

Improving ENTECH's Concentrator Module

ENTECH, Inc., participated in both Phase 1 and 2A of PVMaT.

PVMaT is a 5-year, cost-shared partnership between the U.S. Department of Energy and the U.S. PV industry to improve the worldwide competitiveness of U.S. commercial PV manufacturing.



ENTECH, Inc.

Goals

ENTECH's goals under the PVMaT Project have been to (1) enhance module quality, (2) increase performance, (3) improve durability, (4) expand manufacturing capability to 10 megawatts per year, (5) address environmental, safety, and health issues, and (6) reduce manufacturing costs.

Technology

ENTECH's fourth-generation concentrator photovoltaic (PV) module uses a large acrylic plastic Fresnel lens to capture incident sunlight and focus it onto small packages of silicon cells. Concentrating the sunlight to 20 times its normal intensity reduces the use of expensive silicon cell material by 95%, compared to conventional flat-plate PV modules. The cell packages are mounted to a large, extruded-aluminum heat sink, which keeps the cells about as cool as conventional 1-sun cells. The cell packages, electrically insulated and encapsulated for durability, use a unique optical device called a prism cover to boost performance. An aluminum housing supports and encloses the module. This is the world's largest photovoltaic module, with an aperture area of 3 m² and a rated power output of 430 watts (with 17%-efficient cells) to 480 watts (with 19%-efficient cells).

Results

Under the PVMaT Project, ENTECH worked with key manufacturers to ensure the best possible PV concentrator product. For example, the 3M Company developed a new continuous process for making 90%-efficient, ready-to-use lenses, delivered on rolls 200 meters long, reducing materials costs by 20% and eliminating solvent use in ENTECH's module fabrication. 3M also developed a new prism-cover tape for the cells that reduces material and labor costs for that processing step by 90%. Three cell suppliers (BP Solar, ASE Americas, and



100-kW system at CSW Solar Park in Ft. Davis, Texas.

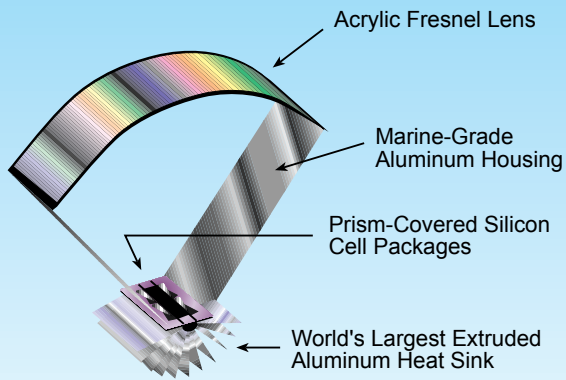
Solarex) now make 19%-efficient cells, and another cell supplier (Siemens Solar Industries) makes 17%-efficient cells for the ENTECH module. Columbia Aluminum provides the world's largest extruded heat sink; Consumers, Inc., makes the aluminum module housing (endplates and sidewalls); and DuPont provides the dielectric and encapsulant films for the module.

ENTECH streamlined its assembly of the cell packages and modules, using a semiautomated workstation to align and attach each prism cover to each solar-cell package. Other workstations solder cell packages, apply dielectric film to the heat sink, encapsulate cell strings, and assemble modules. As an example of increased efficiencies, the ribbon soldering technique reduced materials costs by 80% and allowed a savings in labor.

The ENTECH team can now produce lenses, heat sinks, and cells at rates well above 10 megawatts per year (MW/yr) and can scale up to 100 MW/yr very quickly, as the worldwide market develops and matures.

At a production rate of 30 MW/yr, ENTECH can produce concentrator modules at costs of \$1.25 per watt, which, in sunny parts of the world, equates to a price of 7 to 15 cents per kilowatt-hour.

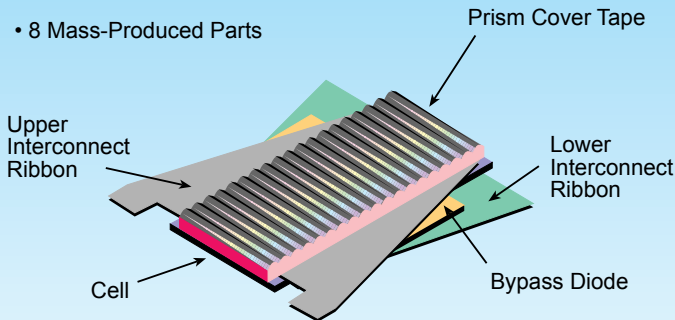
Fourth Generation Concentrator Module



Cross section of ENTECH's fourth-generation concentrator module

Concentrator Cell Package

ENTECH's improved PV cell package



Applications

During 1995, ENTECH completed two 100-kilowatt PV power plants for the two largest utility companies in Texas. One system is located at the CSW Solar Park in Ft. Davis, Texas. The other is located at the TU Electric Energy Park in Dallas. Each system uses 288 of the new concentrator modules.

ENTECH also developed a two-module, 800-watt system (called SunLine) for the small, remote, off-grid market.

Company Profile

ENTECH, Inc., was established in 1983 to implement a management buyout of the solar energy business of E-Systems, Inc. Five of the original founders still maintain majority ownership of this privately held small business, located in a new facility at 1077 Chisolm Trail, Keller, Texas 76248. ENTECH is the world's leading manu-

facturer of PV concentrator systems, in terms of installed system capacity, production history, and business longevity.

References

O'Neill, M.J., et al. (1991). *Photovoltaic Manufacturing Technology Improvements for ENTECH's Concentrator Module: Phase 1 Final Technical Report*, NREL/TP-214-4486, Denver, CO.



For More Information

Ed Witt, NREL 303-384-6402
 Richard King, DOE 202-586-1693
 Doug Ruby, SNL 505-844-0317
 Clay Aldrich, SEIA 202-383-2628
 Mark O'Neill
 ENTECH, Inc. 817-379-0100

O'Neill, M.J. et al., (1992). *ENTECH's Fourth-Generation Linear Concentrator Module*, 1992 DOE/Sandia Crystalline Photovoltaic Technology Project Review Meeting, SAND92-1454, Albuquerque, NM.

Bruton, T.M. et al., (1992). "Recent Developments in Concentrator Cells and Modules Using Silicon Laser-Grooved Buried Grid Cells," 11th E.C. Photovoltaic Solar Energy Conference; *Proceedings of the International Conference; Montreaux, Switzerland, 12-16 October 1992*; pp. 1042-1044.

O'Neill, M.J. (1992). "Fourth-Generation, Line-Focus, Fresnel Lens Photovoltaic Concentrator," 4th Sunshine Workshop on Crystalline Silicon Solar Cells, Tokyo, Japan.

O'Neill, M.J. and McDanal, A.J. (1993). "Manufacturing Technology Improvements for a Line-Focus Concentrator Module," *Conference Record of the Twenty-Third IEEE Photovoltaic Specialists Conference - 1993, 10-14 May 1993, Louisville, Kentucky*; pp. 1082-1089.

O'Neill, M.J. (1994). "Photovoltaic Manufacturing Technology (PVMaT) Improvements for ENTECH's Concentrator Module," *AIP Conference Proceedings 306; 12th NREL Photovoltaic Program Review, Denver, Colorado*; pp. 219-226.

O'Neill, M.J. and McDanal, A.J. (1994). "Fourth-Generation Concentrator System: From the Lab to the Factory to the Field," *1994 IEEE First World Conference on Photovoltaic Energy Conversion: Conference Record of the Twenty-Fourth IEEE Photovoltaic Specialists Conference, 5-9 December 1994, Waikoloa, Hawaii*, Vol. I: pp. 816-819.

O'Neill, M.J. and McDanal, A.J. (1995). "Manufacturing Technology Improvements for ENTECH's Photovoltaic Concentrator Module," *AIP Conference Proceedings 353; 13th NREL Photovoltaics Program Review; Lakewood, Colorado, 16-19 May 1995*; pp. 621-628.

O'Neill, M.J.; McDanal, A.J. (November 1995). *Photovoltaic Manufacturing Technology (PVMaT) Improvements for ENTECH's Concentrator Module; Final Subcontract Report, 17 February 1992 - 14 June 1995*. NREL/TP-411-20277. Golden, CO: National Renewable Energy Laboratory. Work performed by ENTECH, Inc., DFW Airport, Texas.



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

Color printing costs were paid for by several U.S. PV companies.

SP21599
 DOE/GO-10096-310
 DE96013092