



Low Cost High Concentration PV Systems for Utility Power Generation

Program Team: PV

Presenter: R. D. McConnell

Organization: Amonix, Inc.

Contact Info: bob@amonix.com

Date: May 26, 2010

Timeline

- Start: May 14, 2007
- Requested End: June 30, 2011
- 75% complete

Budget

- Total project funding
 - \$15,600,000 (DOE)
 - \$18,000,000 (Investors)
- FY09: \$10,000,000
- FY10: \$12,000,000

Barriers

- Design & Packaging
- Manufacturing Processes
- Efficiency

Partners

- University of Nevada Las Vegas
- NREL
- Component suppliers
- Investors

“This presentation does NOT contain any proprietary, confidential, or otherwise restricted information”

- Reduce material costs
 - Increase system performance
 - Reduce product cost
 - Establish reliability
-
- The sole reason for overcoming these barriers and challenges is to reduce energy cost and achieve the Levelized Cost of Energy (LCOE) goals of DOE's Solar Energy Technologies Program.

- Objectives
 - Develop a high-volume (30 MW/yr), low-cost manufacturing facility
 - Redesign components of the Amonix high-concentration PV system for high-volume, low-cost manufacturing and installation
 - Incorporate high-efficiency multijunction solar cells into redesigned system
 - Conduct reliability testing of redesigned system components
- These objectives contribute to overcoming the barriers of:
 - Achieving high reliability through suitable designs and cell assembly packaging
 - Reducing costs through redesign and manufacturing processes
 - Increasing system performance through higher efficiency solar cells
 - Reducing LCOE low enough for Amonix to compete in the toughest solar market of all, the large-scale utility market

Total Systems Approach — Advantages at Every Stage

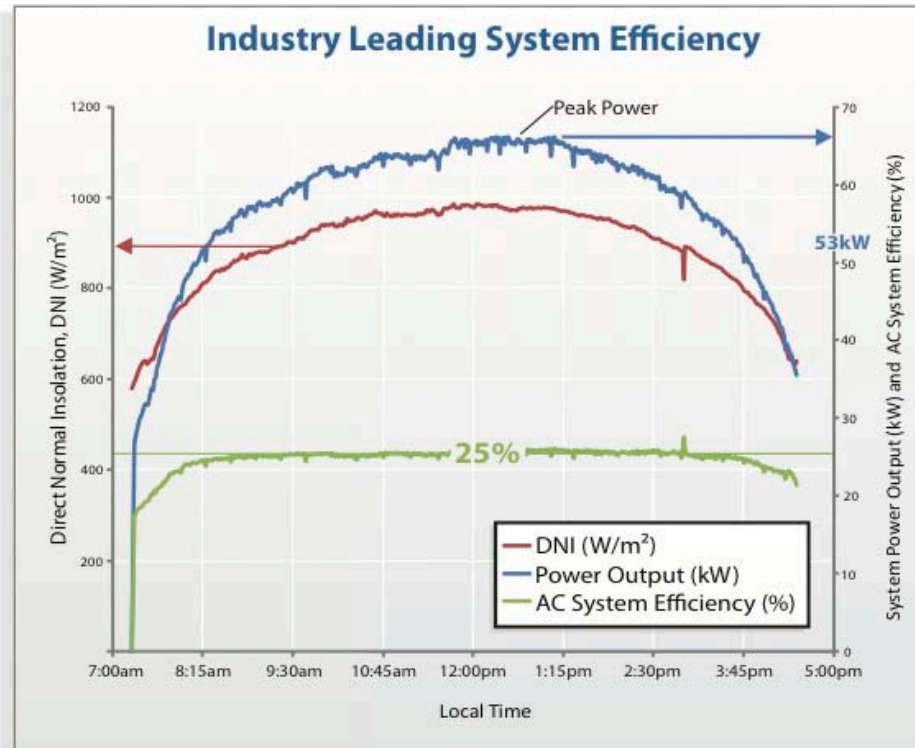
Stage	Approach	Advantage
Design	Integrated structure	MegaModule® moves assembly from field to factory, reducing installation from months to days.
Manufacturing	Capital efficient — minimizes capital requirements for manufacturing	One-third to one-half the cost of competing technologies; automated assembly enables distributed manufacturing.
Shipping	MegaModule® is optimally sized for transportation.	Can ship 42 kW per truck.
Installation	Rapid field deployment	Installation rate is >0.7 kW/min (more than double the speed of the largest thin-film modules).
Performance	Highest efficiency and energy density (2 to 3 times better than most competing technologies)	Produces more energy per acre, maximizing return on investment.
Operation and Maintenance	Design modularity	Can easily repair, replace, or upgrade cells without having to replace entire system.



- October 27, 2009 Press Release: High Volume Manufacturing
 - “The Amonix facility in Seal Beach currently manufactures the company’s Amonix 7700 Solar Power Generator, including proprietary MegaModules[®] incorporating the industry’s highest efficiency multijunction solar cells. Production started late last year in the 78,000 square foot facility; the company recently automated the MegaModule[®] assembly process to support higher volume production. By employing state-of-the-art robotics, Amonix has improved its MegaModule[®] manufacturing. According to Vahid Ghassemian, Amonix’s Vice President, Manufacturing, “The new automated MegaModule[®] assembly delivers multiple benefits; not only does it improve manufacturing throughput and quality, but also the Amonix 7700’s field performance.”
 - Amonix now has 30MW of annual manufacturing capacity. The automated assembly process is replicable and will serve as the model for the company’s future manufacturing facilities.”



January 14, 2010 Press Release: SEAL BEACH, Calif.– “Solar panel manufacturer Amonix (www.amonix.com) will create a total of 436 clean energy manufacturing jobs in Nevada and Arizona based on its award of \$9.5 million in stimulus funding as part of the federal Recovery Act’s Advanced Energy Manufacturing Tax Credit. The company was granted \$5.9 million for manufacturing work in Nevada, and \$3.6 million for work in Arizona.”



Amonix multijunction system performance under field operating conditions.

The DC (module) efficiency is close to 29% (as verified by Sandia), whereas the AC (system) efficiency of 25% includes inverter losses. DC efficiency is used by the majority of the PV community for reporting cell and module efficiency. Note that the graph peaks well above 65 kW (AC) because the direct-normal insolation (DNI) went well above 850 W/m^2 , while the average system power is noted as 53 kW (AC). Scientists at Sandia, NREL, and Amonix all believe this DC module efficiency is a world record. The problem is that the record keepers have never tested such a large module as the MegaModule® with such a high efficiency.



This installation of six Amonix CPV systems provides 240 kW of electricity for the River Mountains Water Treatment Facility in the Nevada desert. The facility treats 300 million gallons of water daily.

This installation of prototypes has operated for more than a year.

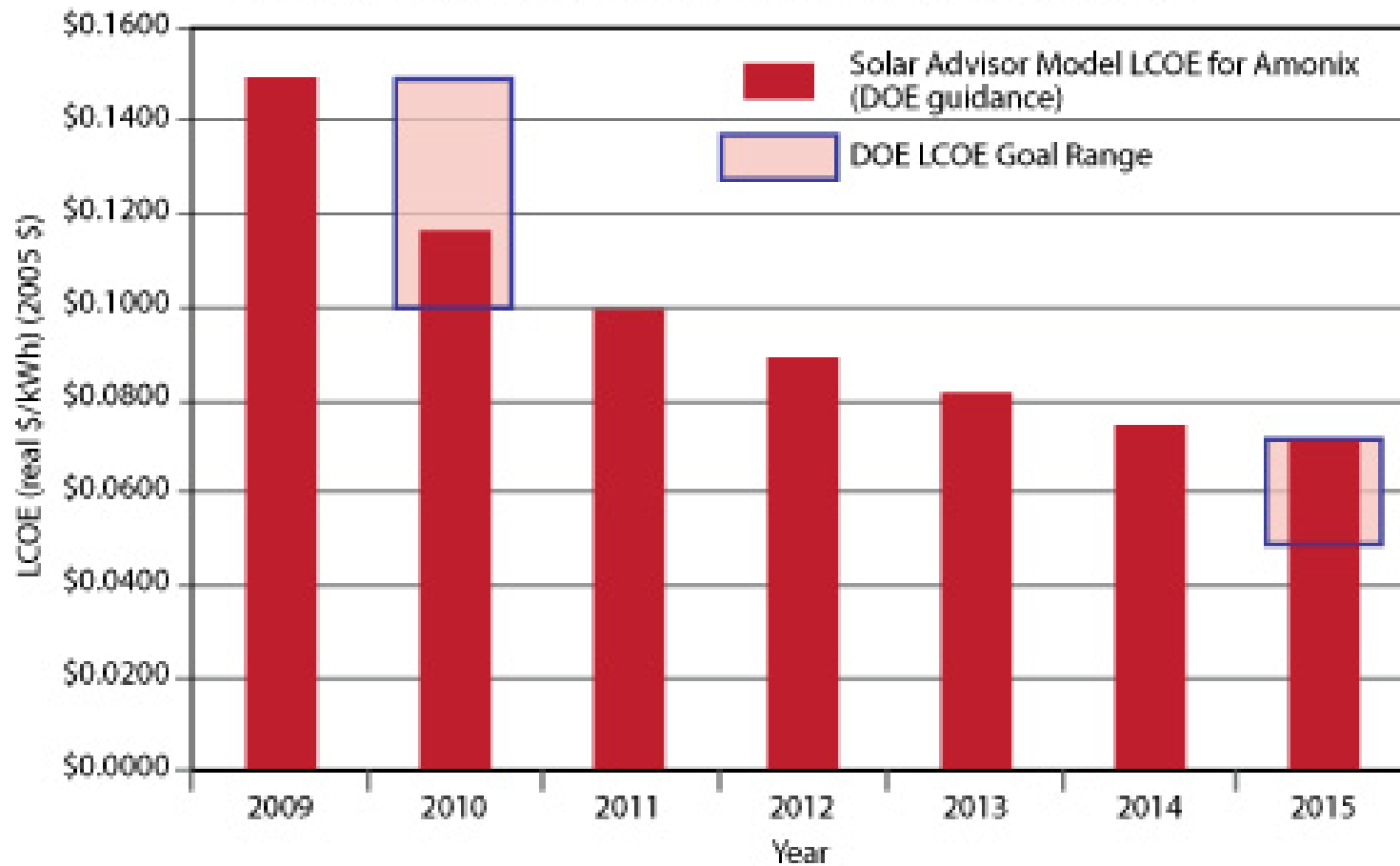
“Senate Majority Leader Harry Reid, D-Nev., told attendees at the (dedication) ceremony that the state needs businesses such as Amonix to diversify the economy, which is too reliant on the casino industry.”

Las Vegas Review Journal

May 16, 2010



AMONIX Levelized Cost of Energy (LCOE) Roadmap



- **Seal Beach, California – December 21, 2009** – The Board of Directors of Amonix, Inc., the best choice for utility-scale solar power in hot and dry climates, announced today that it has named Brian Robertson Chief Executive Officer. Robertson succeeds Vahan Garboushian in that role. Garboushian, who founded the company more than 20 years ago, continues as its Chief Technology Officer and Chairman.
- Robertson joined Amonix through the company's acquisition of Sunworks Solar, LLC, a solar manufacturing plant developer he co-founded. Previously, Robertson co-founded and was president of SunEdison, North America's largest solar energy services provider. SunEdison was acquired by MEMC in November 2009. Robertson is a graduate of MIT with a degree in Computer Science and has an MBA from Harvard Business School.
- "Demand for utility-scale solar power is increasing rapidly around the world and with our CPV industry-leading 15 years' experience with successful deployments in real-world conditions, Amonix is uniquely positioned to drive growth," said Garboushian. "Brian is one of a handful of solar industry executives with deep experience leading field-tested solar companies, and he is the right person at the right time to take Amonix to the next level."



High winds in Nevada



Heavy rains in California



Ice accumulation in Arizona



Earthquakes in LA



Multiple lightning strikes in Texas



- University of Nevada Las Vegas: Prototype Testing
- NREL: Accelerated Life Testing
- Sandia: Testing and Evaluation
- Component suppliers
- Investors
 - Seal Beach, California – April 20, 2010 – “Amonix, Inc., a leading designer and manufacturer of concentrated photovoltaic (CPV) solar power systems, announced today that it has raised a \$129.4 million Series B financing round led by Kleiner, Perkins, Caufield & Byers. Other participants in the round include Adams Street Partners, Angeleno Group, PCG Clean Energy & Technology Fund, Vedanta Capital LP, New Silk Route, The Westly Group, and current investor MissionPoint Capital Partners. Amonix will use the proceeds to accelerate deployments of its CPV systems and expand manufacturing capacity.”



- **Objectives**

- Develop a high-volume (30 MW/yr), low-cost manufacturing facility in three years
- Redesign components of the high-concentration PV system for high-volume, low-cost manufacturing and installation
- Incorporate high-efficiency multijunction solar cells into redesigned system
- Conduct reliability testing of redesigned system components

- **Accomplishments**

- Fielded the Amonix 7700 Solar Power Generator equipped with high-efficiency multijunction solar cells
- Developed a parameter model well-correlated to more than 12 months of field performance
- Compiled energy performance data for a proposed IEC energy rating specification for CPV
- Conducted accelerated life tests under a NREL CRADA for validating and improving cell package designs
- Sent representative test modules to UL for certification to IEC 62108 and UL 8703
- TUV conducted tests on representative modules to obtain California Energy Commission listing
- Sandia measurements of MegaModule performance exceeded Stage Gate milestones for Phase 2 and for Phase 3
- Completed Amonix LCOE roadmap out to 2015 with SAM results falling within LCOE goal ranges set out by the DOE Solar Energy Technologies Program
- Using this TPP's accomplishments, Amonix completed the next round of funding needed to commercialize Amonix' CPV systems

- **Future Directions**

- Complete IEC 62108 qualification and UL 8703 safety certification
- Expand reliability studies through system deployment, compilation of reliability data and investigation of lifetime prediction methodologies

Questions

