TECH BRIEF

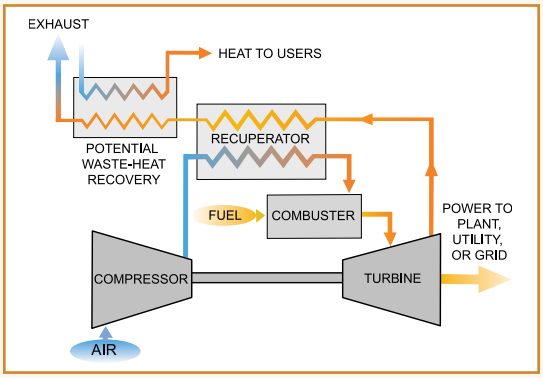
MICROTURBINES

DISTRIBUTED ENERGY TECHNOLOGIES

To meet the country's need for cleaner, more reliable and efficient energy, the U.S. Department of Energy's Office of Distributed Energy and Electric Reliability and its Programs are working with energy technology suppliers and end-users to promote the understanding and adoption of distributed energy. Distributed Energy Technologies can be located at or near the building or facility where the energy is used to provide greater power reliability and reduced emissions. Controls and communications, energy storage, and combined cooling, heating and power are End-Use Integration and Distribution systems. High Temperature Superconductivity is one way to harness high-tech to efficiently distribute power. Tools and systems that increase the reliability and performance of the existing energy grid are part of Transmission Reliability.

Microturbines are a new type of combustion turbine for use in distributed energy generation applications. About the size of a refrigerator, microturbines produce 25 to 500 kW of energy and can be located on sites with limited space for power production. Waste heat recovery can be used in combined cooling, heating, and power (CHP) systems to achieve energy efficiency levels greater than 80 percent.

Microturbine generator units are comprised of a compressor, combustor, turbine, alternator, recuperator, and generator. In a simple-cycle turbine (without a recuperator), compressed air is mixed with fuel and burned under constant pressure conditions. The resulting hot gas is allowed to expand through a turbine to perform work.



A split shaft microturbine can provide both power and heat to end-users.

Recuperated units use a heat exchanger (recuperator or regenerator) that recovers some of the heat from the turbine exhaust and transfers it to the incoming air stream for combustion in the turbine. By using recuperators that capture and return waste exhaust heat, existing microturbine systems can reach 25 to 30 percent cycle efficiency. The incorporation of advanced materials, such as ceramics and thermal barrier coatings, could further improve their efficiency by enabling a significant increase in engine operating temperature.

Microturbines offer many advantages over other technologies for small-scale power generation, including the ability to provide reliable backup power, provide power for remote locations, and peak shave. Other

MARKET POTENTIAL

- Because of their compact size and low operation and maintenance costs, microturbines are expected to capture a significant share of the distributed generation market.
- Scalability lends technology to modular buildout of high-density electric load facilities, which need high power reliability.

ENVIRONMENTAL BENEFITS

- Low greenhouse gas emissions.
- Relatively low noise.

advantages include less maintenance and longer lifetimes because of a small number of moving parts, compact size, lighter weight, greater efficiency, lower emissions, and quicker starting. Microturbines also offer opportunities to use waste fuels such as landfill gas.

APPLICATIONS

Microturbine systems can be used in commercial, institutional, and industrial applications. Users with serious concerns about the reliability of grid power quality may be interested in installing continuous onsite power generation. During system emergencies or short-term price spikes, users may need to provide peak shaving of less than 1,000 hours of operation per year.

Microturbines are modular and in various configurations can be adapted to changing power demand. High-density electric load facilities, which need large amounts of highly reliable power, may use microturbines increasingly to meet their changing energy needs. Other applications for microturbines include back-up power; remote power; CHP systems; mechanical drive; and resource recovery of waste fuels.

Modular microturbines are best suited for commercial and institutional applications, but can be connected together for larger industrial uses.

PROGRAM GOALS & ACTIVITIES

The U.S. Department of Energy is currently leading a national effort to design, develop, test, and demonstrate a new generation of microturbines for distributed energy technology applications. 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. The Microturbines Program focuses on the following performance targets for the next generation of microturbine products:

- **High Efficiency**—The target for fuel-to-electricity conversion efficiency is at least 40%.
- **Environment**—The NO_x target for emissions is less than seven parts per million 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 kW, a cost of electricity competitive with current technologies.
- **Fuel Flexibility**—The next generation of microturbine products should be capable of using different kinds of fuels, including natural gas, diesel, ethanol, landfill gas, and other biomass-derived liquids and gases.

PARTNERS

BASELINE TESTING

National Rural Electric Cooperative Association (NRECA)

Southern California Edison

University of California-Irvine

MICROTURBINE TECHNOLOGY DEVELOPMENT

Capstone

General Electric

Honeywell Power Systems

Ingersoll Rand

Solar Turbines

United Technologies Research Center

SUPPORTING MATERIALS TECHNOLOGY

Argonne National Laboratory

Honeywell Advanced Ceramics

Kyocera Industrial Ceramics

NASA

Oak Ridge National Laboratory

University of Dayton Research Institute

FOR FURTHER INFORMATION

Distributed Energy and Electric Reliability Program
www.eren.doe.gov/deer.html

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