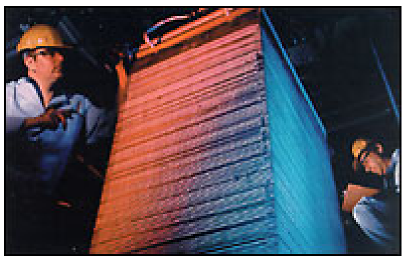
Future Fuel Cells R&D



"...we're creating the National Climate Change Technology Initiative...to fund demonstration projects for cutting-edge technologies, such as fuel cells."

President George W. Bush

June 11, 2001

MORE INFO

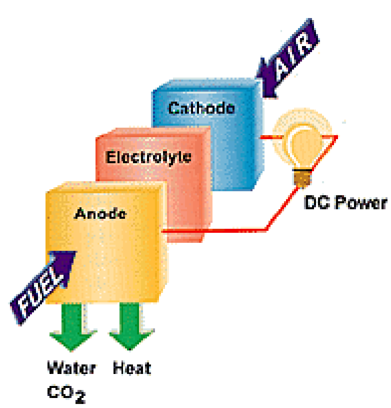
- Solid State Energy Conversion Alliance
- Tubular Solid Oxide Fuel Cells
- Molten Carbonate Fuel Cells
- Phosphoric Acid Fuel Cells

Fuel cells are an energy user's dream: an efficient, combustion-less, virtually pollution-free power source, capable of being sited in downtown urban areas or in remote regions, that runs almost silently, and has few moving parts.

Using an electrochemical process discovered more than 150 years ago, fuel cells began supplying electric power for spacecraft in the 1960s. Today they are being used in more down-to-earth distributed generation applications: to provide on-site power (and waste heat in some cases) for military bases, banks, police stations, and office buildings from natural gas. Fuel cells can also convert the energy in waste gases from water treatment plants to electricity.

In the near future, fuel cells could be propelling automobiles and allowing homeowners to generate electricity in their basements or backyards.

Fuel cells operate much like a battery, using electrodes in an electrolyte to generate electricity. Unlike a battery, however, fuel cells never lose their charge. As long as there is a constant source of fuel, fuel cells will generate electricity.



DOE's Stationary Power Fuel Cell Program

The U.S. Department of Energy's Office of Fossil Energy is partnering with several fuel cell developers to develop the technology for the stationary power generation

RELATED NEWS

> FuelCell Energy Inc. Project Chosen as Part of DOE's Coal-Based Fuel Cell Program

> More Related News

PROJECT INFO

> Database of Fuel Cell R&D Projects

> National Energy Technology Laboratory Web Site

KEY PUBLICATIONS

> FY 2005 Annual Report [26.2MB PDF]

> Distributed Generation Brochure [1.4MB PDF]

> SECA Brochure [7.5MB PDF]

sector - that is, central power and distributed generation. Industry participation is extensive, with more than 40 percent of the program funded by the private sector. If the joint government-industry fuel cell program is successful, the world's power industry will have a revolutionary new option for generating electricity with efficiencies, reliabilities, and environmental performance unmatched by conventional electricity generating approaches.

For most of the 1970s and early 1980s, the Federal program included development of the phosphoric acid fuel cell system, considered the "first generation" of modern-day fuel cell technologies. Largely because of the R&D support provided by the Federal program, United Technologies Corporation and its subsidiaries manufactured and sold phosphoric acid fuel cells around the world.

In the late 1980s, the department shifted its emphasis to development of advanced generations of higher temperature fuel cell technologies, specifically the molten carbonate and solid oxide fuel cell systems. Federal funding for these technologies have concluded. Private commercial manufacturing facilities have been built and commercial sales have been achieved.

While first generation fuel cells continue to spur interest in fuel cell technologies, the focus of the Department of Energy's Fossil Energy fuel cell program is to develop a much lower cost fuel cell. The target is $400 per kilowatt or less, which is significantly lower (by about a factor of ten) than current fuel cell products. It is expected that lower cost fuel cells will lead to widespread utilization.

Solid State Energy Conversion Alliance

The Department of Energy formed the Solid State Energy Conversion Alliance (SECA) with a goal of producing a core solid-state fuel cell module that would cost no more than $400/kW. At this price, fuel cells would compete with gas turbine and diesel generators and likely gain widespread market acceptance.

The key to the ambitious cost reductions will be the development of a compact, lightweight, 3 kW to 10 kW "building block" module that can be mass-produced using many of the same manufacturing advances that have dramatically lowered costs in the electronics industry. The building blocks would be clustered into a variety of custom-built stacks for a wide variety of applications – from small portable military power sources to multi-megawatt central generating stations. The system could also be a prime option for powering auxiliary systems.

SECA is comprised of fuel cell developers, small businesses, universities and national laboratories. It is administered by the Energy Department through the National Energy Technology Laboratory (NETL) and its Pacific Northwest National Laboratory (PNNL). The SECA program is currently structured to include six competing Industry Teams supported by a crosscutting Core Technology Program. These teams are led by: FuelCell

> HiTEC Brochure [401KB PDF]

PROGRAM CONTACTS

> Samuel Biondo
Office of Fossil Energy (FE-22)
U.S. Dept. of Energy
Washington, DC 20585
301-903-5910

> Wayne Surdoval
National Energy Technology Laboratory
P.O. Box 10940
U.S. Department of Energy
Pittsburgh, PA 15236
412-386-6002

Energy, Delphi, General Electric, Siemens Power Generation, Acumentrics, and Cummins Power Generation.

SECA Fuel Cell Coal-Based Systems

Fuel cell/gas turbine hybrids will form the essential power block component of the FutureGen plant, enabling high overall efficiency and superior environmental performance to be achieved at low cost. These benefits and feasibility of hybrid systems have been clearly established through conceptual studies and limited small-scale demonstrations fueled with natural gas. Making large-scale (greater than 100 MW) fuel cell/ turbine hybrid systems a reality requires reduction in fuel cell cost and scalability to larger sizes. Cost issues are being addressed with considerable success within the SECA program, as 3 to 10 kW SOFC system costs of less than $800/kW have been demonstrated in FY 2005.

In order to address the issue of scalability, DOE initiated the new SECA Fuel Cell Coal-Based Systems program in FY 2005. The goal of this program is to develop and demonstrate the fuel cell technology required for central power station applications to produce affordable, efficient, environmentally-friendly electricity from coal. The new program leverages the advances made in solid oxide fuel cell (SOFC) technology under the SECA program, extending coal-based SOFC technology to large central power generation station applications.

The research will help meet the Nation’s future energy needs while achieving near-zero emissions in coal-fueled central power station applications. Key systems requirements to be achieved include 50 percent or greater overall efficiency in converting the energy contained in coal to grid electrical power, the capture of 90 percent or more of the carbon contained in the coal fuel (as CO2), and a cost of $400 per kilowatt, exclusive of the coal gasification unit and CO2 separation subsystems.

The projects will be conducted by three research teams—one led by General Electric Hybrid Power Generations Systems (GE HPGS), Siemens Power Generation, and FuelCell Energy. The three teams will research, develop, and demonstrate fuel cell technologies that can support power generation systems larger than 100 megawatts capacity:

- GE HPGS, is partnering with GE Energy, GE Global Research, PNNL, and the University of South Carolina to develop an integrated gasification fuel cell (IGFC) system that merges GE’s SECA-based planar SOFC, gas turbine, and recently acquired (from ChevronTexaco) coal gasification technologies. The system design incorporates a SOFC/gas turbine hybrid as the main power generation unit.
- Siemens Power Generation is partnering with ConocoPhillips and Air Products and Chemicals, Inc., (APCI) to develop large-scale fuel cell systems based upon their in-house gas turbine and SECA SOFC technologies. ConocoPhillips will provide coal gasification expertise. In addition, the baseline design incorporates an ion transport membrane (ITM) oxygen air separation unit (ASU) from APCI, offering system efficiency advantages over traditional ASUs.
- FuelCell Energy will partner with Versa Power Systems, Nexant, and Gas Technology Institute to develop an affordable fuel-cell-based technology that will operate on synthesis gas from a coal

gasifier. One of the key objectives is the development of fuel cell technologies, fabrication processes, and manufacturing infrastructure and capabilities for scale-up of solid oxide fuel cell stacks for large, multi-megawatt base-load power generation plants.

Advanced Fuel Cell Research

The High Temperature Electrochemistry Center (HiTEC) Advanced Research Program provides crosscutting, multidisciplinary research supporting SECA, Fuel Cell Coal Based Systems, and FutureGen. HiTEC is centered at Pacific Northwest National Laboratory (PNNL) with satellite centers at Montana State University and the University of Florida. Research includes the development of low-loss electrodes for reversible solid oxide fuel cells, the development of high temperature membranes for hydrogen separation, and the study of fundamental electrochemical processes at interfaces. HiTEC is also pursuing the development of high temperature electrochemical power generation and storage technologies and advanced fuel feedstock.

Newly awarded projects are conducted at the University of Utah, Massachusetts Institute of Technology, Northwestern University, United Technologies Research Center, and SRI International. The selected projects focus primarily on SOFC.

Coal-based power production systems that incorporate SOFC have the potential for significantly higher efficiencies and lower emissions than conventional technologies. In addition, high-temperature electro-chemical systems can enhance energy storage in central coal power plants, reducing the impact felt during hours of peak demand and making the plants more cost effective.

Fuel Cell Benefits

Fuel cells are the cleanest and most efficient technologies for generating electricity from fossil fuels. Since there is no combustion, fuel cells do not produce any of the pollutants commonly emitted by boilers and furnaces. For systems designed to consume hydrogen directly, the only products are electricity, water and heat.

When a fuel cell consumes natural gas or other hydrocarbons, it produces some carbon dioxide, though much less than burned fuel. Advanced fuel cells using natural gas, for example, could potentially reduce carbon dioxide emissions by 60% compared to a conventional coal plant and by 25% compared to modern natural gas plants. Moreover, the carbon dioxide is emitted in concentrated form which makes its capture and storage, or sequestration, much easier.

Fuel cells are so clean that, in the United States, over half of the states have financial incentives to support their installation. In fact, the South Coast Air Quality Management District in southern California and regulatory authorities in both Massachusetts and Connecticut have exempted fuel cells from air quality permitting requirements. Some states have portfolio standards or set asides for fuel cells.

Additionally, there are major fuel cell programs in New York (NYSERDA), Connecticut (Connecticut Clean Energy Fund), Ohio (Ohio Development Department), and California (California Energy Commission). Certain states have favorable policies that improve the economics of fuel cell projects. For example, some states have net metering, and some have net metering for fuel cells which obligates utilities to deduct any excess power produced by fuel cells from the customer's bill.

Fuel cells are also inherently flexible. Like batteries in a flashlight, the cells can be stacked to produce voltage levels that match specific power needs; from a few watts for certain appliances to multiple megawatt power stations that can light a community.

Cost - the Major Hurdle

So why aren't fuel cells being installed everywhere there is a need for more power?

The primary reason is cost. Fuel cells developed for the space program in the 1960s and 1970s were extremely expensive ($600,000/kW) and impractical for terrestrial power applications. During the past three decades, significant efforts have been made to develop more practical and affordable designs for stationary power applications. But progress has been slow. Today, the most widely deployed fuel cells cost about $4,500 per kilowatt; by contrast, a diesel generator costs $800 to $1,500 per kilowatt, and a natural gas turbine can be even less.

Recent technological advances, however, have significantly improved the economic outlook for fuel cells. The U.S. Department of Energy has launched a major initiative - the Solid State Energy Conversion Alliance (www.seca.doe.gov) - will bring about dramatic reductions in fuel cell costs. The goal is to cut costs to as low as $400 per kilowatt by the end of this decade, which would make fuel cells competitive for virtually every type of power application. The initiative signifies the Department's objective of developing a modular, all-solid-state fuel cell that could be mass-produced for different uses much the way electronic components are manufactured and sold today.

Financial Support for Fuel Cells

The Energy Policy Act of 2005 includes the first tax incentive for fuel cell power plants at the Federal level. To qualify, a fuel cell facility must be an integrated system comprised of a fuel cell stack assembly and associated balance of plant components that convert a fuel into electricity using electrochemical means, and which has an electricity-only generation efficiency of greater than 30 percent and generates at least 0.5 megawatts of electricity, and which is placed in service after December 31, 2005, and before January 1, 2009. The taxpayer can claim the 1.5 cents-per-kilowatt-hour (indexed for inflation) credit for a five-year period commencing on the date the facility is placed in service.

Page owner: Fossil Energy Office of Communications

Page updated on: March 27, 2006

The White House PRESIDENT GEORGE W. BUSH | FIRSTGOV.gov The U.S. Government's Official Web Portal | E·GOV | IQ | FOIA

U.S. Department of Energy | 1000 Independence Ave., SW | Washington, DC 20585

1-800-dial-DOE | f/202-586-4403 | e/General Contact

Web Policies | No Fear Act | Site Map | Privacy | Phone Book | Employment