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5.8.3 Microturbines

Microturbines are emerging as a very promising technology for power generation at the scale of 25 to 300 kW. A handful of companies have introduced—or will soon introduce—these small, self-contained gas-turbines for utility distributed-power applications and self-contained power systems at manufacturing plants, hospitals, data processing centers, and other commercial-scale facilities.

Opportunities

Microturbines should be considered for power generation in the following situations:

- When the reliability of the power supply is extremely important;
- When grid-supplied power is limited or very costly (whether from kWh usage, time-of-use, or demand charges);
- When power quality is a concern either because of problems with grid-supplied electricity or because of particular needs for the facility;
- When utility companies require distributed generation capacity to meet remote power-user demands; and
- When thermal energy needs (for heating, absorption cooling, water heating, and industrial processes) can be matched with electricity generation.

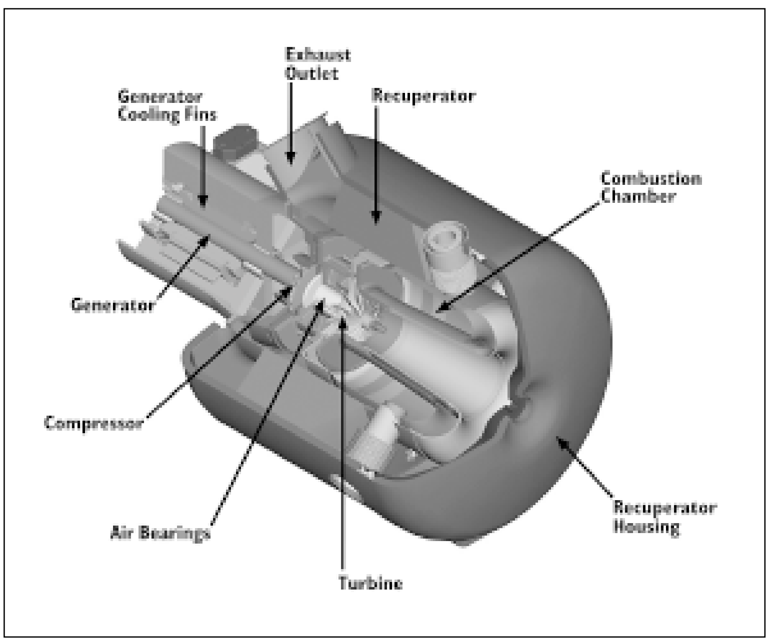
From an environmental standpoint, the potential of producing both heat and electricity—combined-heat-and-power (CHP) or cogeneration—with microturbines is particularly exciting. CHP systems provide an opportunity to dramatically increase the overall efficiency of delivered energy—by 25–30% with the microturbine alone to well over 50% when waste heat is utilized.

Technical Information

Microturbines, or turbogenerators as they are sometimes called, evolved out of turbocharger technology that is used to boost power output in cars, trucks, propeller-driven airplanes, and jet aircraft. The first microturbines were developed in the 1960s by Allison Engine Company (a division of Rolls-Royce) and used on a test basis to power several Greyhound buses. The fuel (usually natural gas, but also such fuels as propane, methane, landfill gas, gasified biomass, gasoline, and diesel) is superheated and burned. Combustion gases power a turbine, spinning the shaft extremely rapidly—up to 100,000 revolutions per minute (rpm). This spinning shaft, in turn, powers a high-speed generator, producing electricity. Waste heat can be extracted from the exhaust and used. However, current microturbines offer no improvements in efficiency or emissions over larger turbines.

While the commercialization of microturbines is just beginning, the Gas Technology Institute expects com-

Microturbines like this work like jet engines but produce electricity instead of thrust. Capstone's products have one moving part and operate with air bearings.



Source: Capstone Turbine Corporation

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The Underwriters Laboratory (UL)-rated Capstone MicroTurbine™ Model 330 produces 25–30 kW of electricity and can be configured for cogeneration.

mercial products to have an operating life of 25,000 to 50,000 hours, very low polluting emissions (nitrous oxide [NO_X], levels of 9 to 42 parts per million), and a purchase price of $600 to $1,200 per kW. Unlike most of the larger gas turbines used for utility power generation that are custom-made for the application, microturbines will be mass-produced, off-the-shelf items. They are being designed to have very few moving parts (often only one!), in comparison to the many hundreds of parts for reciprocating engines that have generally served this power-generation market. The simple design and the use of air bearings contribute to quiet operation—typically less than 70 dB at 10 feet (3 m)—and long service life between overhauls. The use of ceramics in turbine manufacture may further improve durability and performance in the future.

Among the active developers of microturbines are Honeywell (previously AlliedSignal Power Systems), Capstone Turbine Corporation, Allison Engine Company, NREC Energy Systems (a division of Ingersoll-Rand Co.), and Elliot Energy Systems (which is teaming up with GE Power Systems and NICOR). Among the first products to be introduced, the Capstone MicroTurbine™ Model 330 burns natural gas and produces 25–30 kW at approximately 27% efficiency with less than 9 ppm of NO_X. The 1,050-pound (476 kg) unit stands just over 6 feet (1.8 m) tall and looks somewhat like an oversized computer (see photo).

TINY MICROTURBINES

Another class of microturbines—very small units with outputs sometimes measured in watts rather than kilowatts—is being developed primarily for military applications. These units will provide portable power to soldiers for radios, GPS equipment, and battlefield computers. Going the furthest with this concept, the Massachusetts Institute of Technology has designed a tiny, flat microturbine under 1/2 in. (12 mm) in diameter, 1/8 in. (3 mm) long, and weighing just a gram, with a turbine speed of 1.4 million rpm, fuel consumption of a gram per hour, and output of 10 to 20 watts! As these products evolve, they may find applications in houses and small commercial buildings. A shoebox-sized microturbine might someday be able to power a house and heat its water.

$ The Gas Research Institute projects that microturbines will cost $600 to $1,200 per kW to install. Some other organizations project costs as low as $225 per kW, with a delivered electricity cost below 5¢ per kWh, including amortized equipment costs. For facilities with time-of-day electricity pricing or high demand charges, microturbine costs can be repaid much more quickly than the 5¢/kWh cost might imply. Using cogenerated heat can further improve the economics of microturbines.

Contacts

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