Producing and Using *Electricity* IN THE 21ST CENTURY

U.S. DEPARTMENT OF ENERGY
OFFICE OF ENERGY EFFICIENCY
AND RENEWABLE ENERGY

Electricity is indispensable to modern society, and the demand for it is growing. Although energy efficiency measures can help meet some of the increased demand, additional electricity production may also be necessary. Fossil fuels provide the power for many of today's technologies, but their use contributes to air pollution and produces greenhouse gases. In the new century, the world will increasingly be powered by nonpolluting and renewable energy sources, such as the sun, wind, organic matter, geothermal energy, and hydropower along with clean-burning natural gas. In concert with the electricity industry, the U.S. Department of Energy's (DOE) Office of Power Technologies (OPT) is leading the nation's effort to develop clean, competitive, reliable power technologies for the 21st century.

Transforming U.S. Power Generation and Delivery

OPT directs research, development, and demonstration (RD&D) programs for an integrated portfolio of renewable power technologies and advanced electric power systems. Those technologies include photovoltaics (PV), solar buildings, concentrating solar power, biopower, wind power, geothermal power, and hydroelectric power.

OPT also manages R&D that integrates power from renewable energy resources into the nation's electric grid and/or improves the efficiency and reliability of the electric sector including advanced transmission reliability technologies, high-temperature superconductivity, energy storage, and hydrogen power systems. As part of its electric power systems portfolio, OPT is addressing impediments to the increased use of distributed power (decentralized power-generating technologies).

Internationally, OPT encourages greater use of U.S. energy technologies in the world marketplace by providing technical assistance and information to energy users and their intermediaries, including governments, trade organizations, and professional associations.

Harnessing Renewable Energy

OPT-managed RD&D has contributed to performance and cost improvements in several renewable energy technologies over the past two decades.

- The cost of electricity from wind energy has dropped from 35–40 cents per kilowatt-hour (kWh) in 1980 to 4–5 cents/kWh today. Wind power is now competitive with traditional generating technologies in some parts of the country. The further development of the next generation wind turbine, coupled with the Wind Powering America Initiative, will bring us even closer to the DOE goal of providing 5% of the nation's electricity needs with wind energy in 2020.
- OPT-supported research has cut the cost of solar water heaters from 20 cents/kWh in 1980 to 8 cents/kWh today. OPT research also led to transpired solar collector technology which reduces the cost of solar air heating from 20 cents/kWh to about 2 cents/kWh.
- Worldwide, the PV industry has grown to more than $1 billion in annual sales. Of this amount, the U.S. PV industry, which has grown from a few government-supported

NREL/PIX 00062, GEOTHERMAL RESOURCES COUNCIL

Geothermal power plants, such as the Mammoth Pacific Power Plant in California, are among the cleanest sources of electric power currently available, and generate nearly 2800 megawatts of power for our country.

Changes in the Power Industry

As the electricity industry is restructured, one of OPT's major efforts is to ensure the reliability of the nation's electricity supply. Although emerging competition in the electricity industry makes power reliability a major concern, it is also opening the door to renewable energy technologies by favoring small, modular power plants. In addition to generating electricity at central power plants, providers are adding smaller generating units to the distribution grid to avoid expensive transmission line upgrades. OPT is working with industry stakeholders to streamline this integration, which helps small power providers compete in the electricity market and enhances consumer choice among power supply options.

Benefits of OPT's Work

- **Access to an inexhaustible, domestic fuel supply**
- **Greater power reliability and quality**
- **Cleaner environment**
- **Lower greenhouse gas emissions**
- **Lower electricity costs from sustainable sources.**

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The U.S. PV industry is thriving, with annual sales totaling more than $500 million. U.S. manufacturers are expanding their output to meet the growing demand for PV systems, and are generating many new jobs as a result.

THE OFFICE OF POWER TECHNOLOGIES

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EERE's goal of providing 5% of the nation's electricity needs with wind energy in 2020 will be achieved through the use of wind power plants, such as this one in New England.

companies into a thriving business, accounts for more than $500 million. The cost of electricity from PV is now 25–30 cents/kWh, down from about $1/kWh in 1980. Ongoing solar energy R&D efforts, complemented by the Million Solar Roofs Initiative, are projected to result in the installation of one million PV and solar hot water systems across the nation by 2010.

- The biomass power industry has grown to 350 U.S. power plants providing 7000 megawatts (MW) of power. New, high-efficiency gasifier technologies are currently being tested. Coupled with other DOE research in biofuels, the power program is part of an integrated Bioenergy Initiative.
- Concentrating solar power technologies have moved from the research laboratory to the field, with 354 MW of capacity produced by parabolic-trough systems in the Mojave Desert, and a 25-kW dish/engine system which is being tested in Arizona.
- Geothermal power plants, once restricted to a single location in northern California, now generate 2800 MW from facilities in four states. Geothermal heat pumps, which use buried pipes to heat or cool buildings, are commercially available, with more than 400,000 installations to date.
- Hydroelectric power is currently the nation's largest renewable energy source of electricity. OPT is developing advanced hydroelectric technologies, including turbines that have low fish-mortality rates.
- Materials that achieve superconductivity at high temperatures can save energy in the generation, transmission, and use of electricity, potentially saving as much as 10% of all the electricity generated in the United States. Once confined to research laboratories, these materials are now being applied in the development of super-efficient generators, cables, motors, and other electrical devices.

The success of these technologies is good news for the nation. Renewable energy and advanced power systems improve our nation's energy security and help to protect the environment. And, as markets in the developing world expand, these technologies represent an increasingly important export commodity for U.S. businesses.

Committed to Deployment

Much of OPT's research is cost-shared with industry, whose contribution ranges between 30% and 75% of the project's total budget, particularly for system hardware development and demonstration. Industry's willingness to share the cost of this R&D reflects its belief in the market potential of these technologies and its commitment to commercialize and deploy them.

OPT works with industry through Cooperative R&D Agreements (CRADAs), joint initiatives, and user facilities such as the National Wind Technology Center and the National Center for Photovoltaics. Partnerships with the power industry, universities, and other stakeholders are encouraged, and these alliances play a critical role in bringing clean energy technologies to market.

For More Information

Visit the OPT Web site at http://www.eren.doe.gov/power/

Read *Dollars from Sense: The Economic Benefits of Renewable Energy* (DOE/GO-10097-261), which highlights renewable energy power projects in several states. This document is posted on the OPT Web site under *Information Resources.*

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