NREL FACTS

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NREL Research

Photovoltaic Research

Creating electricty from an unlimited resource—sunlight

In 1954, the first modern photovoltaic (solar) cell was developed. In the 1960s, photovoltaics were used to power space satellites. But it took the oil embargoes of the 1970s for America to grasp the technology's potential. The country wanted abundant, domestic energy sources and photovoltaics were a perfect match. Since the late 1970s, researchers at the National Renewable Energy Laboratory have spearheaded the effort to make photovoltaics a major contributor to our global energy portfolio.

Photovoltaic Technology

Photovoltaic devices, commonly called solar cells or modules, use semiconductor material to directly convert sunlight into electricity. They have no moving parts, require little maintenance and cause no air or water pollution. Photovoltaics are used to power remote residences, satellites, highway traffic and information signs, water pumps, communications stations, navigation buoys, street lights and calculators.

NREL's Photovoltaic Research

NREL's scientists and engineers help lower photovoltaic costs and improve performance and reliability by developing prototype solar cells; improving cell efficiency (the amount of sunlight the device converts into electricity); helping industry develop better, less expensive manufacturing technologies; and testing solar cell and module performance.

Cell and Material Research

NREL researchers develop advanced semiconductor materials and use these materials to make prototype solar cells. Currently, about 95 percent of commercially available photovoltaic modules are made from crystalline silicon cells. The other 5 percent is from a newer thin film technology.

Crystalline silicon technology uses wafers similar to computer chips. Thin film photovoltaic cells use very thin layers of semiconductor material. While not as efficient as crystalline silicon cells, thin film cells use 30 to 100 times less semiconductor material and are easier and less expensive to make. NREL performs research in both areas.

Collaborative Research

NREL works with companies, universities and other national laboratories to develop advanced solar cells and modules, and improve manufacturing technologies. This is achieved through cooperative research projects, cost-shared subcontracts and licensing NREL technologies to industry.

Testing Activities

NREL's Outdoor Test Facility and Solar Energy Research Facility are used to test the performance and reliability of proto-type solar cells, modules, and systems made by NREL and industry partners.

More than 3,500 tests are done on photovoltaic cells and modules annually. These testing activities help companies reduce photovoltaic costs and improve performance, reliability, and safety.

Recent Accomplishments

Advancing Photovoltaic Technology—NREL has developed numerous solar cells that have set efficiency records. These advances help industry improve efficiency and reduce costs.

Improving Photovoltaic Systems—NREL's Photovoltaic Manufacturing Technology project has helped participating companies reduce manufacturing costs by almost 50 percent. The Building Opportunities for Photovoltaics in the United States program is helping companies develop new products that integrate photovoltaics into buildings.

Expanding Photovoltaic Markets—NREL's Brazil Project is supplying hundreds of rural Brazilian villages with electricity for the first time. NREL also is initiating other international programs and is working with utilities to install and demonstrate large-scale photovoltaic systems.

Benefits of Photovoltaics

High Reliability—Photovoltaics operate reliably for long periods of time with virtually no maintenance. They also have low operating costs.

Non-polluting—Photovoltaics burn no fuel and have no moving parts. They are clean and silent.

Modular—A photovoltaic system can be constructed to meet any size requirement and can be enlarged or moved to meet changing energy needs.

Secure Energy Source—Photovoltaics provide us with a virtually inexhaustible, domestic energy source.

Challenges

Photovoltaics work best in regions receiving abundant sunlight. However, even in these areas, batteries or a backup system are necessary to provide electricity at night and during cloudy weather. Cost is another consideration. In the U.S., utilities generate electricity from coal, oil and natural gas at very low costs. While the gap is closing, photovoltaics are not yet cost-effective for large-scale electricity generation.

Markets

Developing countries, where half the population is currently without electricity, represent the biggest and fastest growing photovoltaic market. U.S. companies currently export 75 percent of photovoltaic products, mostly to developing countries. Domestically, utilities are the largest potential market, but even at current prices, photovoltaics are less expensive than costly grid extensions and are the most viable form of electric power for many applications.

Potential

Photovoltaic production has nearly tripled in the last seven years. More than 89.6 megawatts of modules were manufactured worldwide in 1996. At 39.85 megawatts, the U.S. was the largest manufacturer, with Japan second at 21.2 megawatts. Further cost reductions from technical improvements and economies of scale will help the technology play an even larger role in meeting our energy needs.

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