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# Photovoltaic Technology Incubator Selections

## Technology Development



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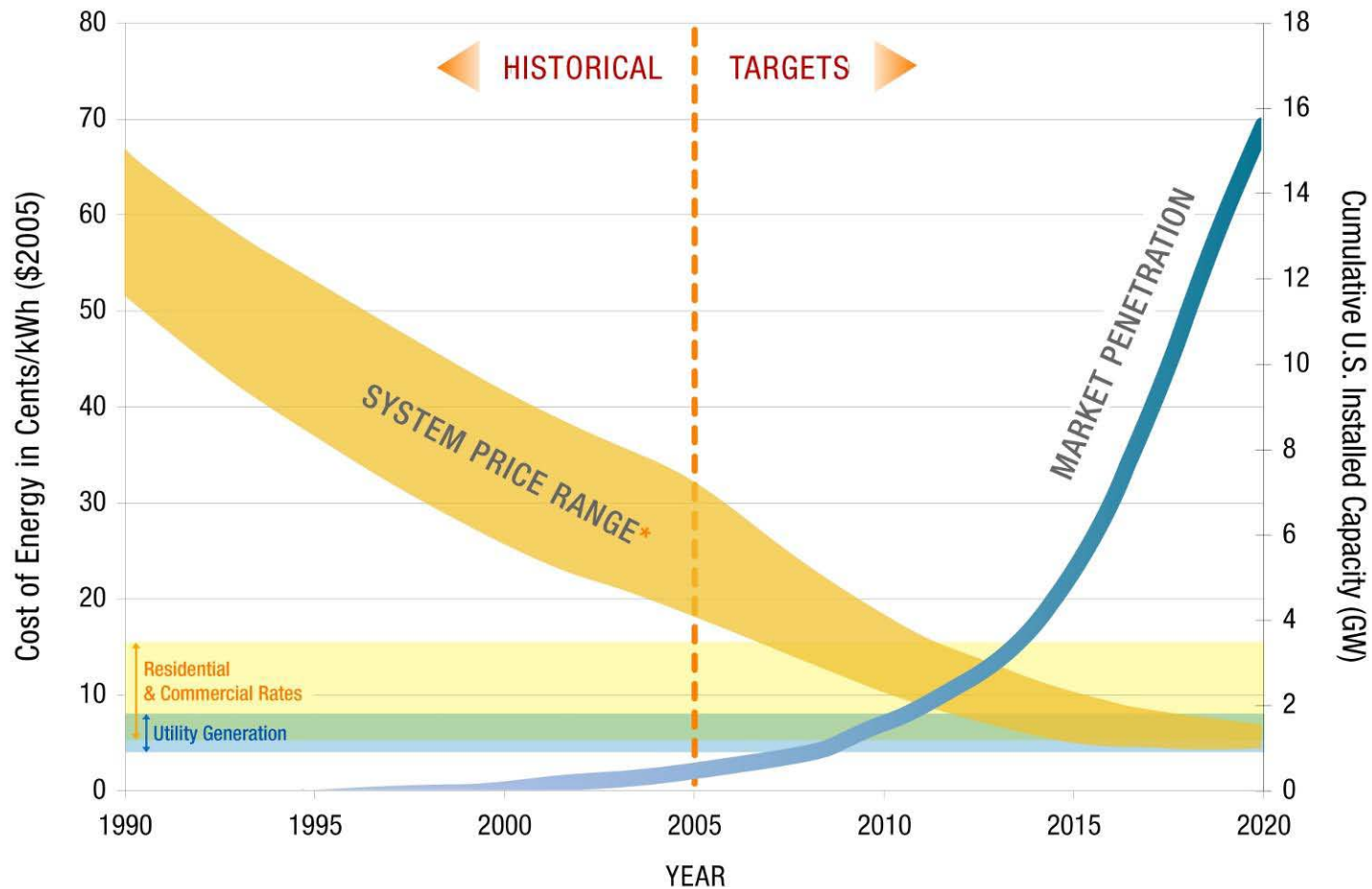
DOE Solar Energy Technologies Program

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# Making Solar Cost-Competitive Nationwide by 2015



Market Sector	Current U.S. Market Price Range (¢/kWh)	Cost (¢/kWh) Benchmark 2005	Cost (¢/kWh) Target 2010	Cost (¢/kWh) Target 2015
Residential	5.8-16.7	23-32	13-18	8-10
Commercial	5.4-15.0	16-22	9-12	6-8
Utility	4.0-7.6	13-22	10-15	5-7

# Photovoltaic Technology Incubator Objectives



## **Explore the commercial potential of new manufacturing processes and products**

- Promote the development of a diverse set of PV technologies which cover a variety of target markets including residential, commercial, and utility power generation.
- Investigate the scale-up potential of promising technology which has already be proven on a small scale.

## **Foster innovation and growth in the domestic PV industry**

- Provide U.S. small businesses with a chance to expand quickly in a rapidly maturing industry. Successful projects will position companies to apply into the second phase of the larger, "Technology Pathway Partnerships" which focuses on full cost reductions to make PV cost-competitive by 2015.

## **Establish an efficient and cyclic funding opportunity**

- Funding is structured so that companies receive funding from the Department only upon successful performance of pre-specified new hardware.
- Provide funding opportunities for new applicants every 9 months.
- Perform a stage gate review of funded incubator projects at 9 months.

# Project Development Focused on Improvements at the Module Level



TECHNICAL IMPROVEMENT OPPORTUNITIES		METRICS			
TEIR 1 TIOs	TEIR 2 TIOs	Performance	Cost	O&M	Reliability
<b>Modules</b>	<b>Module</b>	High-Impact	High-Impact	Moderate-Impact	Moderate-Impact
	Absorber	High-Impact	High-Impact	Moderate-Impact	Moderate-Impact
	Cells and Contacts	High-Impact	High-Impact	Moderate-Impact	Moderate-Impact
	Interconnects	Moderate-Impact	Moderate-Impact	Moderate-Impact	Moderate-Impact
	Packaging	Moderate-Impact	Moderate-Impact	Moderate-Impact	High-Impact
	Manufacturing	Moderate-Impact	High-Impact	Moderate-Impact	Moderate-Impact

■ = High-Impact Opportunities   
 ■ = Moderate-Impact Opportunities

- Project development is focused on a limited number of high impact technical improvement opportunities at the module level that lie on the critical path to scaling-up their technology to full manufacture.
- Full system cost reductions including installation, inverters, and balance of system components is the focus the Technology Pathway Partnerships project currently in phase 1.

# Photovoltaic Technology Incubator

## Details of Selected Projects



**Incubator projects will significantly expand and diversify domestic “market ready” PV technologies:**

- Establish up to 1 GW of annual manufacturing capacity by 2010 of technology which is not commercially produced today.
- Position 10 U.S. companies competitively among world PV manufacturers by 2010.

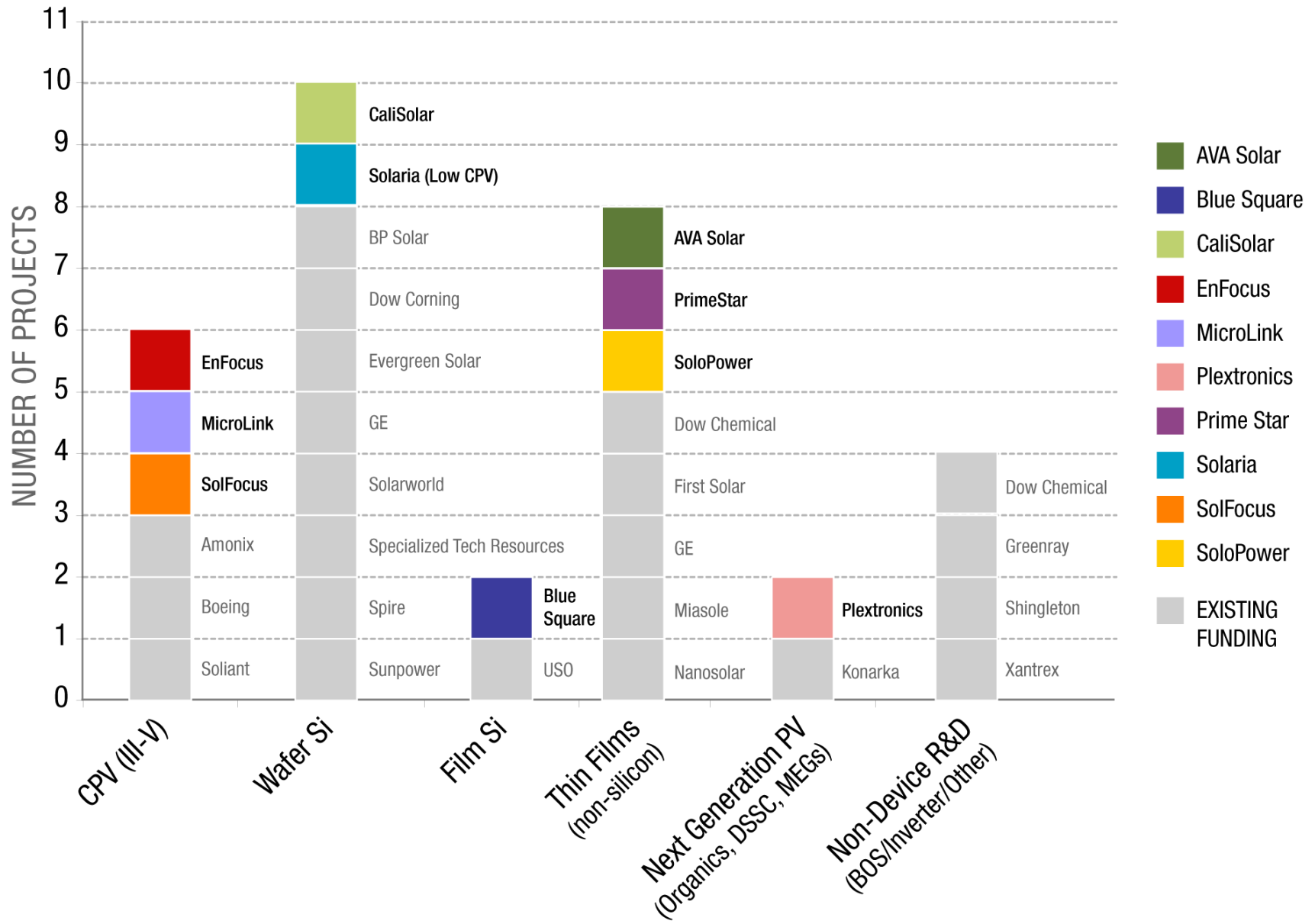
**Projects include a diverse set of technological approaches:**

- Inexpensive and Thin Film Si
- Innovative thin film manufacturing
- Low and High Concentration
- Low Cost Multi-Junction Cell Production

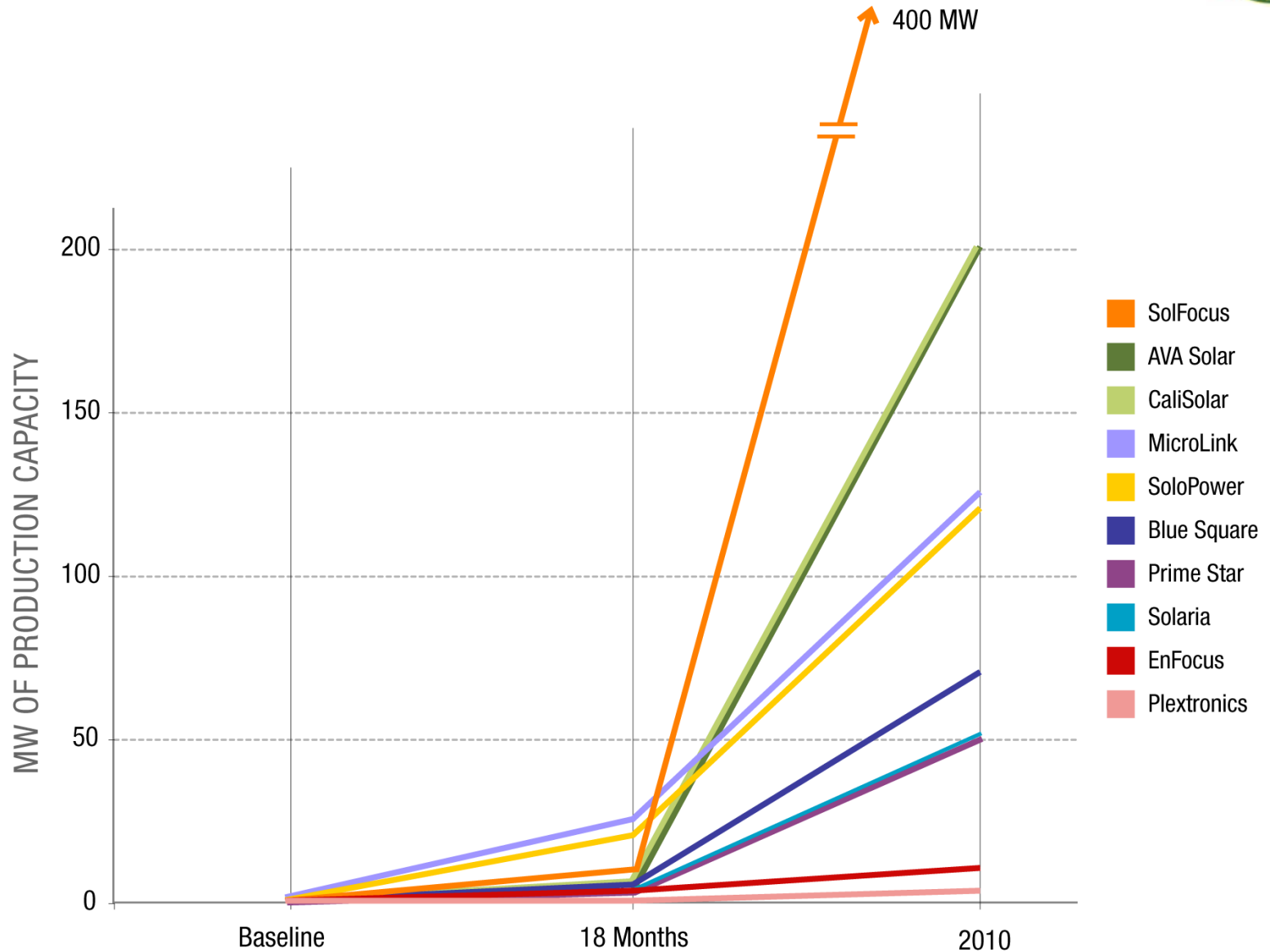
**Selected PV Technology Incubator Projects:**

- AVA Solar
- Blue Square Energy
- CaliSolar
- EnFocus Engineering
- MicroLink Devices
- Plextronics
- PrimeStar Solar
- Solaria
- SolFocus
- SoloPower

# DOE's Portfolio Balances Technology, Maturity & Risk



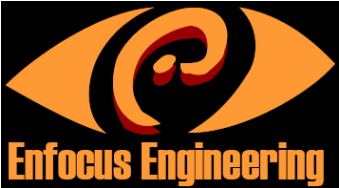
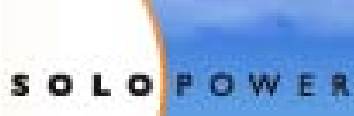
# Incubator Projects Quickly Ramp Production Capacity to Pilot and Commercial Levels



# DOE's Photovoltaic Technology Incubator



AVA Solar





# AVA Solar: Low Cost, High-Throughput, Automated Fabrication of Thin Film Cells and Modules.



## Technologies Addressed

**CdTe/CdS**

## Target Market

**Commercial**

## Description

AVA Solar has demonstrated fully automated, continuous in-line fabrication of CdS/CdTe PV. This project will enable the demonstration of extremely low manufacturing and equipment costs, improved module efficiencies and the ability for rapid manufacturing capacity expansion.

## Resources (\$)

Total Project	DOE Funds	Cost Share
<b>\$16,830,000</b>	<b>\$3,000,000</b>	<b>\$13,830,000</b>

## Annual Production (MW)

Baseline Production (2007)	<b>0.1 MW</b>
18 Month	<b>3 MW</b>
2010 Potential	<b>200 MW</b>

# Blue Square Energy: Silicon Solar Cells on Low Cost Substrates



## Technologies Addressed

Film Silicon on Wafer Silicon Substrate

## Target Market

Industrial, Commercial and Utility

## Description

Manufacturing of thin crystalline silicon solar cell by growing a high purity silicon layer onto a low cost metallurgical grade silicon substrate. This approach can produce the high performance and reliability of traditional solar cells with reduced material utilization and manufacturing costs.



## Resources (\$)

Total Project	DOE Funds	Cost Share
<b>\$4,520,000</b>	<b>\$2,990,000</b>	<b>\$1,530,000</b>

## Annual Production (MW)

Baseline Production (2007)	<b>0 MW</b>
18 Month	<b>5 MW</b>
2010 Potential	<b>70 MW</b>

# CaliSolar: Manufacturing High Efficiency Cells Using Upgraded Metallurgical Grade Silicon



## Technologies Addressed

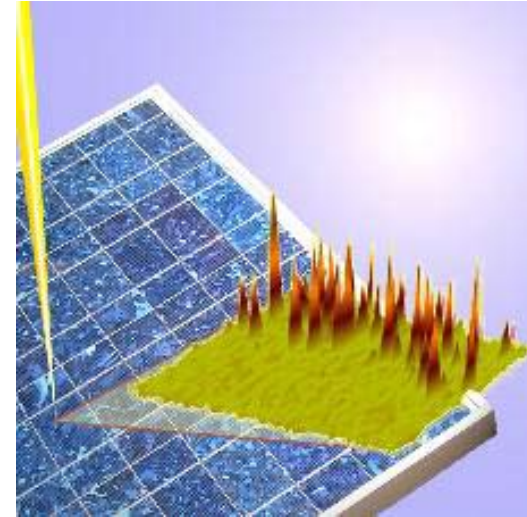
**Crystalline Silicon**

## Target Market

**Residential / Commercial**

## Description

Production of cost-effective solar cells from low-cost, abundant, but impurity-rich Si feedstock materials. The focus will be on a novel and adapted metallization method specifically suitable for the use of metallurgical Si to manufacture solar cells with over 17% efficiency using multi-crystalline Si within the next 18 months.



## Resources (\$)

Total Project	DOE Funds	Cost Share
<b>\$11,300,000</b>	<b>\$3,000,000</b>	<b>\$8,300,000</b>

## Annual Production (MW)

Baseline Production (2007)	<b>0 MW</b>
18 Month	<b>6 MW</b>
2010 Potential	<b>200 MW</b>

# EnFocus: Pilot Manufacturing of Rooftop-Ready Solar Panels Using High Concentration Photovoltaics



## Technologies Addressed

High Concentration PV

## Target Market

Residential and Commercial Rooftops

## Description

A lightweight, low profile, high concentration PV module which is fully encapsulated and protected from wind, hail, dust and moisture. This module will utilize high efficiency multi-junction cells to generate higher power outputs in area constrained applications such as rooftops.



## Resources (\$)

Total Project	DOE Funds	Cost Share
<b>\$3,920,000</b>	<b>\$2,900,000</b>	<b>\$1,020,000</b>

## Annual Production (MW)

Baseline Production (2007)	<b>0 MW</b>
18 Month	<b>3 MW</b>
2010 Potential	<b>10 MW</b>

# MicroLink Devices: Development of Lower Cost, High-Efficiency, Solar Cells For Concentrating Applications



## Technologies Addressed

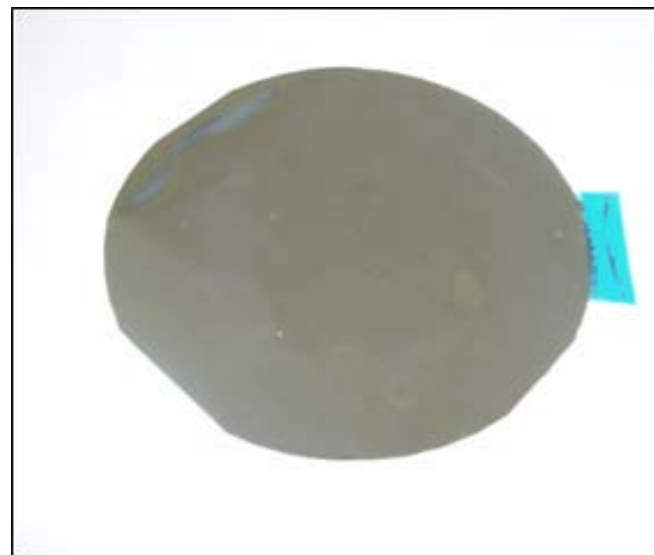
High Concentration PV (Cell)

## Target Market

Utility and Commercial concentrating systems.

## Description

MicroLink Devices will develop a low-cost, high efficiency dual-junction GaAs-based solar cell for use in 500x concentrator systems. The developed solar cell maximizes GaAs material usage while improving heat dissipation with a potential to reduce cost by 50%.



## Resources (\$)

Total Project	DOE Funds	Cost Share
<b>\$3,000,000</b>	<b>\$2,400,000</b>	<b>\$600,000</b>

## Annual Production (MW)

Baseline Production (2007)	<b>1 MW</b>
18 Month	<b>25 MW</b>
2010 Potential	<b>125 MW</b>

# Plextronics: Economic On-Grid Solar Energy via Organic Thin Film Technology



## Technologies Addressed

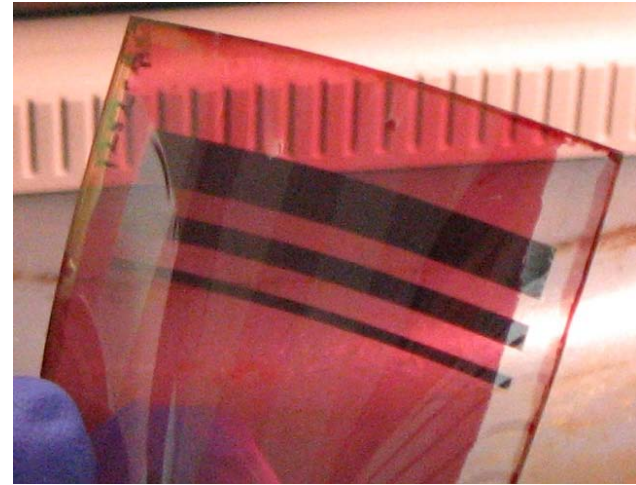
Next Generation PV - Organics

## Target Market

Industrial and Commercial

## Description

Commercialization of Thin-Film Organic Photovoltaic (OPV) Technology. Plextronics will develop higher efficiency cells while increasing module lifetime design to enable this ultra low cost material to compete with traditional PV technology.



## Resources (\$)

Total Project	DOE Funds	Cost Share
<b>\$3,750,000</b>	<b>\$3,000,000</b>	<b>\$750,000</b>

## Annual Production (MW)

Baseline Production (2007)	<b>0 MW</b>
18 Month	-
2010 Potential	<b>3 MW</b>

# PrimeStar Solar: Production Scale-Up of World Record CdTe/CdS Cell



## Technologies Addressed

CdTe Thin Film



## Target Market

Utility and Commercial

## Description

Develop commercial CdTe module production based on the NREL 16.5% world record CdTe laboratory solar cell technology. The increased module energy conversion efficiency will lower installation costs and open new markets for CdTe based thin film modules.

## Resources (\$)

Total Project	DOE Funds	Cost Share
<b>\$11,610,000</b>	<b>\$2,980,000</b>	<b>\$8,630,000</b>

## Annual Production (MW)

Baseline Production (2007)	<b>0 MW</b>
18 Month	<b>3 MW</b>
2010 Potential	<b>50 MW</b>



# Solaria Corporation: Simplified, Low Cost, 2x Concentration Flat Plate Module



## Technologies Addressed

**Low Concentration PV**

## Target Market

**Commercial and Utility (Rooftop or Ground Mounted)**

## Description

Solaria Corp. is solving the economics of solar power through cell and module innovations. Based on an extensive IP portfolio, Solaria's reliable PV-multiplying process yields two to three highly efficient cells from one, via solar cell singulation and optical amplification to create cost effective modules. Solaria's DOE project aims to produce a non-tracking standard module form factor with 2-3X concentration manufactured in a reliable high volume automated process.

**SOLARIA**



## Resources (\$)

Total Project	DOE Funds	Cost Share
<b>\$4,620,000</b>	<b>\$2,600,000</b>	<b>\$2,020,000</b>

## Annual Production (MW)

Baseline Production (2007)	<b>0 MW</b>
18 Month	<b>3 MW</b>
2010 Potential	<b>50 MW</b>



# SolFocus: Reflective Concentrating PV Panels Enabling Large-Scale, Reliable Energy Generation



## Technologies Addressed

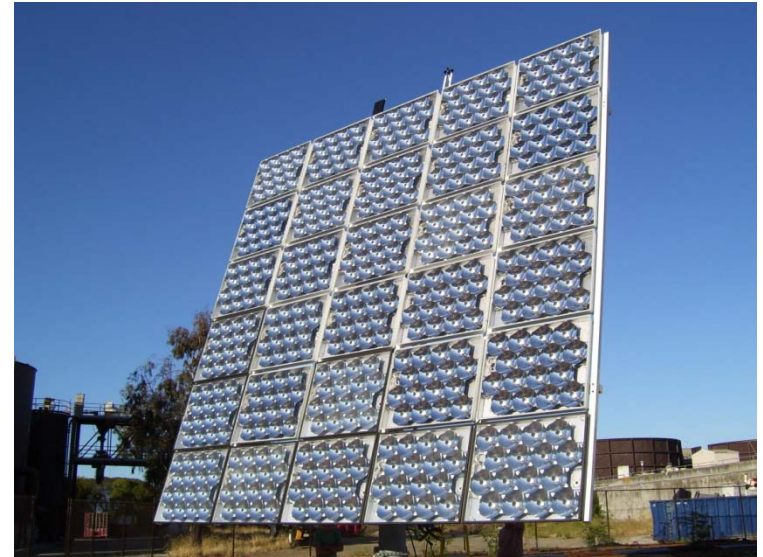
High Concentrating PV

## Target Market

Industrial, Commercial and Utility

## Description

500x concentrating PV module emphasizing high reliability and high efficiency to enable large-scale commercial and utility market penetration. A folded reflective design allows for a high optical efficiency and acceptance angle in a compact frame.



## Resources (\$)

Total Project	DOE Funds	Cost Share
<b>\$4,280,000</b>	<b>\$2,000,000</b>	<b>\$2,280,000</b>

## Annual Production (MW)

Baseline Production (2007)	<b>0 MW</b>
18 Month	<b>10 MW</b>
2010 Potential	<b>400 MW</b>

# SoloPower: CIGS Technology Based on Electroplating



## Technologies Addressed

**Flexible CIGS Thin Film**

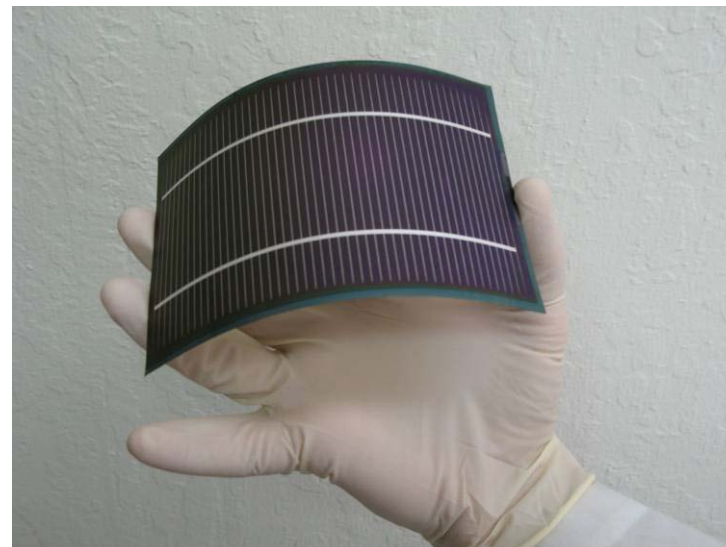
## Target Market

**Commercial**

## Description

Development of an electroplating-based, high-efficiency, low-cost CIGS cell and module manufacturing technology.

Advantages of this deposition technique include lower equipment costs, reduced processing times and increased material utilization.



## Resources (\$)

Total Project	DOE Funds	Cost Share
<b>\$29,300,000</b>	<b>\$2,370,000</b>	<b>\$26,930,000</b>

## Annual Production (MW)

Baseline Production (2007)	<b>0.1 MW</b>
18 Month	<b>20 MW</b>
2010 Potential	<b>120 MW</b>