Photovoltaics Program

Technology Overview

Photovoltaics is the direct conversion of light (photons) into electricity (voltage) using semiconductor materials. The photovoltaic (PV) modules that perform this conversion have many benefits. They are durable and reliable, and require minimal maintenance as they have no moving parts. They are also completely silent and require only sunlight as fuel.

PV devices can be made from many different materials in many different designs. The choice of material and design for a particular application is influenced by the associated conversion efficiency and cost. Conversion efficiency refers to the amount of incident solar energy that is actually converted into electricity by the PV device. Cost is determined by factors such as the amount of PV material used and the complexity of the manufacturing process.

The most mature PV technology is crystalline silicon, which has relatively high efficiency and moderate production costs. Designs using gallium arsenide and related compounds have even higher efficiencies, but production costs are also quite high. Thin-film technologies are generally not as efficient as crystalline silicon, but costs are lower, in part because much less PV material is required. Thin films use materials such as copper indium diselenide and its alloys, cadmium telluride, and amorphous silicon.

In addition to the module, PV systems include various balance-of-systems components, such as frames, inverters, charge controllers, and batteries. Some systems, particularly those that use concentrated sunlight, include a means of tracking the sun across the sky.

U.S. Department of Energy Program

The purpose of the U.S. Department of Energy (DOE) PV Program is twofold: to accelerate the development of PV as a national and global energy option, and to ensure U.S technology and global market leadership.

The program has helped to build a national effort, supporting partnerships that span the range from basic and applied research to manufacturing technology, product development, and commercialization. The work is performed by the National Center for Photovoltaics (NCPV) and associated research centers at the National Renewable Energy Laboratory, Sandia National Laboratories, and Brookhaven National Laboratory; and by more than 180 companies, universities, and utilities from some 40 states across the nation.

The national laboratories of the NCPV provide the PV community with program management and centralized technical support, characterize PV materials and devices, perform research on fundamental concepts, and conduct innovative research on materials, devices, and processing. The laboratories generally take a lead role in the early stages of a technology's development, but assume a more facilitating role as the technology approaches commercialization.

The mission of the NCPV is to mobilize national PV resources by:

- Performing world-class research and development (R&D).
- Promoting partnering and growth opportunities.
- Serving as a forum and information source for the PV community.

The National PV Program carries out long-range planning with industry through the *Industry PV Technology Roadmap*, which has a 20-year planning horizon. Five-year goals are set for specific project areas, and short-range planning is conducted through an annual operating plan. These three planning "cycles" are designed to mesh coherently with one another.

Kiss + Cathcart - Architects/PIX06456

The 4 Times Square building in New York City uses a thin-film photovoltaic skin instead of traditional glass cladding on some of the upper floors. This building-integrated PV skin extends from the 38th to the 45th floor on the south and east walls of the building.

PHOTOVOLTAICS PROGRAM

Partnering with Industry

As part of its commitment to bring new technologies to market, the DOE PV Program works with U.S companies in a variety of joint research and development programs. One of these partnerships, the Photovoltaic Manufacturing Technology (PVMaT) initiative, focuses on optimizing commercial manufacturing processes to reduce costs and boost production capacity. More than two dozen PV companies have been involved in this program. Since 1992, PVMaT has helped cut module manufacturing costs for industry partners by more than 36%. It has also helped to increase production capacity more than seven fold.

Siemens Solar Industries/PIX06142

Under PVMaT, DOE is working with the U.S. PV industry to cut manufacturing costs and raise output.

MARKET POTENTIAL

In high-value niche markets, such as remote, stand-alone power for telecommunications, PV is the most cost-effective option. The international market continues to show strong growth for applications ranging from water pumping, communications, and lighting, to village power. As manufacturing costs fall, PV is increasingly used for homes and other buildings already connected to the grid.

Federal, state, and municipal planning departments are using PV for a wide variety of stand-alone applications. PV systems are being added to grid-connected buildings in the United States and around the world. And utility companies are using PV to supplement the power grid and reduce peak demand by consumers. In a deregulated domestic electricity market, distributed power may represent a significant niche for photovoltaic systems. In addition, the use of PV can help to reduce the emission of greenhouse gases in the United States.

For the international market, PV is already the power of choice for applications ranging from water pumping, communications, and lighting, to village power. This is a fast-growing market, as there are more than two billion people in developing countries who are without electricity. People in areas having no well-developed power infrastructure see favorable economics for the use of stand-alone PV systems or hybrid systems incorporating PV.

The PV Program and industry believe that a sustained growth rate of 25% is achievable. At this rate, worldwide production would approach 18 billion watts per year by 2020. And U.S. PV production would reach 7 billion watts by 2020, with more than 3 billion watts for domestic use. This means that PV would be supplying about 15% of America's added generating capacity. Another stated goal is for the costs – including operation and maintenance – to the end-user to drop to $3.00 per watt for household alternating current (AC) by 2010 and to about $1.50 per watt AC by 2020.

For More Information:

DOE Photovoltaics Program
Web: http://www.eren.doe.gov/pv/

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Industry: Solar Energy Industries Association
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Produced for the
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
by the National Renewable Energy Laboratory
a DOE national laboratory

DOE/GO-102001-1177
April 2001

Printed with renewable-source ink on paper containing at least 50% wastepaper, including 20% postconsumer waste