

Thin-Film PV: Leadership in Materials R&D

Success
Stories

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The United States leads the world in thin-film PV technology because the DOE research program has invested in thin-film materials R&D for more than a decade

Photovoltaics (PV) is a modern energy technology that makes use of semiconductor materials to convert sunlight directly to electricity. It is basically divided into "wafer" and "thin-film" technologies. Wafer-like devices (solar cells) cut from ingots of crystalline silicon have been available commercially for decades.

The idea of thin films is relatively simple: we can produce truly low-cost PV devices by

using pennies worth of active (semiconductor) materials rather than the larger quantities required for crystalline silicon cells. Through years of research and development (R&D), the U.S. Department of Energy (DOE) has helped pioneer thin-film technology by developing new semiconductor materials.

In fact, DOE's thin-film R&D efforts have been awarded several noteworthy prizes: four R&D 100 awards, a Discover Award from *Discover Magazine*, two Federal Laboratory Consortium "Excellence in Technology Transfer" awards, and a *Popular Science* "Best of What's New" award have been received for thin-film materials development. These awards have been received for breakthrough R&D for materials such as cadmium telluride, copper indium diselenide, and copper indium

Highlights

- **Received four R&D 100 awards, a Discover Award from Discover Magazine, two Federal Laboratory Consortium "Excellence in Technology Transfer" awards, and a Popular Science "Best of What's New" award for thin-film materials development**
- **Increased the world record for copper indium gallium diselenide solar cell efficiency to 17.7%—within one percentage point of the best polycrystalline-silicon cell efficiency**
- **Proved the readiness of thin-film photovoltaics to enter electric utility markets**
- **Demonstrated how government-industry partnerships can develop new technologies and processes to maintain U.S. competitiveness**
- **Developed processes that led to the construction of four new plants for manufacturing thin-film PV modules.**



NREL/PX 01560

This 10-kilowatt photovoltaic array feeds electricity into the Toledo Edison utility grid.

*“One progress
and even our
existence as a
viable PV
company have
depended on the
partnership that
we have
shared with
DOE/NREL to
develop thin-film
modules.”*

*—Mike Cicak,
President, Solar
Cells Inc.*

Project Partners

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of Energy

National Renewable
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EPV

Florida Solar Energy
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Solarex Corporation

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gallium diselenide. But the crucial development for thin-film technology was that manufacturing became cost-effective because of these materials-related R&D breakthroughs. U.S. companies then began to commit to building manufacturing facilities and developing thin-film markets.

Among the numerous private U.S. companies that have worked with DOE to develop low-cost PV is Solar Cells, Inc. (SCI) in Toledo, Ohio. Believing that thin-film technologies have great commercial potential, SCI began in 1992 to develop a continuous, automated manufacturing system that turns out large, efficient, thin-film PV modules.

One result of this automated manufacturing breakthrough is that Toledo Edison, a subsidiary of Centerior Energy, has placed an order for an SCI PV system to deliver as much as 500 kilowatts of PV-generated electricity to the utility grid. This order is by far the largest order to date for utility thin-film PV. SCI announced in 1997 that it plans to open a 20-megawatt (MW) production facility.

Other U.S. companies that have partnered with DOE are also beginning to commercialize thin-film PV modules. These

include BP Solar USA, which is building a 10-MW production line in California; United Solar Systems Corporation, which recently began operating a 5-MW amorphous-silicon production line in Michigan; and Solarex Corporation, whose 10-MW production line is starting up in Virginia.

Through DOE's R&D achievements, thin-film technology has moved from a state of no manufacturers previously to commitments by four manufacturers to build production lines for thin-film modules before the year 2000.



This PV module manufacturing process, developed by Solar Cells, Inc., in Toledo, Ohio, has the highest throughput to date.

For More Information:

Visit these Web sites:
Energy Efficiency and Renewable
Energy Network:
<http://www.eren.doe.gov>

U.S. DOE Photovoltaics Program:
<http://www.eren.doe.gov/pv>

National Renewable Energy Laboratory
Photovoltaics Home Page:
www.nrel.gov/ncpv

or contact:
Energy Efficiency and Renewable
Energy Clearinghouse (EREC)
P.O. Box 3048
Merrifield, VA 22116
(800)-DOE-EREC
www.eren.doe.gov/consumerinfo/
email: doe.erec@nciinc.com



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