PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Fuel Cells

10/2002

SOLID OXIDE FUEL CELL PROJECT

Generating Tomorrow's Electricity Cleanly

PRIMARY PROJECT PARTNER

Siemens Westinghouse Power Corporation
Orlando, Florida

MAIN SITES

Siemens Westinghouse Science & Technology Center
Pittsburgh, Pennsylvania
Edison Technology Solutions
Irwindale, California
Environmental Protection Agency
Fort Meade, Maryland
Ontario Power
Ontario, Canada

COST SHARING

DOE	$87,464,087
Non-DOE	$89,962,313

CUSTOMER SERVICE

800-553-7681

STRATEGIC CENTER FOR NATURAL GAS WEBSITE

www.netl.doe.gov/scng

Description

Siemens Westinghouse Power Corporation is developing the tubular ceramic-based oxide fuel cell, which is one of the simplest, cleanest, most efficient, and most versatile technologies on the power-generation horizon. Siemens Westinghouse is widely recognized as the world leader in this promising new technology.

The $177-million effort—51% of the funding is coming from the private sector—is a 7-year development project aimed at moving this technology to the threshold of commercial use.

Like a battery, the solid oxide fuel cell (SOFC) generates power electrochemically, avoiding the air pollutants and efficiency losses associated with combustion processes. Unlike batteries, fuel cells operate continuously, generating power as long as natural gas, clean coal-derived gas, or other gaseous hydrocarbon fuels are supplied. The solid electrolyte allows for the simplest of fuel cell plant designs, and requires no external fuel reforming.

The solid oxide concept uses ceramics, which requires the SOFCs to operate at higher temperatures than other fuel cells. The high exhaust temperature and pressurization potential of the Siemens Westinghouse design make it particularly suited for combined cycles and high efficiencies, producing more energy per unit of fuel and far less carbon dioxide (a greenhouse gas).

Siemens Westinghouse cell configuration is a tube composed of multiple ceramic layers bonded together. Multiple tubes link to form bundles; bundles link to form sub-modules for small power systems; and submodules link to form a generator module for larger power plants.

The development effort will culminate in tests of a 200-kilowatt fuel cell-microturbine combined cycle power plant, and two 30-kilowatt class fuel cell-turbine combined cycle power plants. These will be tested at RWE in Essen, Germany and Edison SpA's Torrenio in Italy.

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Goals

Commercialization of the Westinghouse concept—the only fuel cell type in which American technology clearly leads the world—could offer a new approach to generating power in the United States and worldwide. It could create a new solid state manufacturing industry, employing skilled workers to design and fabricate power technologies for tomorrow's energy needs.

One program goal is to commercialize the tubular SOFC by 2005. Commercialization of the technology supports DOE goals for emissions reduction and energy security.

Benefits

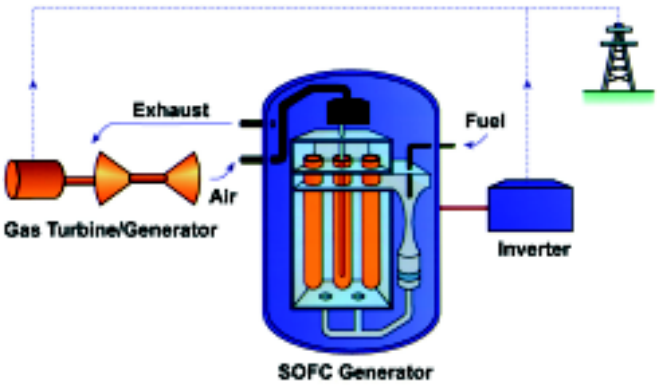
The solid oxide fuel cell is one of the cleanest, most-efficient power-generating technologies now being developed.

Capable of using either natural gas or clean coal gas, it emits no sulfur pollutants and as much as 60%-65% less carbon dioxide (a greenhouse gas) than a conventional coal-burning plant.

It is also one of the most efficient means for generating electricity and usable heat. A simple cycle power generator, it can convert about 50% of the energy in its fuel source to electricity (conventional coal plants, for example, operate at efficiencies of 33%-35%). When the quality waste heat from the electrochemical process is used, overall efficiencies could exceed 85%. When utilized with a gas turbine in a combined cycle power system, electrical efficiencies over 70% can be achieved.

SOFC generator modules are expected to operate reliably for many years because they involve no liquid or moving parts. A unit that can generate 2 megawatts of electricity, enough for a small substation, can fit on under one-tenth of an acre, allowing it to be placed closed to power needs, avoiding long transmission lines.

With a simple adjustment of air and fuel flows—much as a gas pedal is used in a car—a solid oxide fuel cell can easily follow changing demands for electricity, boosting output when necessary, then cycling down when demand is low.



The all-solid-state composition of these fuel cells is compatible with mass-production processes and very low cost in high volume production.

The clean environmental performance of solid oxide fuel cells make them especially well-suited for areas with strict air quality requirements. Future units could cogenerate electricity and steam for hospitals, shopping malls, and large residential or commercial complexes. Both urban centers and remote sites (for example, those with relatively low-cost fuel sources such as coal-bed methane operations) could be candidates for solid oxide fuel cells.