

Building Integrated PV and PV/Hybrid Products – The PV:BONUS Experience

Preprint

H.P. Thomas
National Renewable Energy Laboratory

L.K. Pierce
U.S. Department of Energy

*To be presented at the NCPV Program Review Meeting
Lakewood, Colorado
14-17 October 2001*



able Energy Laboratory

1617 Cole Boulevard
Golden, Colorado 80401-3393

NREL is a U.S. Department of Energy Laboratory
Operated by Midwest Research Institute • Battelle • Bechtel

Contract No. DE-AC36-99-GO10337

NOTICE

The submitted manuscript has been offered by an employee of the Midwest Research Institute (MRI), a contractor of the US Government under Contract No. DE-AC36-99GO10337. Accordingly, the US Government and MRI retain a nonexclusive royalty-free license to publish or reproduce the published form of this contribution, or allow others to do so, for US Government purposes.

This report was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or any agency thereof.

Available electronically at <http://www.osti.gov/bridge>

Available for a processing fee to U.S. Department of Energy
and its contractors, in paper, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
phone: 865.576.8401
fax: 865.576.5728
email: reports@adonis.osti.gov

Available for sale to the public, in paper, from:

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
phone: 800.553.6847
fax: 703.605.6900
email: orders@ntis.fedworld.gov
online ordering: <http://www.ntis.gov/ordering.htm>



Building Integrated PV and PV/Hybrid Products – The PV:BONUS Experience

H.P. Thomas
National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, CO USA 80401

L.K. Pierce
U.S. Department of Energy, Golden Field Office
1617 Cole Boulevard
Golden, CO USA 80401

ABSTRACT

The U.S. Department of Energy (DOE) has conducted a phased research and product development program, Building Opportunities in the United States for Photovoltaics, or PV:BONUS, to develop PV and PV/hybrid products for building applications. The program was initiated in 1993 and is nearing completion. The specific focus is to develop PV and PV/hybrid technologies for the residential and commercial buildings sector. Commercially available products and new business partnerships resulted from this program and the new products are receiving domestic and international recognition. This paper summarizes these successes and lessons learned.

1. Introduction

The DOE initiated the Building Opportunities in the United States for PV (PV:BONUS) program in 1993 to develop cutting-edge solar products for the building industry. Program objectives were to develop technologies and foster business arrangements for products cost-effectively integrating PV or PV/hybrid technology into buildings. An important factor is that these products must be installed without the need for specialized training. The program was conducted through two competitive solicitations, termed PV:BONUS and PV:BONUS2. Twenty-two partnerships were initiated under PV:BONUS and from these, five new products were developed. Products included solar roofing shingles and a factory-built modular home integrating PV. PV:BONUS2 began with 16 partnerships. Seven were selected for additional work, resulting in five commercially available products. Products range from an “enabling” PV

application to dual-purpose or hybrid products, and products for unique applications. Highlights and lessons learned from the overall PV:BONUS program are described in the following sections. Program results and progress are also described in previous papers [1,2].

2. Specific Accomplishments/Lessons Learned

PowerView Viewglass PV Curtain Wall, and PV Sunshade - BP Solarex teamed with Kawaneer, Solar Design Associates, and Viracon to develop three building-integrated PV (BIPV) products using tandem-junction a-Si PV modules. The PowerView is an insulated viewglass functioning as a power producer and a window. The team is also producing an electrically active, opaque spandrel curtain wall, which can be incorporated into a building’s skin. Kawaneer received a design award for their PV Sunshade, an architecturally pleasing product that can be retrofitted or incorporated in the initial building design. All three products are BIPV designs, fully incorporated in the building’s function. Lessons learned include better process control for manufacturing modules, utilizing different materials such as heat-strengthened glass, and creating products meeting the requirements for building materials, PV modules and electrical products. Design factors included flexibility, pressure resistance, insulation and thermal expansion. The industry consortium that collaborated to design, develop and manufacture these products was an important factor in this success.

HeatGuard™ and PowerTherm™ - PowerLight Corporation developed two products for the building market. HeatGuard™ is an interlocking, insulating roof tile that allows only 1% of the thermal insulation into the building.

The benefit of this isolating layer is a significant increase in the overall energy efficiency of the building. PowerLight is also completing final tests for a second product named PowerRoll™, a combined PV/thermal hybrid system for medium-temperature hot water applications. The product combines the USSC flexible triple-junction module adhered to a heat-transfer backing material. Lessons learned in this work are the challenge of combined testing to meet solar concentrator standards, PV module standards and UL requirements. Technical lessons learned included materials selection, such as an adhesive meeting safety codes and surviving outdoor exposure and operating at elevated temperatures.

Phototherm Module - The team of Solar Design Associates (SDA), United Solar Systems Corp. (USSC), and SunEarth Inc. is developing a hybrid PV/thermal product called Phototherm. The product is a unitized combination of a liquid thermal collector and the USSC triple-junction a-Si thin-film module. Phototherm resembles a traditional solar thermal design, except the PV module replaces the top surface of the absorber plate. The current Phototherm product is designed for installation on an existing roof. The partners gained experience in defining a solar product capable of higher temperature operation and selecting materials to lower product cost. Because the hybrid product will operate as a PV module and a source for hot water, qualification tests had to be defined. The product must also meet requirements for safety (UL), PV modules and solar thermal products and building codes.

Flexible PV membrane - USSC developed a field-applied, flexible PV membrane (PVM) for roof applications. The 30-in-wide by 18-ft long Peel and Stick PV module is shipped in rolls and to be applied to the roof at the job-site. Shipped with a factory-installed termination or a field-installed termination, both designs meet NEC requirements and are UL listed. The modules are fully compatible with metal roofing materials, and work is being completed for adhesives compatible with other roofing and building materials such as concrete and wood. Lessons learned include designing a product and materials meeting all requirements for building materials, and existing trade practices for roofing materials.

Electrochromic windows - Sage Electrochromics teamed with BP Solarex, Viracon, and Libbey-Owens-Ford to develop electrochromic (EC) windows with a PV-powered variable control. The PV controls are an

enabling technology for this product to be suitable for more applications and will simplify building wiring. Currently the preproduction run of 60 windows is undergoing demonstration testing and evaluation. The partnership is an example of how to establish a team with common interests to produce an innovative product for future markets.

4. Summary

The availability of BIPV and interest in efficient building design are growing markets for PV and solar applications. The products must meet the combined requirements of safety and electrical performance, as well as design, manufacturing and marketing hurdles. They must meet requirements for building products and the expectations of designers, architects, and builders who want reliability, aesthetic design, and low-cost installation. The PV:BONUS program addressed these issues and several products resulting from this program meet these requirements. In addition, the participants have gained from learning how to design to meet the codes and trade practices for building products. Successes in the program demonstrate the benefit of collaborative teams with specialized expertise who work together to design, develop, produce, and market the products.

5. Acknowledgments

The PV:BONUS program is funded through the Office of Power Technologies, with support from the Office of Building Technologies, U.S. DOE, and is managed by the Golden Field Office, DOE. Technical assistance is managed by NREL, a national laboratory managed by Midwest Research Institute under DOE Contract Number DE-AC36-99GO10337. Sandia National Laboratories and the Florida Solar Energy Center also contributed to this program. Many people have contributed to the program and the authors acknowledge that this paper represents their work.

6. References

- [1] S. J. Hayter, S.J., R.L. Martin, "Photovoltaics for Buildings - Cutting-Edge PV," Utility PhotoVoltaic Group UPEX'98 Conference Proceedings, September 1998, San Diego, California USA.
- [2] H. P. Thomas, S.J. Hayter, R.L. Martin, L.K. Pierce, "PV and PV/Hybrid Products for Buildings" 16th European Solar Energy Conference and Exhibition Proceedings, May 2000 Glasgow, Scotland, British Isles.