Distributed Energy Resources

Advanced Microturbine Systems Program

Technology Overview

Microturbines are a new type of combustion turbine being used for stationary energy generation applications. They are small combustion turbines, approximately the size of a refrigerator, with outputs of 25 kW to 500 kW, and can be located on sites with space limitations for power production. Microturbines are composed of a compressor, combustor, turbine, alternator, recuperator, and generator. Waste heat recovery can be used in combined heat and power systems to achieve energy efficiency levels greater than 80 percent. In addition to power generation, microturbines offer an efficient and clean solution to direct mechanical drive markets such as compression and air conditioning

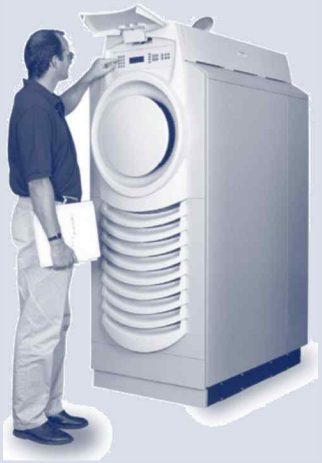
Microturbines evolved from automotive and truck turbochargers, auxiliary power units for airplanes, and small jet engines.

By using recuperators that capture and return waste exhaust heat, existing microturbine systems can reach 25-30 percent efficiency.

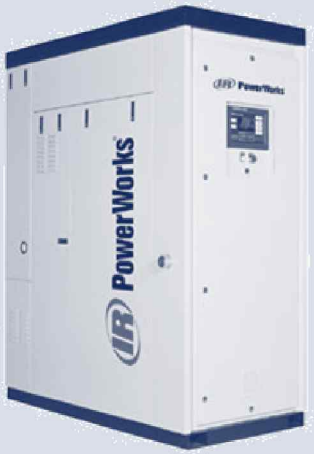
Microturbines offer a number of potential advantages compared to other technologies for small-scale power generation. These advantages include: a small number of moving parts, compact size, light weight, greater efficiency, lower emissions, lower electricity costs, potential for low cost mass production, and opportunities to utilize waste fuels. These advantages and small footprint lead to non-disruptive, fast installation.

Advanced materials, such as ceramics and thermal barrier coatings, are key enabling technologies to further improve microturbines. Efficiency gains can be achieved with materials like ceramics, which allow a significant increase in engine operating temperature.

75 KW



30 KW



70 KW

Market Potential

Because of their compact size, relatively low capital costs, and expected low operations and maintenance costs, microturbines are expected to capture a significant share of the distributed generation market.

Microturbine Systems can be used in a variety of applications. Users with serious concerns about the reliability of grid power quality may be interested in installing continuous on-site power generation. Microturbines can provide continuous generation for sites that require more than 6,000 hours of operation per year. During system emergencies or short-term price spikes, users may need applications to provide peak shaving of less than 1,000 hours of operation per year. For peak shaving, users would run on-site microturbine generation to avoid paying peak prices or utility demand charges. Other applications for microturbines include back-up power, premium power, remote power, cooling and heating power, mechanical drive, and use of wastes and biofuels.

Several manufacturers are selling commercial units for a variety of applications. Oil field flare gas utilization; grocery store backup power; base load for water pumping stations; building, cooling, heating and power for buildings; and commercial business peak shaving are just some of the current uses of microturbines. Combined with energy storage, microturbines are providing remote power and high-nines of reliability.

DISTRIBUTED ENERGY RESOURCES

Microturbine Program Activities and Partners

Baseline Microturbine Testing

- University of California-Irvine & Southern California Edison
- National Rural Electric Cooperative Association (NRECA)

Advanced Microturbine Development

- Capstone
- General Electric
- Honeywell Power Systems
- Ingersoll Rand
- Solar Turbines
- United Technologies Research Center

Supporting Materials Technology Projects in Ceramics and Advanced Alloys

- Argonne National Laboratory
- Honeywell Advanced Ceramics
- Kyocera Industrial Ceramics
- NASA
- Oak Ridge National Laboratory
- University of Dayton Research Institute

Combined Heating, Cooling, and Power Applications

- Oak Ridge National Laboratory

Oil Combustion Research

- Brookhaven National Laboratory

U.S. DEPARTMENT OF ENERGY PROGRAM

The U.S. Department of Energy Office of Power Technologies is currently leading a national effort to design, develop, test, and demonstrate a new generation of microturbine systems for distributed energy resource (DER) applications in industry, buildings, and utility settings. DER refers to local energy systems that generate electric, thermal, or mechanical energy on or near customer sites. In addition to generation systems, DER includes energy storage, grid interconnection, and demand management systems, which are important components in power quality and availability. Advanced microturbines will be cleaner, more fuel efficient and fuel-flexible, more reliable and durable, and lower in cost than the first generation products entering the market today.

Planned activities for this program focus on the following performance targets for the next generation of "ultra-clean, highly efficient" microturbine product designs:

High Efficiency - The target fuel-to-electricity conversion efficiency is at least 40 percent.

Environment - The NOx target for emissions is less than seven parts per million for natural gas machines in practical operating ranges.

Durability - The goal is 11,000 hours of operation between major overhauls and a service life of at least 45,000 hours.

Cost of Power - The target is achieving installed cost lower than $500 per kilowatt, cost of electricity competitive with alternatives (including grid-connected power) for market applications.

Fuel Flexibility - Should be capable of using alternative/optional fuels including natural gas, diesel, ethanol, landfill gas, and other biomass-derived liquids and gases.

For More Information:

DOE Advanced Microturbine Program
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