Low Cost Thin Film Building-Integrated PV Systems

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GLOBAL PV MARKET

World PV market in 2005 exceeded 1600 MW; 10 players had about 75% share of the market.
World market in 2020 is expected to be more than 15 GW.
Each of the top players must produce more than one GW/year.
Who would be those players?
What technologies would survive?

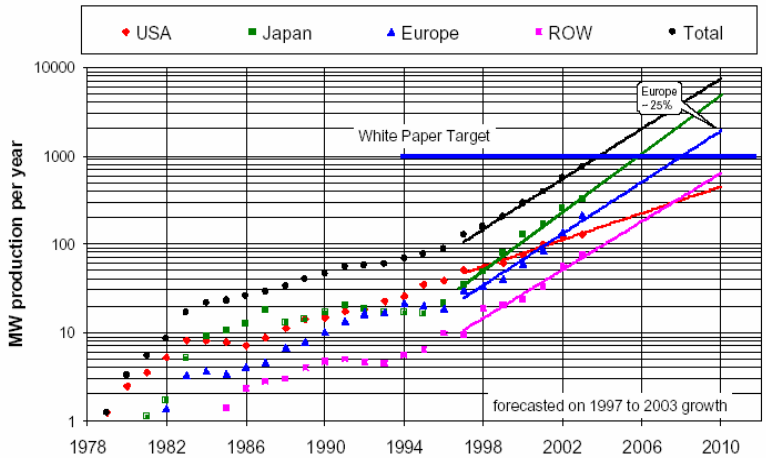


Fig. 26: Extrapolated increase of production capacities up until 2010 using the growth rates from 1997 to 2003 (Data source: PV News [May 2004])

TECHNOLOGY OPTIONS

- Single crystal/polycrystalline silicon
- Thin films
  - Amorphous/nanocrystalline silicon
  - CdTe
  - CIGS
  - Silicon film
- Concentrators
- Organic and others

➢ Winner/winners would be those technologies that offer systems at lowest cost per kWh, and can stand behind their products and systems. Focus on installed cost, system performance, service and reliability.

WHY THIN FILM (AMORPHOUS AND NANOCRYSTALLINE) SILICON PV?

Low material cost and automated manufacturing result in low manufacturing cost
-Advantage to the manufacturer

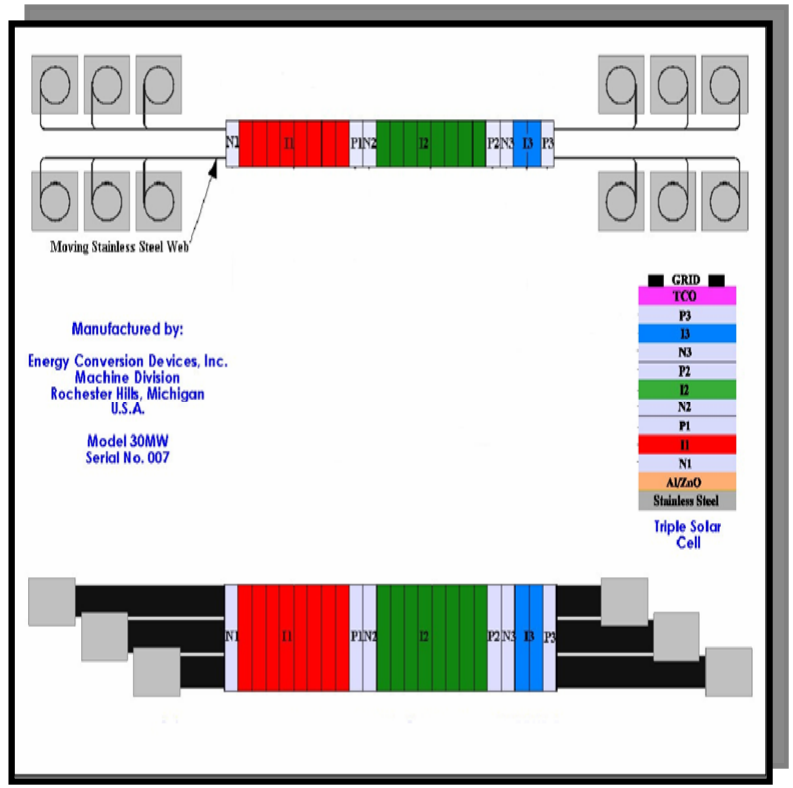
Low installation cost with flexible products results in lower system cost
-Advantage to the system integrator

Higher kWh/kW results in lower c/kWh
-Advantage to the customer

❖**No constraint on capacity expansion because of polysilicon shortage**

Manufacturing Advantage

Solar cells are deposited on six rolls of stainless steel, each 1.5 mile long, simultaneously to make 9 miles of solar cell in 62 hours



Product Advantage – Low Installation Cost

ADD-ON PRODUCTS → INTEGRATED SYSTEM

High installation cost

PV

+

ROOFING

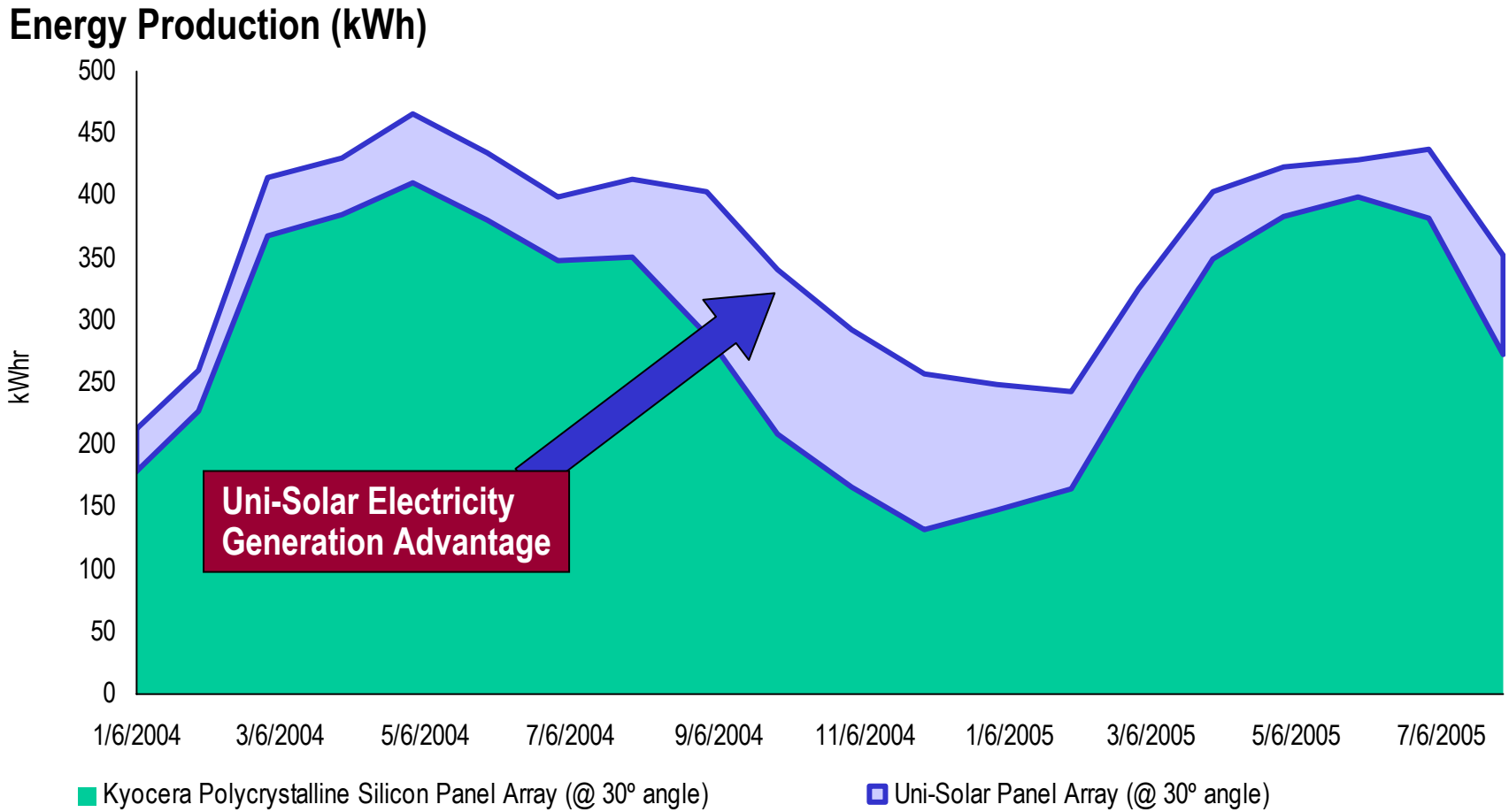
Low installation cost

PV

ROOFING

Courtesy:SIT

PRODUCT ADVANTAGE: Up to 20% more electricity generated for the same rated power



Source: PV System Performance Santa Cruz Test Site, United Solar Ovonic and Solar Quest

U.S. Department of Energy

Energy Efficiency and Renewable Energy

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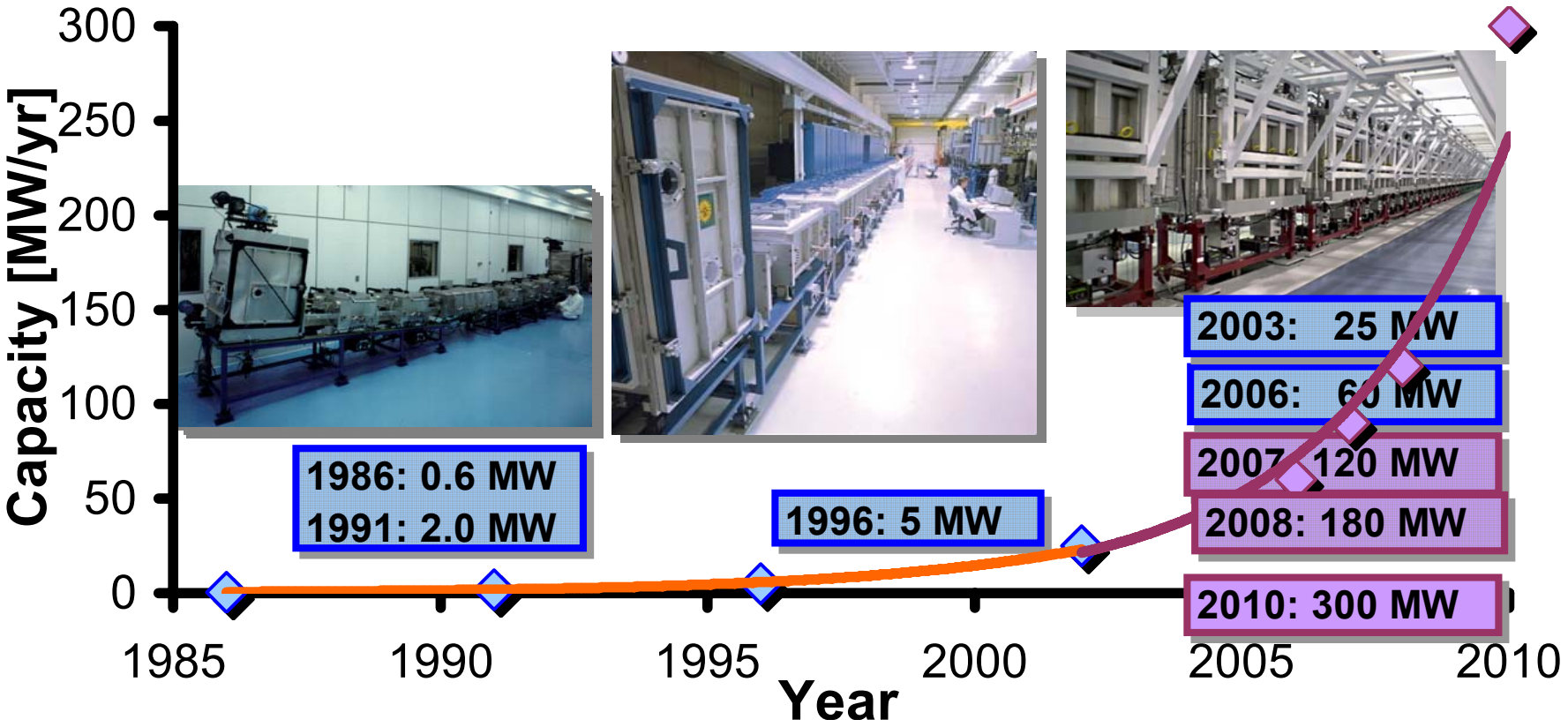
UNI-SOLAR

Capacity Expansion



With increased acceptance of its products, United Solar has embarked on a very aggressive expansion plan.

Marketing-Global Product Positioning

Peel & Stick Market

Commercial

Residential

Commercial

Distribution

High Value

OEM

Key Account Builders

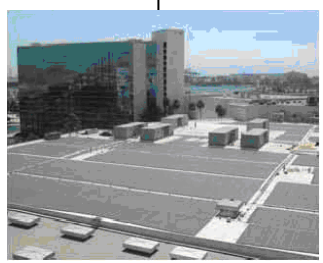
Key Account Design/build

Key Account Solar Integrator

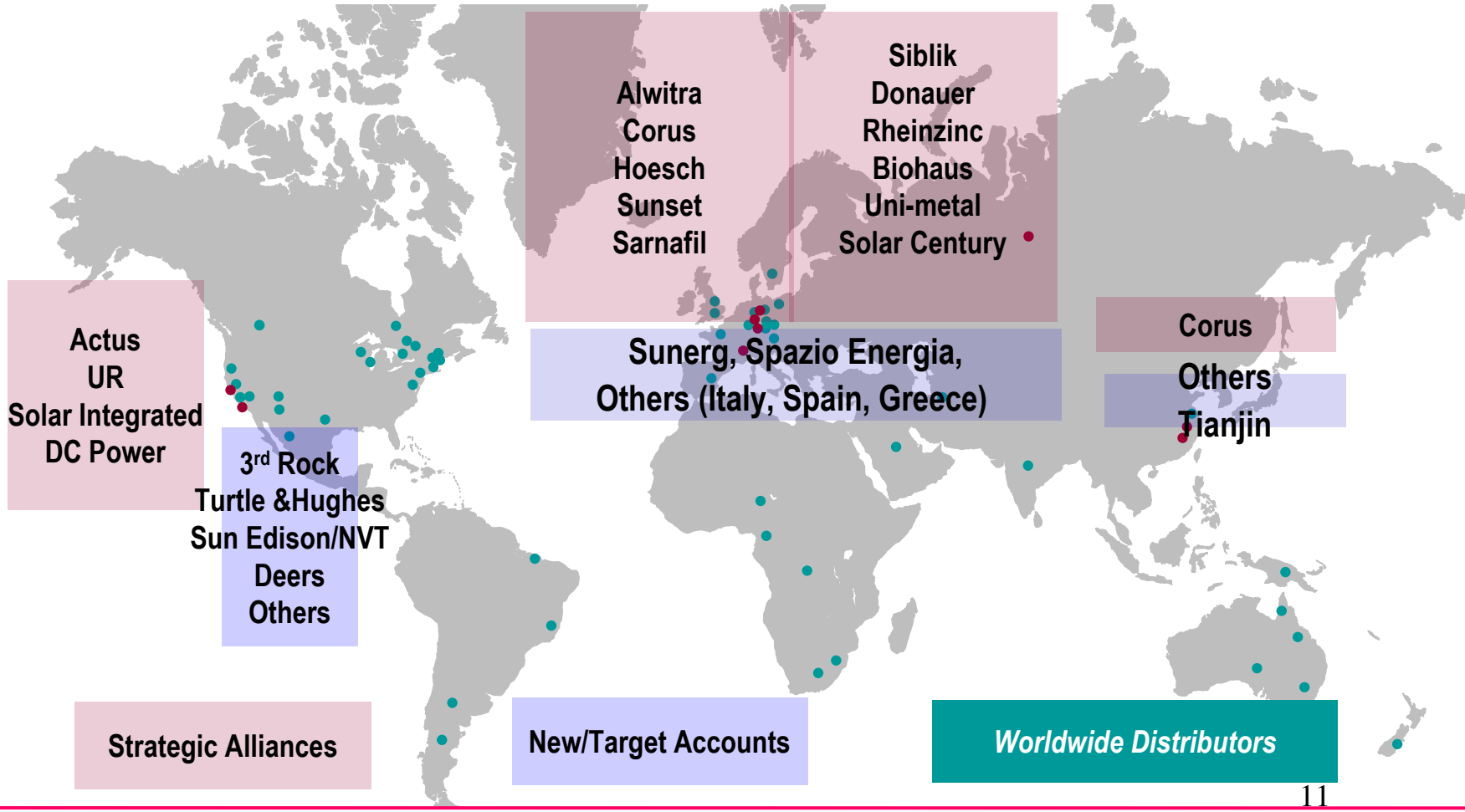
Govt., Military

Lightweight, Aesthetic Value, Durability, Flexibility, Functional Value, Building Integration





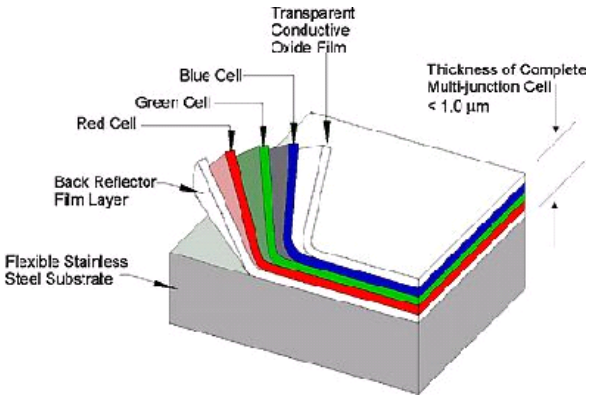
MARKETING - GLOBAL ALLIANCES

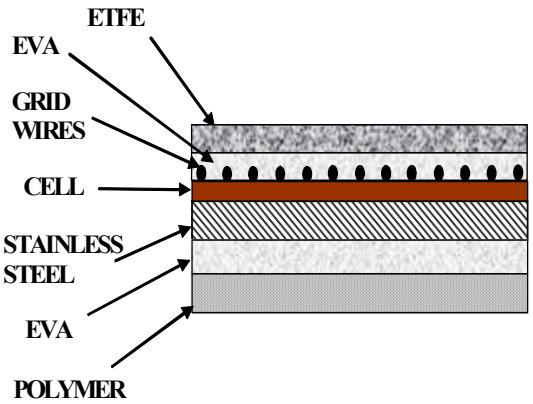


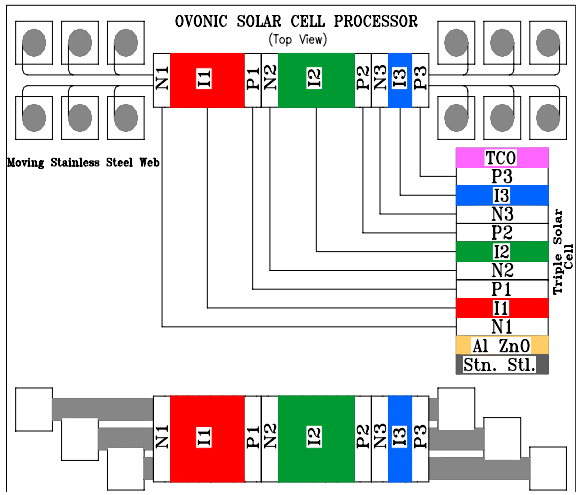
SAI Objective

Demonstrate LCOE of 12.8 c/kWh and 7.6 c/kWh by years 2010 and 2015, respectively, for BIPV systems on commercial/institutional buildings using lightweight, flexible, and aesthetically pleasing thin film solar cell based PV arrays and installations.

United Solar Technology







(a) (b) (c)

(a) Triple-junction device structure, (b) Schematic of cross section of module, and (c) Schematic of roll to roll silicon processor and triple junction structure formation.

2006 Cost Structure for Large Commercial BIPV Installation

- Modules: 59%
- Inverter & BOS: 17%
- Installation: 8%
- Deployment/Indirect: 17%

In order to meet the SAI goals, we have assembled a team consisting of experts from industries, universities, and national laboratory, and developed a plan with a stage gate approach for implementation.
We have identified specific cost centers and will address these cost centers to reduce the Levelized Cost of Energy (LCOE).
Some of these cost centers will have an impact on LCOE in 2010 and others in 2015.

Cost centers and technical approaches

Cost Center	Topic	Approach
Cell	1. High efficiency nc-Si materials and cells 2. High deposition rate for a-Si and a-SiGe	Very high frequency deposition; Collaboration with academia and national labs
Module	1. Efficiency improvement using production equipment 2. Grid wire 3. EVA 4. Back lamination 5. Stainless steel 6. Productivity 7. Reliability	1. Kaizen 2. In house development 3. In house development; Collaboration with plastic extruders 4. In house development 5. Material qualification 6. Lean manufacturing 7. Accelerated testing
Inverter and BOS	New design; better integration	Work with inverter companies
Installation & System integration	Inexpensive installation for different types of roofs	Work with installers; Reliability testing for different solutions
Deployment	Demonstrate cost benefits	Work with installers and accredited centers

Team Responsibilities

#	Team Member	Responsibility
1	United Solar - Overall responsibility	i) Team lead, ii) Coordinator of all tasks iii) Module/cell development, iv) Deployment
2	Energy Conversion Devices, Inc. (ECD)	i) Cell and module development ii) Manufacturing technology development
3	SMA-America	Inverter/BOS supply
4	Sat Con	Inverter/BOS supply
5	PV Powered	Inverter development and supply
6	ABB	Inverter/BOS supply
7	Solectria Renewables	Inverter development and supply
8	DEERS	i) Systems engineering and installation, ii) Deployment facilitation
9	Turtle Energy	Deployment facilitation
10	Sun Edison	Deployment facilitation
11	University of Oregon	Cell development
12	Syracuse University	Cell development
13	Colorado School of Mines	Cell development
14	NREL	Cell development

Path to Achieve LCOE Targets

Advance cutting edge technology: Secured key technology collaborators
Improve product efficiency: Optimize roll-to-roll deposition parameters
Improve solar cell efficiency: a-Si, a-SiGe, and nc-Si cells, and back reflector
High rate deposition: a-Si, a-SiGe, nc-Si, back reflector layers
Reduce module cost: (1) Stainless steel substrate by working with vendors and (2) top grid wire through R&D and equipment vendors
Reduce cost of packaging materials: (1) New materials for front and back lamination and (2) develop new design for direct integration of PV module with roofing membrane
Manufacturing issues: (1) Economies of scale, (2) lean techniques, and (3) incorporate advanced diagnostic systems in roll-to-roll machines
Inverter and BOS: Develop inexpensive large capacity 3-phase inverters
Systems engineering and integration: (1) Innovative solutions for various roofing applications and (2) reduce systems and installation costs
Deployment: Deploy several systems of different sizes in different locations, monitor energy output, and analyze LCOE

TPP Collaborative Activities

- Development of improved or new test protocols for accelerated testing, performance rating
- Participation on standard-setting committees on O&M protocols, ES&H standards
- Contribution to codes and standard definition activities
- Collaboration with other participants in the Technology Acceptance partnerships
- Work with DOE/NREL/SEIA to support and facilitate the achievement of DOE goals.

Demonstration of 12.8 c/kWh LCOE in 2010

Install several large systems in agreed-upon geographic locations. Systems will be equipped with DAS to monitor dc and ac power, insolation, temperature, and electricity generated. Total cost data will be provided and the results will be analyzed with the help of SAM to demonstrate an LCOE of 12.8c/kWh.

We have assembled a great team drawing experts from industries, universities, and national laboratory to address the SAI goals. The program follows the stage gate approach with milestones and deliverables at the end of each phase.