

The Department of Energy has developed and provided radioisotope thermoelectric generators (RTGs) to power spacecraft used in the exploration of outer space (24 missions) for more than 30 years. **These deep space missions would not have been possible without the RTGs.** RTGs convert heat from the radioactive decay of plutonium-238 directly into electricity. They are powering experiments left on the moon by Apollo astronauts, as well as experiments on Mars. The RTGs provide the enabling power for the Pioneer and Voyager spacecraft that have studied Jupiter, Saturn, and Neptune and continue to send back data from beyond our solar system. RTGs power the Galileo spacecraft that is on its way to orbit Jupiter and that provided pictures of the recent Levy-Shoemaker comet impact. RTGs also power the Ulysses spacecraft that is the first such craft to study the polar regions of the Sun. By powering NASA spacecraft, RTGs have made a major contribution to our knowledge of the universe.

### **Advanced Electricity Generation and Storage Technologies**

The convenience and flexibility of electric power have made this energy form a basic component of our economy and way of life. As previously discussed, the Department of Energy supports R&D activities that focus on improving the economics, environmental acceptability, and efficiency of conventional and emerging technologies. But in addition, the Department has been actively working on a variety of advanced electric technologies, some of which do not fit neatly into specific program areas.

For example, the Department's Office of Fossil Energy and Office of Energy Efficiency and Renewable Energy have been working with industry on an accelerated program to develop advanced gas-fired turbine systems and fuel cell systems. The new generation of electric power generating systems are expected to have environmental performances and fuel-to-electricity efficiencies that are much improved over today's conventional technologies. Other crosscutting technological areas include large and small-scale electricity-storage technologies.

### **Phosphoric Acid Fuel Cells**

A Federal investment in the 1980s and early 1990s yielded a radically new approach for commercial power generation, the fuel cell, and positioned the United States as the world leader in fuel cell technology. Relying on electro-chemistry rather than combustion, the fuel cell is attractive for both heavily polluted urban areas and remote applications.

The phosphoric acid fuel cell was the first technology to emerge from one joint public-private, cost-shared program sponsored by the Department of Energy. Seventy-five 200-kilowatt commercial onsite cogeneration systems have been sold throughout the world, including 31 in the United States, by International Fuel Cells Corporation of South Windsor, Connecticut. One of these fuel cells, operated by Southern California Gas, set a record last year for uninterrupted operation at more than 80 percent efficiency. Phosphoric acid fuel cells have also been successfully developed by the Department for transportation applications. A fuel-cell-powered bus, now undergoing field testing, demonstrates significant energy benefits (twice the fuel economy of comparable diesel buses) and environmental benefits (emissions reduced by more than 99 percent compared to diesel buses). The projected annual sales of fuel cell technologies could total **more than \$1 billion by 2020, a market that could create as many as 100,000 U.S. jobs.**

### **Advanced Gas Turbine Components**

The Department of Energy is cost-sharing an 8-year development program to produce a leapfrog advanced gas turbine technology that will ensure continued U.S. leadership in the global market. While the entire turbine system will not be completed until the year 2000, key components have already emerged from the development effort and are being used in commercial turbines. In late 1994, Westinghouse Corporation announced a new type of industrial gas turbine, the 501G, the most fuel-efficient machine in its class. Advanced technology from the Department's R&D program is