PV Manufacturing R&D
Inverter Manufacturing Progress

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The DOE Workshop on
Systems Driven Approach
To Inverter Research & Development

Maritime Institute, Baltimore, MD
April 23-24, 2003

New PV Manufacturing R&D Solicitation

PV Manufacturing R&D – Large-scale Module and Component Yield, Durability, and Reliability

http://www.nrel.gov/contracts/solicitations.html

Letter of Interests Due July 15, 2003

Acknowledgements

- U.S. DOE
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PV Manufacturing R&D Project Goal

The U.S. DOE, working with the U.S. photovoltaic industry, initiated the PV Manufacturing R&D Project to conduct manufacturing research to accelerate PV production capacity scale-up and affect manufacturing cost reductions

Program Background

- Initiated in 1990 by DOE, NREL, SNL, and US PV Industry
- Total investment to date - ~$140M - $80M DOE share, $60M industry share
- Six procurements to date
- Current procurement – In-line Diagnostics and Intelligent Processing (IDIP)

PV Manufacturing R&D Inverter History

- 8 subcontracts containing inverter work since 1995
- $8,252k total contract values to date - ~6% of total project
- $5,353k DOE Share – average of 35% cost share
- One currently active

Inverter Related Subcontracts

- **1995 – Phase 4A1**
  - **Advanced Energy Systems** – *Next-Generation Three Phase Inverter*
  - **Ascension Technologies** – *Manufacture of an AC Photovoltaic Module*
  - **Omnion Power System Engineering** – *Three-Phase Power Conversion for Utility-Interconnected PV Applications*
  - **Solar Design Associates** – *The Development of Standardized, Low-Cost AC PV Systems*
  - **Trace Engineering** – *Modular Bi-Directional DC-to-AC Power Inverter Module for PV Applications*

Inverter Related Subcontracts

- **1998 – Phase 5A1**
  - **Ascension Technologies** – *Cost Reduction and Manufacture for the SunSine 325 AC Module*
  - **Omnion Power System Engineering** – *Manufacturing and System Integration Improvements for One- and Two-Kilowatt Residential PV Inverters*
- **2000 – In-line Diagnostics and Intelligent Processing**
  - **Xantrex** – *PV Inverter Products Manufacturing and Desi8gn Improvement for Cost Reduction and Performance Enhancements*

Advanced Energy Systems

Next-Generation Three Phase Inverter – '95

- Goal – Simplify mfg methods for 50-100 kW inverters to reduce costs and improve reliability
- Incorporated digital control, smart power components, and soft switching
- Designed and built prototypes for grid-tied and stand-alone/hybrid inverters
- Tested at SNL and NREL/NWTC

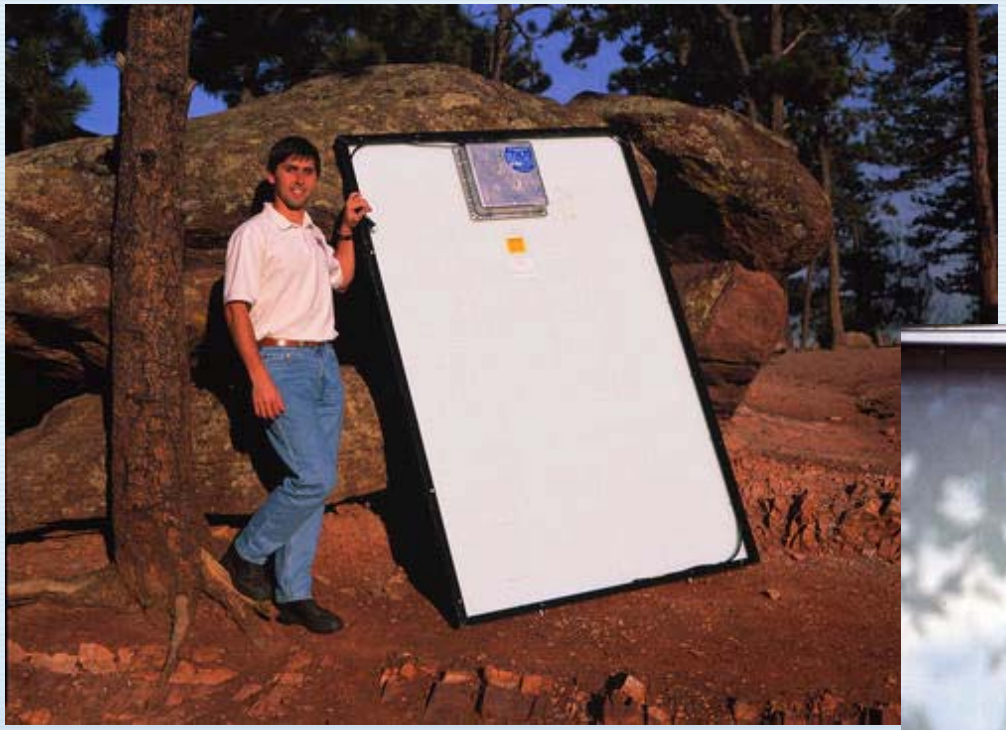
Ascension Technology

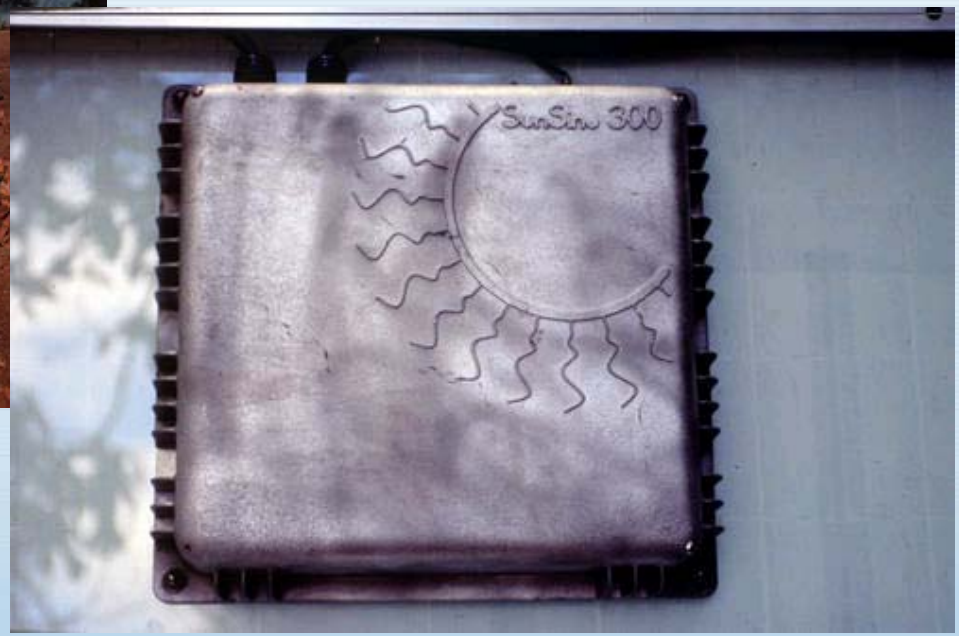
Manufacture of an AC Photovoltaic Module – '95
Cost Reduction and Mfg of the SunSine 325 AC Module – '98

- Goal – Develop an integrated, grid-tied, AC PV module. 5000/yr mfg rate
  - 300 W inverter designed with grid isolation, no output until properly grid-tied, auto shutdown when grid is down
  - Soft switching introduced in '98
  - UL Listed (UL 1741)

Ascension Technology

Manufacture of an AC Photovoltaic Module





Omnion Power Corporation

Three-phase Power Conversion for Utility-interconnected PV Applications – '95

- Goal – Develop a mfg process for 3-phase, 100 kW grid-tied inverter
- Product to achieve MTBF of 40,000 hr
- 94% DC/AC conversion efficiency over 15 kW
- Current THD <4%, voltage THD <2%
- ISO 9001 manufacturing

Omnion Power Corporation

Three-phase Power Conversion for Utility-interconnected PV Applications – '95

Omnion Power Corporation

Mfg and System Integration Improvements of 1 and 2kW Residential PV Inverters – '98

- Goal – Pursue design and mfg enhancement to 1 and 2 kW residential products
- ISO 9001 manufacturing approach
  - Input voltage of 100-400V, output 120V
  - Transformerless topology

Solar Design Associates

Development of Standardized, Low-cost, AC PV Systems – '95

- Goal – Design and build a micro-inverter for a 240 W PV module
- Goal of $0.20-0.25 per Wp at 10,000 units per year
  - ➢ UL listed
  - ➢ FCC certified

Trace Engineering

Development of Modular, Bi-directional Power Inverter for PV Applications – '95

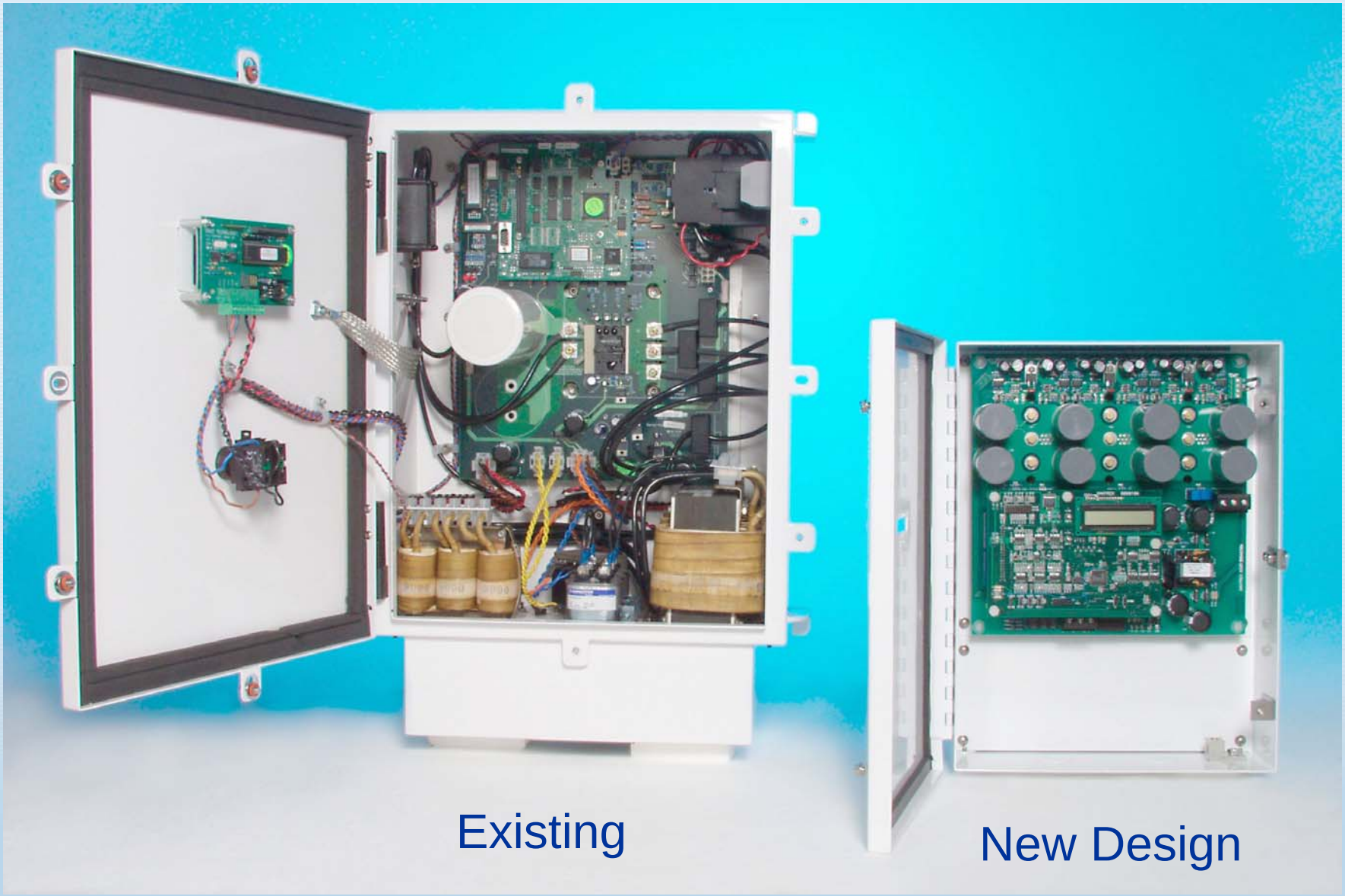
- Goal – Develop prototype for a modular, bi-directional inverter that is highly manufacturable and compact
  - Reduced size 30%, parts costs 35%, labor costs 42%
  - UL listed

Xantrex

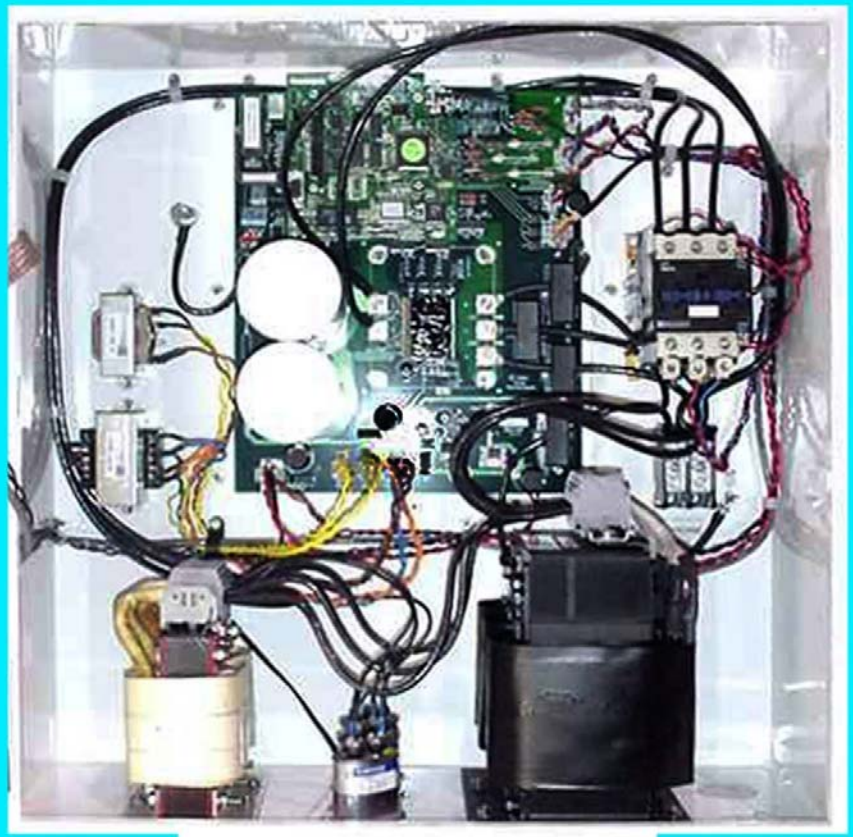
PV Inverter Products Mfg and Design Improvement for Cost Reduction and Performance Enhancements – '01

- Goal – Use latest Digital Signal Processor technology to develop next generation products with common platforms, reduced costs, and increased performance
- Work underway on PV10-208, PV20-208, and new PV2.5A
- For 10 kW unit, costs ↓53%, housing volume ↓58%, conversion loss ↓49%, labor ↓47%

Xantrex 10 kW



Xantrex 20 kW



Existing

New Design

Xantrex

10 kW

20 kW

Summary

- 8 subcontracts containing inverter work since 1995
- Continued inclusion of component, BOS, and systems efforts in PV Manufacturing R&D efforts
- Development of metrics for these programmatic categories similar to module cost/capacity
- Explicit effort to ensure that future awards support inverter 5-year plan

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