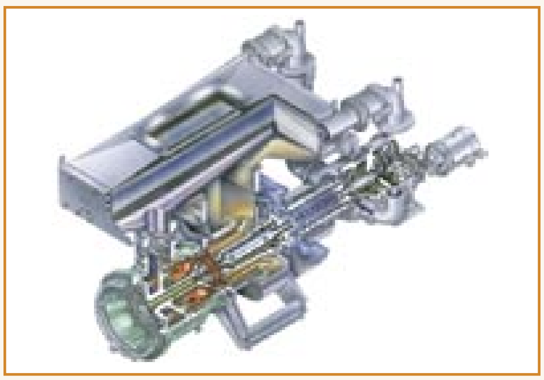
INDUSTRIAL GAS TURBINES

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.

Combustion turbines are a class of electricity generation devices that produce high-temperature, high-pressure gas to induce shaft rotation by impingement of the gas on a series of specially designed blades. Industrial gas turbines are used in many industrial and commercial applications ranging from 1MW to 20MW.



The inner workings of the Solar Mercury 50 Turbine.

A key effort in the Industrial Gas Turbine Program has been to enhance the performance of gas turbines for applications up to 20MW. The focus of this effort is on advanced materials research, such as composite ceramics and thermal barrier coatings which will continue to improve performance of industrial gas turbines. In addition, low emissions technologies research and development will improve the combustion system by greatly reducing the NO_x and CO produced without negatively impacting turbine performance.

APPLICATIONS

Because gas turbines are compact, lightweight, quick starting, and simple to operate, they are used widely in industry, universities and colleges, hospitals, and

MARKET POTENTIAL

- At least half of all new power generating capacity to be added between now and 2010 is likely to use gas turbines.
- Turbines can be used in a variety of applications with a range of 1MW to 20MW.
- Mid-sized turbines have tremendous potential for use as baseload, CHP, peaking, and standby/backup power in commercial and industrial settings.
- Primary end-users include petro-chemical, pulp and paper, pharmaceuticals, cement, textiles, and oil and gas exploration, as well as universities and colleges, hospitals, and airports.

ENVIRONMENTAL BENEFITS

- The use of advanced ceramics in turbines will increase efficiency and significantly reduce NO_x and CO^2 emissions by allowing operation at higher temperatures.
- Implementing newly developed catalytic combustion systems will reduce NO_x emissions to less than 5 ppm without impacting the performance of the turbine.

commercial buildings to produce electricity, heat, or steam. In such cases, "simple cycle" gas turbines convert a portion of input energy from the fuel to electricity and use the remaining energy, normally rejected to the atmosphere, to produce heat. This waste heat may be used to power a separate turbine by creating steam. The attached steam turbine may generate electricity or power a mechanical load. This is referred to as a combined cycle combustion turbine since two separate processes or cycles are derived from one fuel input to the primary turbine.

Advanced materials, such as ceramics, composites, and thermal barrier coatings, are some of the key enabling technologies under development to further improve the efficiency of distributed generation technologies. Efficiency gains can be achieved with materials like ceramics, which allow a significant increase in engine operating temperature. The increased operating temperature also lowers its greenhouse gas and NO_x emissions.

An example of the advanced materials work being done is the evaluation of several ceramic composite components including those with ceramic coatings, such as combustor liners and shrouds. This research is being done in both test rigs and commercial turbines.

Low emission technologies are emerging with the potential to reduce NO_x to single digits. These technologies use techniques to control the conditions for combustion so that NO_x is not formed in the first place. Recent breakthroughs will allow these important technologies to move forward.

A common application of industrial turbines and microturbines is to integrate them into a combined cooling, heating, and power (CHP) system for commercial, institutional, and industrial facilities. These systems capture and use the heat produced during the combustion process for steam, hot water, or thermally activated equipment such as absorption chillers. Taking advantage of the normally wasted heat means the user realized a tremendous gain in efficiency, reaching nearly 90 percent in some cases.

PROGRAM GOALS & ACTIVITIES

The mission of this program is to continue to address key issues in advanced materials and low emissions for industrial gas turbines for distributed energy applications.

At the inception of the Distributed Energy and Electric Reliability (DEER) program, nine new contracts were awarded for research and development in advanced materials and low emissions combustion that could improve the operation of industrial gas turbines.

Planned activities focus on the following performance targets for the next generation of industrial gas turbines:

- **High Efficiency and Performance** — Increase the fuel-to-electricity conversion and improve the overall performance of turbines through the use of advanced materials. New emissions systems and materials should have no negative impact on turbine performance and no more than 10% cost add-on.
- **Environment** — The emissions target is less than 5 ppm NO_x and 25 ppm CO with no post-combustion controls.
- **Durability** — The goal is 8,000 hours of operation between major overhauls.
- **Fuel Flexibility** — Should be capable of using alternative/options fuels, including natural gas, diesel, ethanol, landfill gas, and other biomass-derived liquids and gases.

U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy

PARTNERS

Alzeta Corporation

Catalytica Combustion Systems, Inc.

Honeywell Engines and Systems

Precision Combustion, Inc.

Solar Turbines, Inc.

FOR FURTHER INFORMATION

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

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