Tech Brief

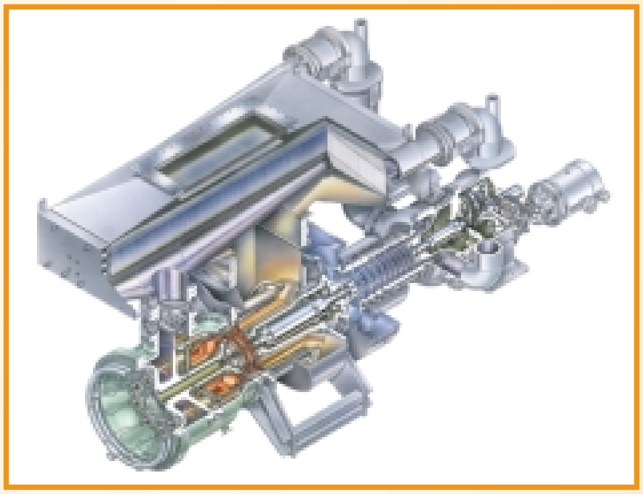
DER
Distributed Energy Resources

Advanced Generation:
Advanced Industrial Gas Turbines

Distributed Energy Resources (DER) are a suite of onsite, grid-connected or stand-alone technology systems that can be integrated into residential, commercial, or institutional buildings and/or industrial facilities. These energy systems include distributed generation, renewable energy, and hybrid generation technologies; energy storage; thermally activated technologies that use recoverable heat for cooling, heating, or power; transmission and delivery mechanisms; control and communication technologies; and demand-side energy management tools. Such decentralized resources offer advantages over conventional grid electricity by offering end users a diversified fuel supply; higher power reliability, quality, and efficiency; lower emissions; and greater flexibility to respond to changing energy needs.

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.

A key effort in the Advanced 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.



Inside the Solar Turbine Mercury 50

Applications

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

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

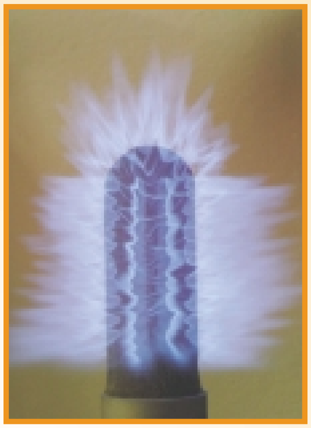
- The use of advanced ceramics in turbines will increase efficiency and significantly reduce NO_x and CO_2 emissions by allowing operation at higher temperatures.
- Implementing newly developed catalytic combustion systems will reduce NO_x emissions to less than five ppm without impacting the performance of the turbine.

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 and testing 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 heat 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.



Advanced T60 fired injector

Program Goals and Activities

The U.S. Department of Energy's Office of Power Technologies is currently developing an industrial gas turbine for distributed energy resource (DER) applications for industry and commercial buildings.

The mission of this program is to continue to work past the former Advanced Turbine Systems program thrusts by addressing key issues in advanced materials and low emissions for industrial gas turbines in DER applications.

At the inception of the DER 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 for this program 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 percent cost add-on.
- **Environment** — The emissions target is less than five 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.

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