transfer" products, evolved from automotive and truck turbochargers, auxiliary power units for airplanes, and small jet engines. Unlike reciprocating engines that use water cooling, all of the waste heat is contained in the combustion exhaust stream.

### FEW MOVING PARTS

Microturbines offer a number of desirable features, including a small number of moving parts, compact size, light weight, low emissions, and an ability to utilize a wide range of fuels. The use of heat recovery with these systems can achieve total efficiencies in the area of 80%. Increasingly, microturbines have become practical and reliable systems for small packaged generation.

For example, Ingersoll-Rand offers microturbine generation packages in sizes of 70 and 250 kWe, in configurations suitable for operation both parallel to the grid and in standalone applications. The units offer built-in heat recovery, with the 70 kWe package providing over 300,000 Btu/hr to the heat exchanger.

I-R microturbines use a mechanical gearbox to convert high speed turbine operation to the lower speed needed for a 60 Hz generators. The advancing technology of I-R microturbine design allows these units maintenance intervals of 8,000 hours and a design life of 80,000 hours.

### BOTH STANDALONE AND PARALLEL INSTALLATION POSSIBLE

Another important developer of microturbine technology is Capstone Turbine Corporation, manufacturing 30 and 60 kWe models. In addition, they are introducing a 200 kW unit this summer. Capstone indicates that it is currently producing 1.5 MW of turbine capacity every week, and that there are currently over 5 million hours of operating experience with their machines.

Capstone recommends their product for both standalone and parallel operation with electric utility service. Capstone microturbines use a high-speed electric alternator that is directly driven by the turbine. The high frequency power output is converted to standard 60 Hz by an electronic power conditioning module.

Because of their small size, simple designs, and because they don't require a cooling water system connection, microturbines are particularly suitable for modular installation. Units are typically installed side by-side, using a common control system and electric distribution panel.

### HEAT RECOVERY KEY TO EFFICIENCY

Because nearly all of the unused heat from microturbines goes into the turbine exhaust, heat recovery is usually the key to economic success. Installations can be true combined heat and power (CHP) installations, sometimes called cogeneration. With the microturbine located in or adjacent to the customer's premises,

**Partial List of Microturbine Manufacturers**

**Bowman Power** — http://www.bowmanpower.uk

**Capstone** — http://www.capstoneturbine.com

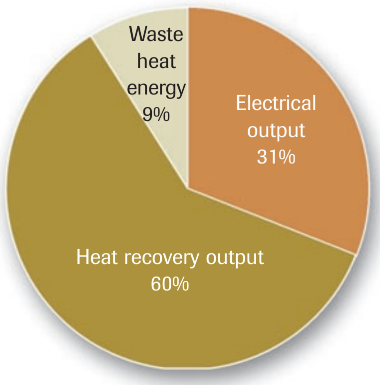
**DTE Energy Technologies - DITech** — http://www.dtetech.com/energynow

**Elliott / Ebara** — http://www.tapower.com

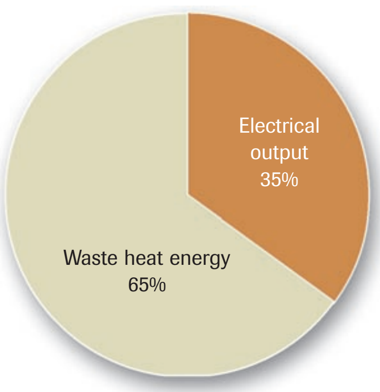
**Ingersoll-Rand PowerWorks** — http://www.irpowerworks.com

### Comparison of Energy Outputs

Packaged Generation with CHP




Central Station Electric Generation




systems can be designed to take full advantage of the turbine exhaust heat.

Exhaust gas-to-liquid heat exchangers or small waste-heat boilers permit full use of this thermal energy for water heating, space heat or process water heat. In large arrays of microturbines, waste heat boilers can provide steam to small steam turbogenerators, in effect becoming mini combined-cycle power plants. Another important development is the use of waste heat for absorption cooling. This concept is completely developed in the UTC Power PureComfort™ 240 packaged power, cooling and heating system.

This system, developed in partnership with Carrier, provides up to 240 kWe of power, using the exhaust heat to supply a double-effect absorption chiller during building cooling mode, and to provide hot water for building heating the rest of the year. The chiller has a coefficient of performance (COP) of 1.3, much higher than single-effect absorption chillers, and can provide 110 refrigeration tons of cooling or up to 900 MBtu/hr of heating. The entire package is available with a sound suppression package that holds acoustic levels to 65dBA at 10 meters. According to UTC Power, the unit also has very low $NO_X$ emissions of less than 9 ppm at full electrical load.

## MICROTURBINE SUCCESS STORY

An example of an industrial customer successfully using microturbines is Harbec Plastics, near Rochester, New York. In 2001 Harbec installed an array of 25 Capstone 30 kW microturbines, with a total electrical capacity of 750 kW, and an additional heat recovery capability of 1.5 MW or 5,128,500 Btu/hr. The motivation for this standalone installation was to improve power supply reliability for the plastic manufacturing facility.

President and company founder Bob Bechtold insisted on a system that would give both high reliability and energy efficiency. Bechtold notes that in the plastics industry, a momentary interruption is nearly as serious a problem as a long-term interruption and can result in significant product loss and operation downtime. He needed a system that would always be there. The installation was designed for this type of high reliability and system energy efficiency is accomplished by using the turbine exhaust as a thermal source for both facility heating and cooling systems. Building cooling is accomplished with a Carrier absorption chiller.

## LARGER, MORE EFFICIENT, BETTER HEAT RECOVERY

Trends in the microturbine industry are toward larger package sizes, more comprehensive control systems, and more complete systems for the recovery of heat and integration with cooling systems. The U.S. Department of Energy's Distributed Energy group (http://www.eere.energy.gov/de) is leading an effort to develop packages with higher operating efficiency and more complete heat recovery. A $60 million research program is rapidly advancing microturbine technology. The future of microturbines looks bright.

This article covers only a few of the available systems. A complete listing of manufacturers providing microturbine packages is available from the Energy Solutions Center at www.poweronsite.org. ‹GT›

*Far left, absorption chiller provides building cooling using microturbine exhaust heat at Harbec Plastics.*

*Left, Capstone microturbine installation at Harbec Plastics displays the modular capability of the units. Plant includes 25 microturbines.*