
Overview of Technology Pathway Partnerships Projects



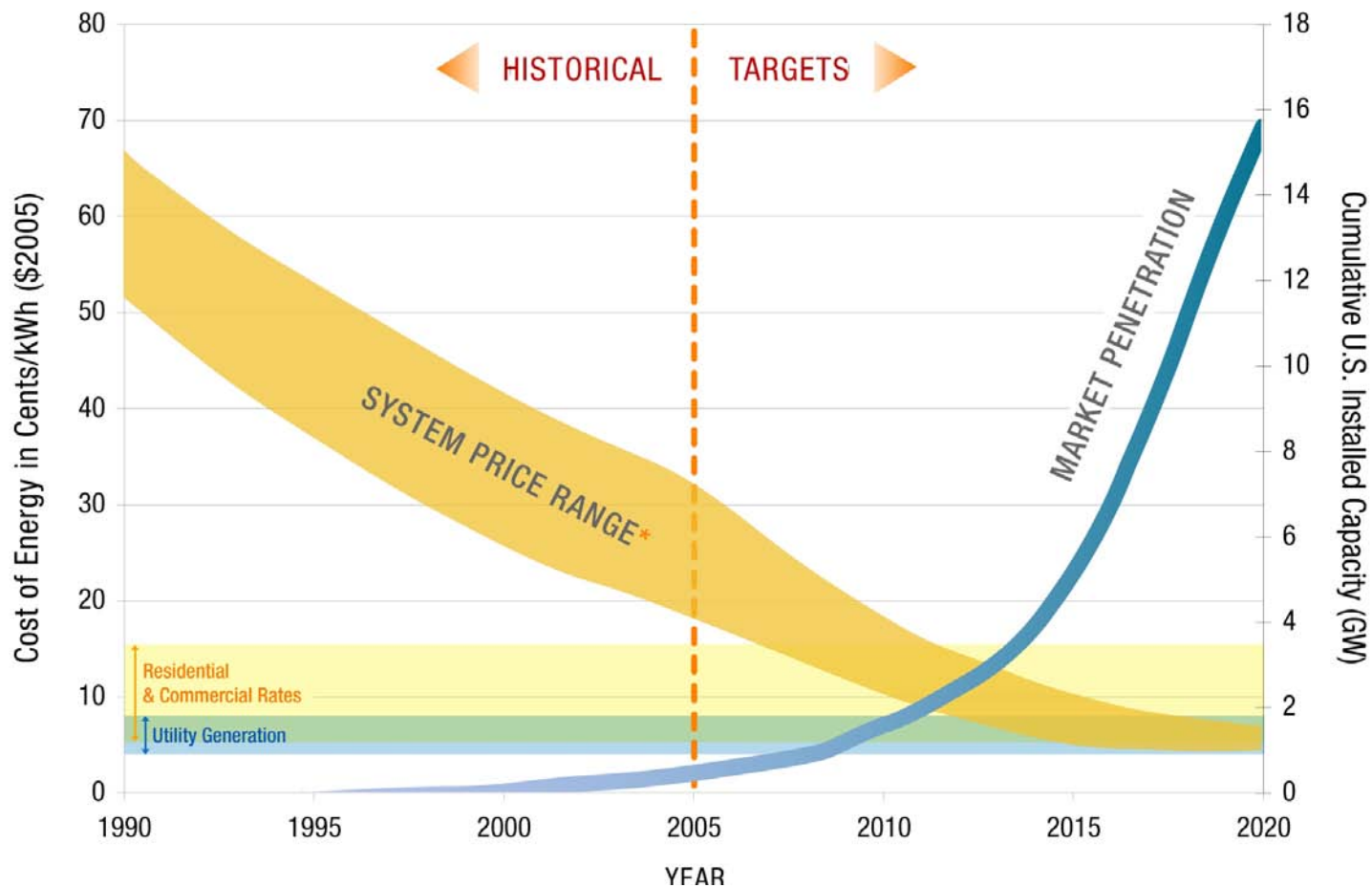
DOE Solar Energy Technologies Program

March 8-9, 2007

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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

Technology Pathway Partnership Objectives

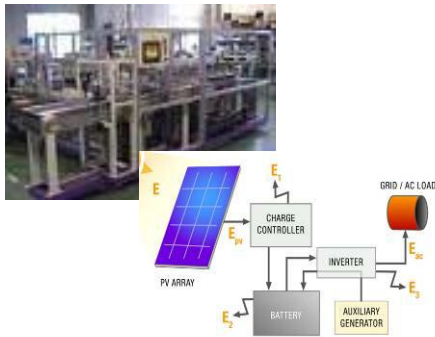


Bring Better Products to Market, Enable New Applications

- Develop modular, turnkey PV systems that provide residential and commercial customers with a complete solution and attractive value proposition (e.g. enabling BIPV and zero-energy homes).
- Develop designs and supply chains for large-field PV installations to service large commercial and utility RPS generating requirements.
- Help U.S. companies to leapfrog global competition, by providing the best designed, lowest-cost solutions for the applications above.

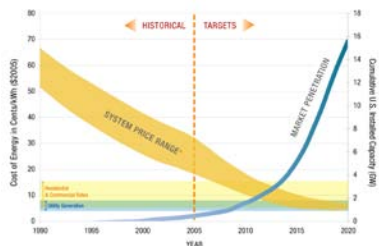
Foster Development of the Domestic PV Industry

- Catalyze collaboration across the value chain to: (1) squeeze out costs; (2) better optimize PV system design; and (3) assure superior performance/reliability.
- Demonstrate novel manufacturing processes that provide U.S. industry with a cost advantage, and that facilitate manufacturing scale-up.



Impact the U.S. Energy Economy With Results

- Accelerate development of U.S.-produced PV systems so that PV-produced electricity reaches parity with the cost of electricity in grid-tied markets across the nation by 2015.
- Expand domestic installed PV generating capacity to 5-10 GW.



Technology Pathway Partnerships

Project Research & Development Approach



TECHNICAL IMPROVEMENT OPPORTUNITIES		METRICS			
TEIR 1 TIOs	TEIR 2 TIOs	Performance	Cost	O&M	Reliability
Modules	Module				
	Absorber				
	Cells and Contacts				
	Interconnects				
	Packaging				
	Manufacturing				
Inverters & BOS	Inverter				
	Inverter Software				
	Inverter Components/Design				
	Inverter Packaging/Manufacturing				
	Inverter Integration				
	Other BOB				
Storage	<i>(Under Consideration)</i>				
SE&I	Systems Engineering & Integration				
	Manufacturing/Assembly				
	Installation/Maintenance				

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

- Teams will target selected components for R&D, based on analysis of impact on total system performance.
- Teams demonstrate new manufacturing approaches for selected components.
- Teams deliver full system for test, built from newly-developed and/or commercial components.

Technology Pathway Partnerships (TPP's)

Details of Selected Projects



Projects will have a significant impact on the domestic energy economy:

- Enable expansion of the annual U.S. production capacity of PV systems from 240 MW in 2005 to as much as 2,850 MW by 2010, representing a 10-fold increase.
- Research toward lowering the cost of electricity from PV to \$0.05 - \$0.10 per kWh by 2015 – a price that is competitive in markets nationwide. [Range given because of various applications (i.e., residential, commercial, utility)]

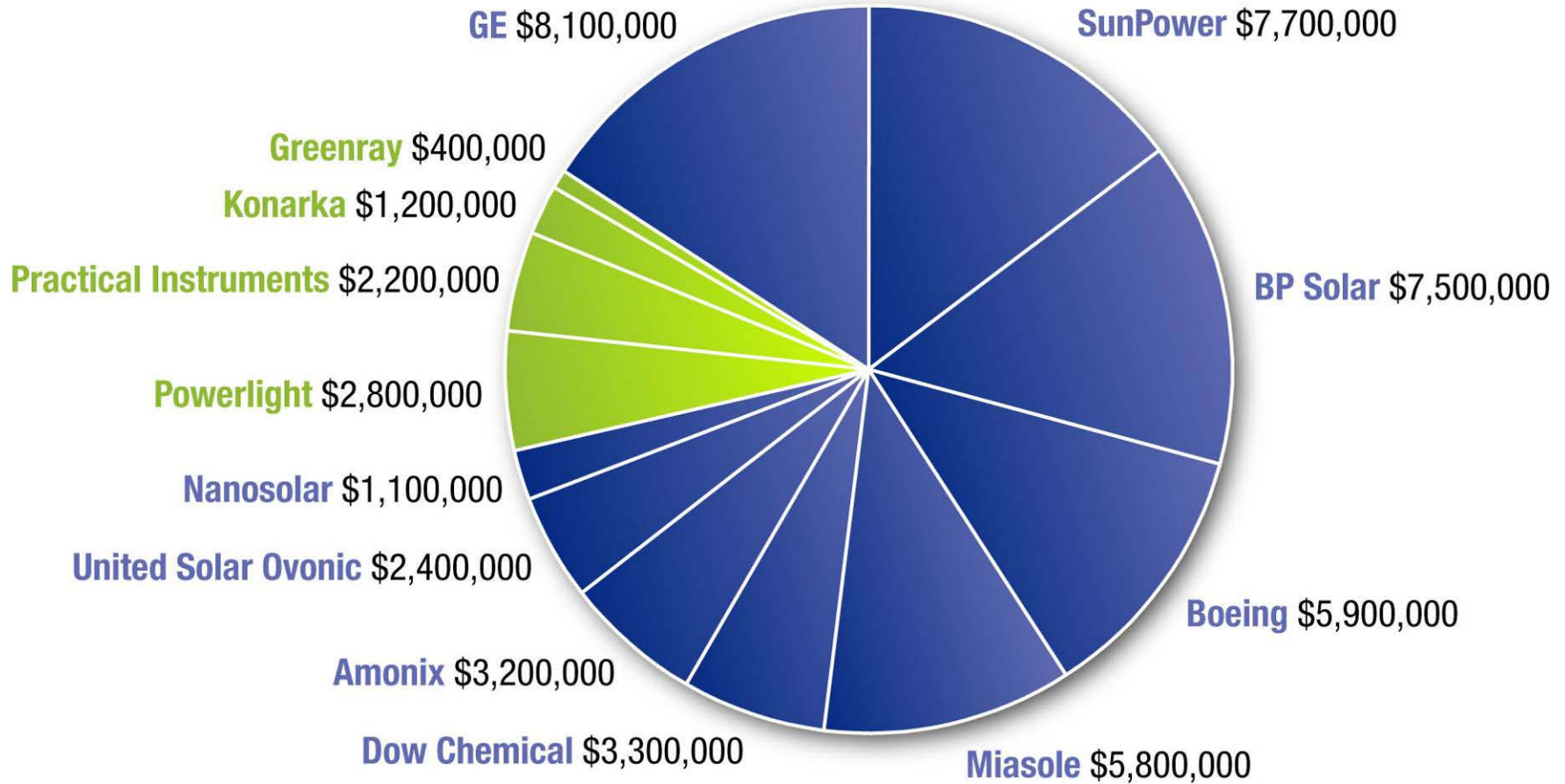
Projects will include a broad cross-section of U.S. industry:

- Involving over 50 companies, 14 universities, 3 non-profits and 2 national laboratories in 20 states across the U.S. (subject to change)
- Teams will contribute well over 50% of the funding for these projects.

Selected projects will be lead by the following corporations:

- Amonix (Los Angeles, CA)
- BP Solar (Frederick, MD)
- Boeing (Los Angeles, CA)
- Dow Chemical (Midland, MI)
- General Electric (Newark, DE)
- Miasole (Santa Clara, CA)
- Nanosolar (Palo Alto, CA)
- Sunpower (San Jose, CA)
- Powerlight (Berkeley, CA)
- United Solar Ovonic (Detroit, MI)
- Konarka (Boston, MA)
- GreenRay (Boston, MA)
- Practical Instruments (Pasadena, CA)

TPP Project DOE Funding Breakdown: Year One

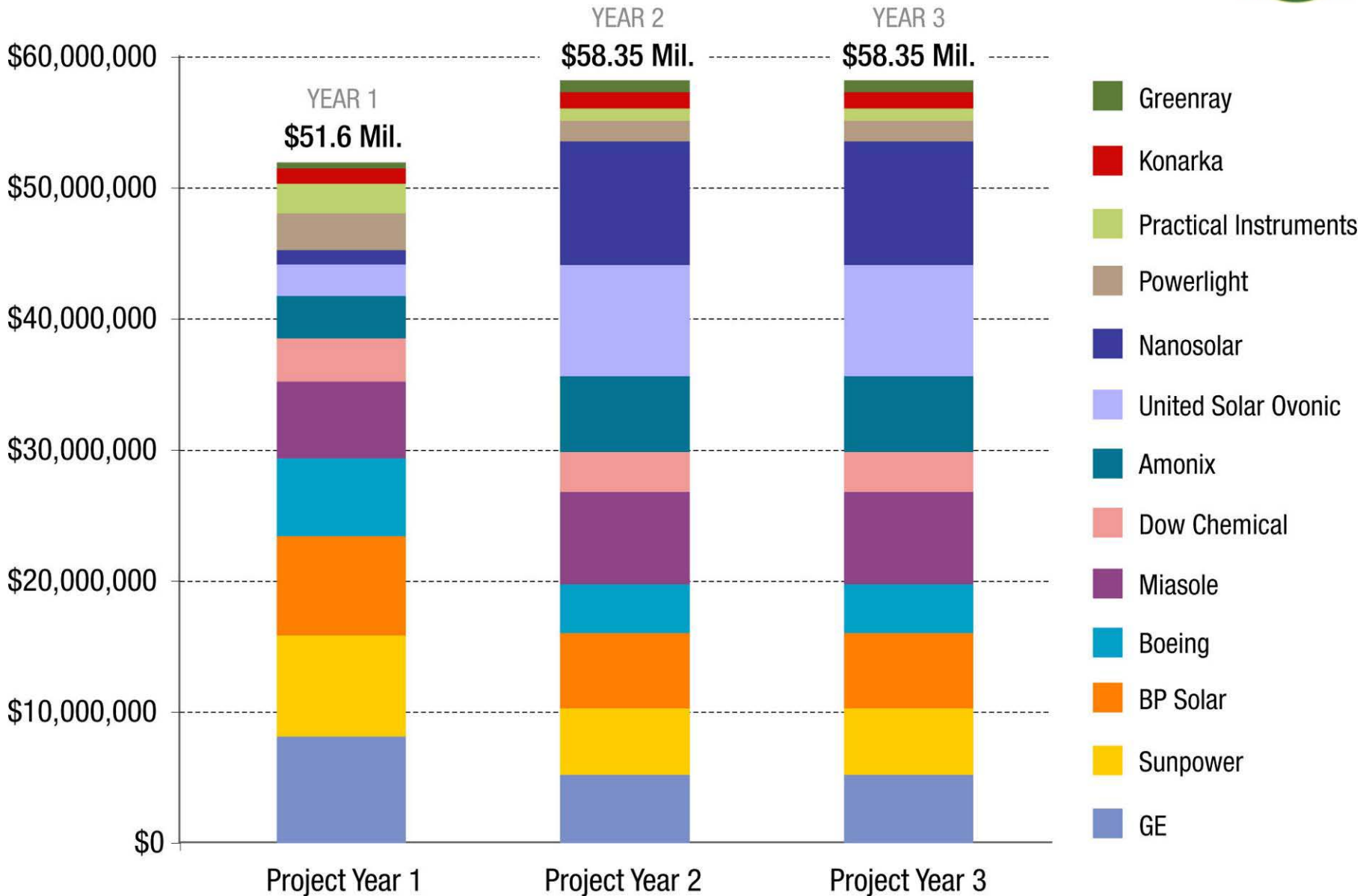


Subsystems Total:
\$6,600,000

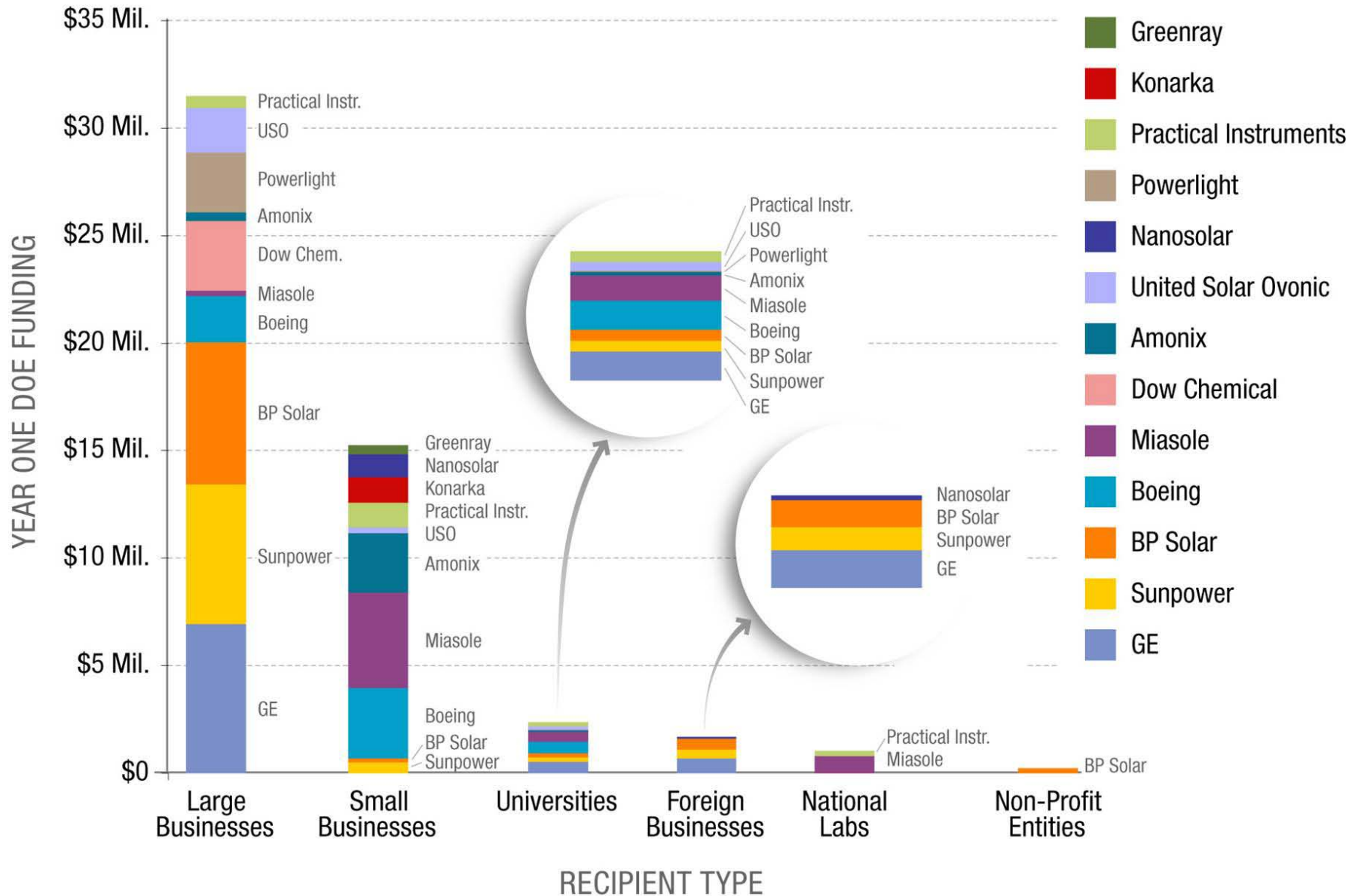
Total Funding:
\$51,600,000

Systems Total:
\$45,000,000

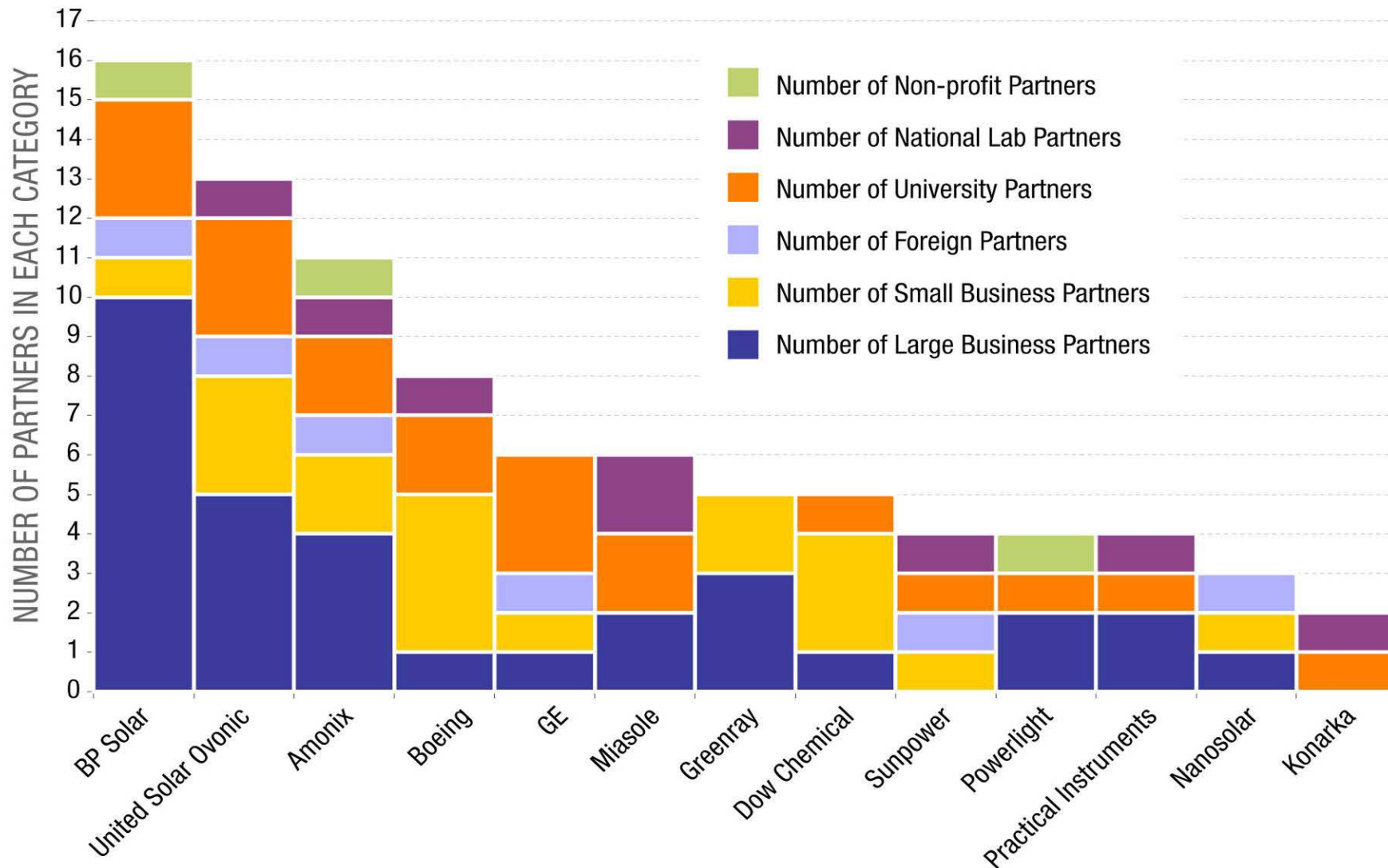
TPP Project DOE Funding Breakdown: 3-Year Totals



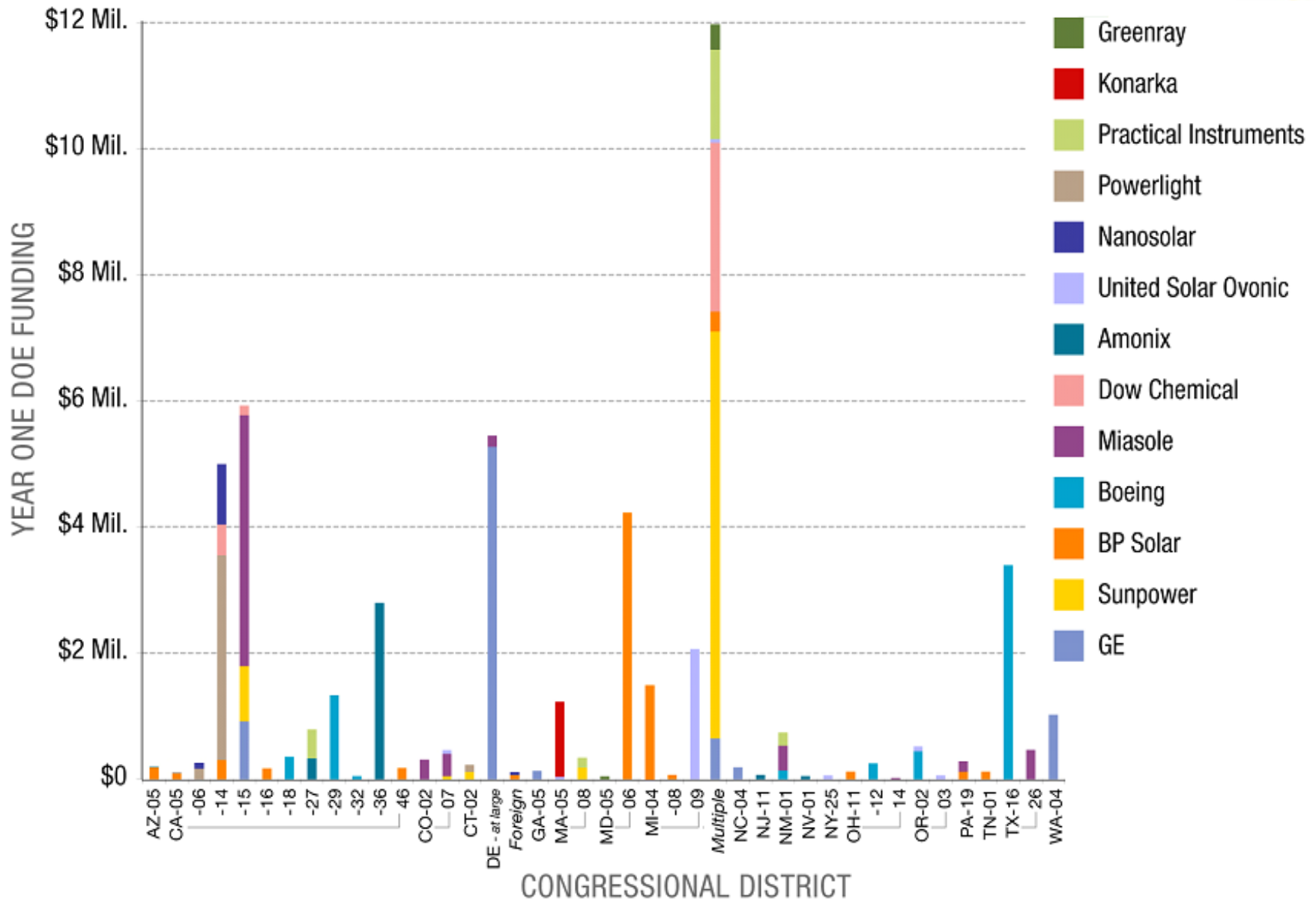
DOE's Funding Will Invest Across the U.S. R&D Base



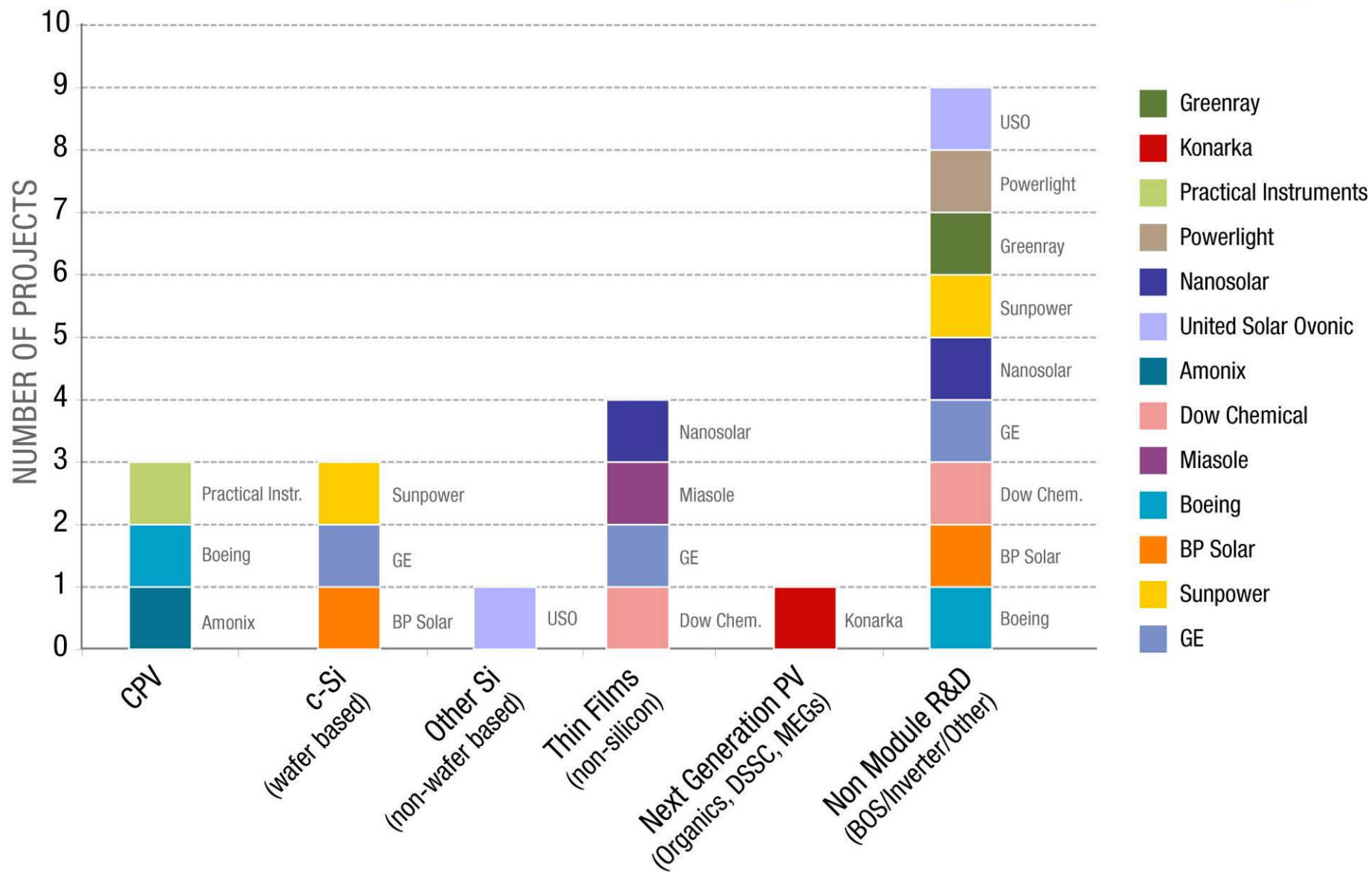
DOE's Funding Promotes Diverse Partnerships



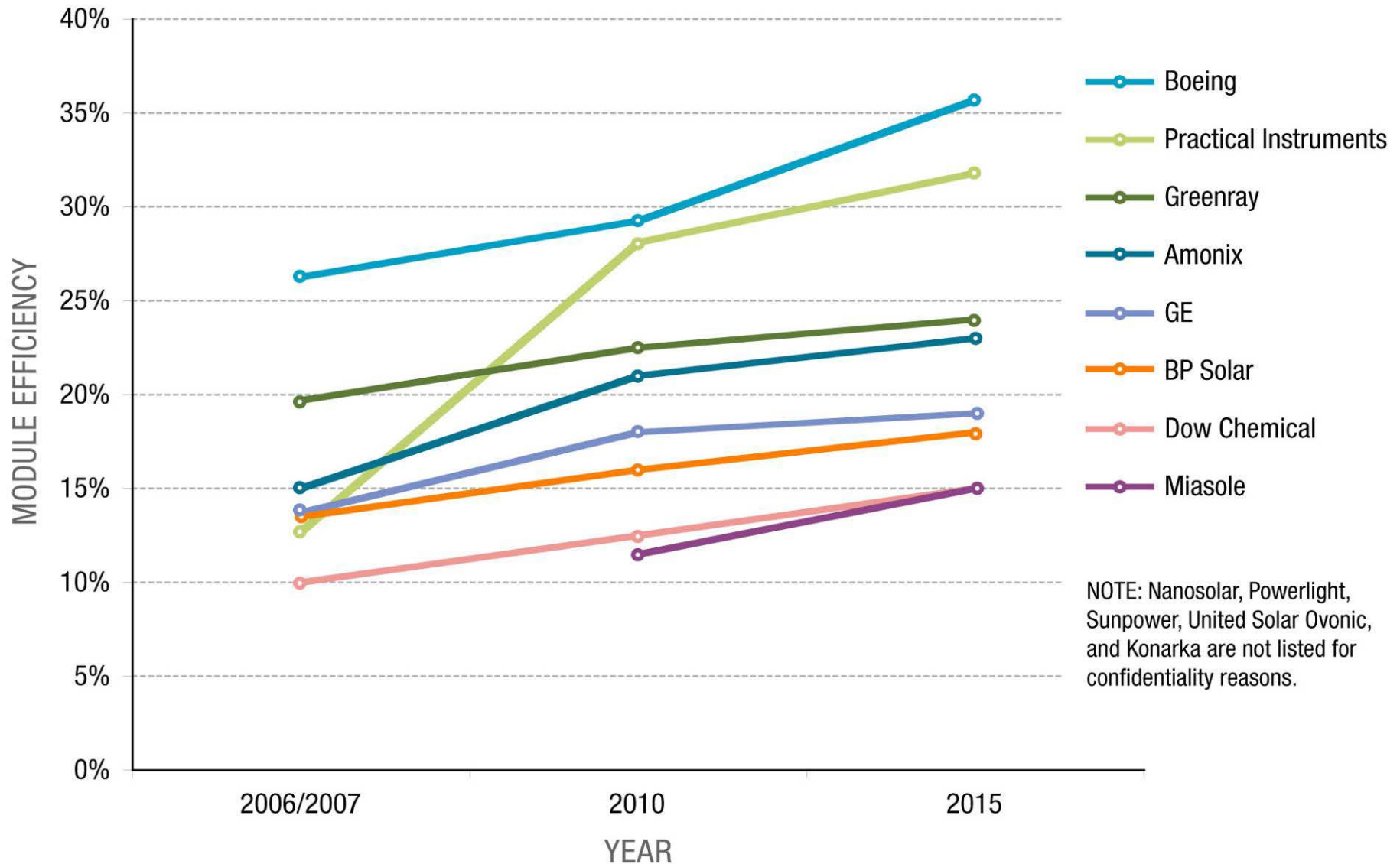
DOE-Funded R&D Will Take Place Across the U.S.



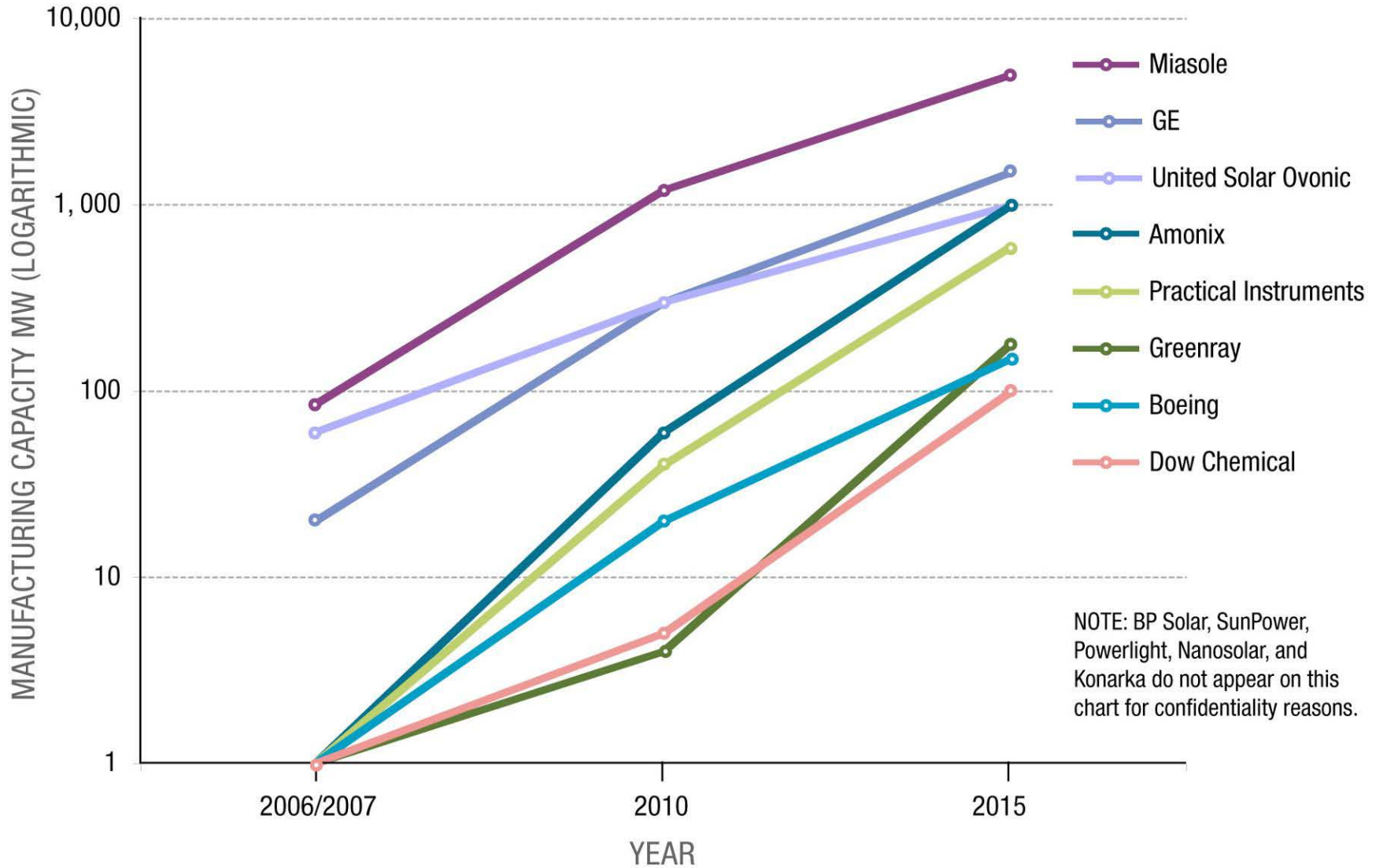
DOE's Portfolio Balances Technology, Maturity & Risk



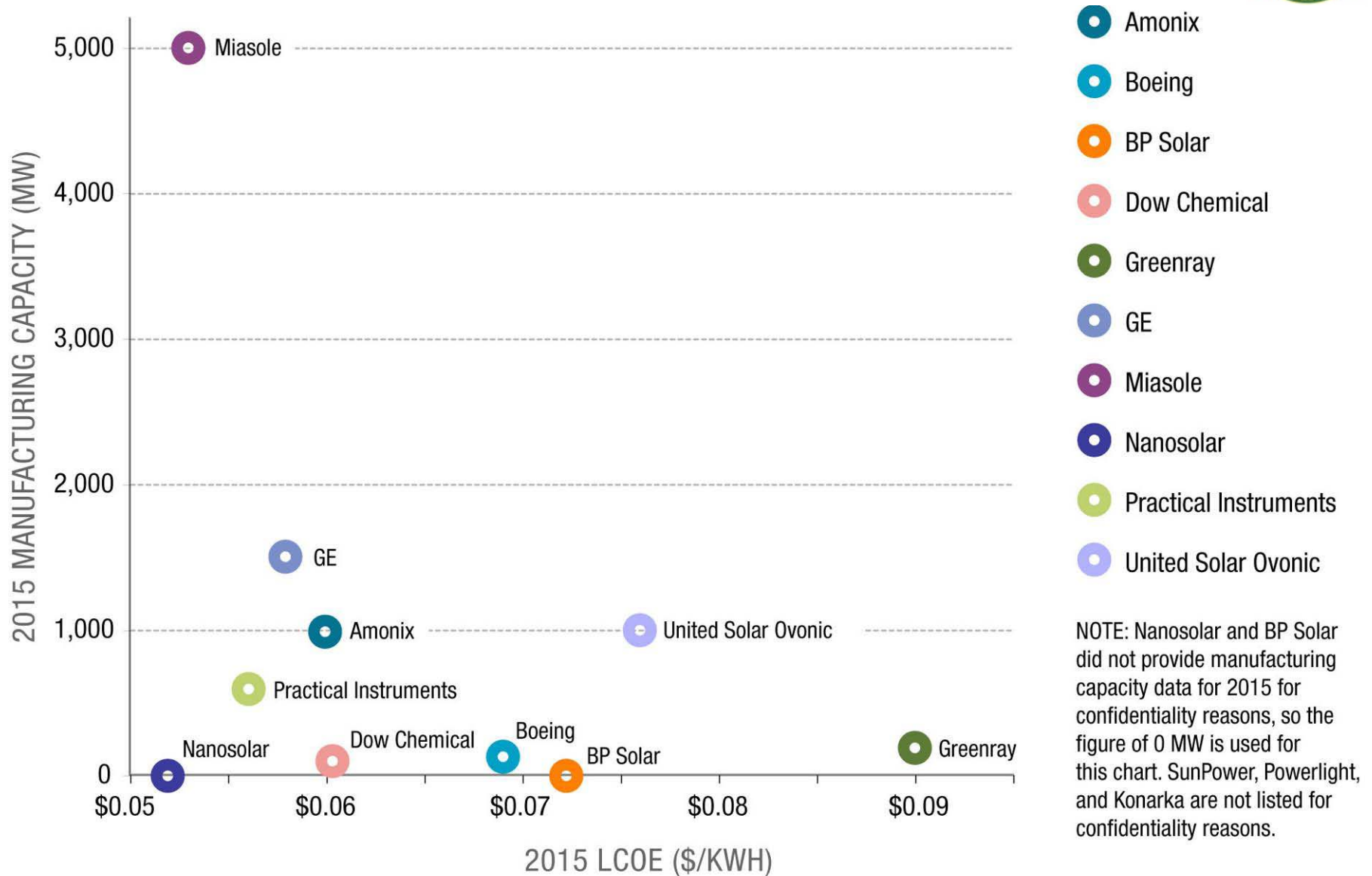
DOE-Funded R&D Will Increase Module Efficiency, Yielding Greater Power Without Increased Costs



DOE-Funded R&D Enables Scale-able Manufacturing Processes That Will Be Implemented by Industry



DOE's R&D Funding Will Deliver Products at Prices and Volumes Needed by Markets Nationwide



Technology Pathway Partnerships



GREENRAY, INC.



System Project

Low Cost High Concentration PV Systems for Utility Power Generation (Amonix)



Technologies Addressed

Concentrating PV

Description

A low-cost, high-concentration PV system for utility markets. This project will utilize our real-world, utility field-tested concentrator system and incorporate the most advanced solar cell technology (> 40 % efficiency) to produce the lowest cost of PV-generated electricity.



Key Metrics

	LCOE (\$/kWh)	Manufacturing Capacity (MW)
Baseline (2006)	\$0.3300	1
2009-2010	\$0.1400	60
2014-2015	\$0.0600	1000

Resources (\$)

DOE Total	DOE Yr. 1	Cost Share (total)
\$14,800,000	\$3,200,000	\$14,800,000

Participants

Lead

Torrance, CA

CYRO Industries / Rockaway, NJ
 Arizona State University / Tempe, AZ
 UNLV / Las Vegas, NV
 Xantrex / Burnaby, British Columbia
 Imperial Irrigation District / Imperial, CA
 Hernandez Electric / Imperial, CA
 NREL / Golden, CO
 Northstar / Gardena, CA
 SpectroLab / Sylmar, CA
 Micrel / San Jose, CA
 JOL Enterprises / Yuma, AZ

System Project

High Efficiency Concentrating Photovoltaic Power System (Boeing)



Technologies Addressed

Concentrating PV
Non-Module R&D

Description

High-efficiency concentrating photovoltaic power system. The Boeing TPP will develop a concentrating PV power system targeted at utility-scale markets drawing on Spectrolab multi-junction solar cell technology and advanced high concentration non-imaging optics.



Key Metrics

	LCOE (\$/kWh)	Manufacturing Capacity (MW)
Baseline (2006)	\$0.3181	1
2009-2010	\$0.1494	20
2014-2015	\$0.069	150

Resources (\$)

DOE Total	DOE Yr. 1	Cost Share (total)
\$13,300,000	\$5,900,000	\$16,500,000

Participants

Lead

Huntington Beach, CA

Light Prescription Innovators / Altadena, CA
University of California / Merced, CA
PV Powered / Bend, OR
Array Technologies Inc. / Albuquerque, NM
James Gregory Associates/Sylarus / Columbus, OH
Southern California Edison / Rosemead, CA
NREL / Golden, CO
Caltech / Pasadena, CA

System Project

Grid Parity using BP Solar C-Si Technology (A Systems Class Application) (BP Solar International)



Technologies Addressed

**Crystalline Silicon (Wafer-based)
Non-Module R&D**

Description

Low-cost approach to grid parity using crystalline silicon. This project will cover all aspects of the PV product chain from raw materials through installation of the systems. Key aspects are development of solar grade silicon feedstock, implementation of Mono2™ casting, optimized thin cell processing and modules designed for integration into roofs.

Key Metrics

	LCOE (\$/kWh)	Manufacturing Capacity (MW)
Baseline (2006)	\$0.1690	---
2009-2010	\$0.1076	---
2014-2015	\$0.0722	---



Resources (\$)

DOE Total	DOE Yr. 1	Cost Share (total)
\$19,100,000	\$7,500,000	\$20,000,000

Participants

Lead		
Frederick, MD	Specialized Tech. Resources / Enfield, CT	Fat Spaniel / San Jose, CA
	Komax / York, PA	Sacramento Municipal Utility District / Sacramento, CA
	Palo Alto Research Center / Palo Alto CA	Recticel / Clarkston, MI
	AFG Industries / Kingsport, TN	Georgia Tech / Atlanta, GA
	ATS-Ohio / Lewis Center, OH	U of Central Florida / Orlando, FL
	Xantrex / Burnaby, British Columbia	AZ State / Tempe, AZ
	Dow Corning / Midland, MI	
	Ceradyne / Costa Mesa, CA	
	Bekaert / Rome, GA	
	Ferro / Cleveland, OH	

System Project

Fully Integrated Building Science Solutions for Residential & Commercial Photovoltaic Energy Generation (Dow Chemical Company)

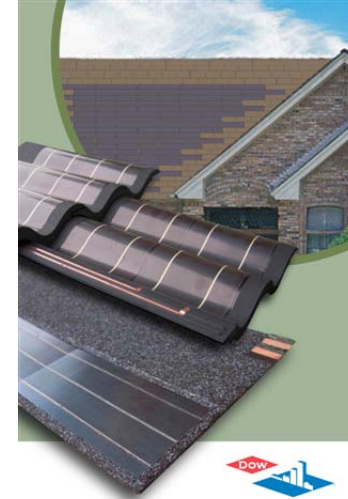


Technologies Addressed

Thin Films (Non-Si-Based)
Integrated Solar System Design

Description

PV-integrated residential and commercial building solutions. This project will employ the team's expertise to explore improvements in PV technology, component design, packaging, integration, and installation to achieve major cost reductions for producing electricity in a building integrated, grid connected system.



Key Metrics

	LCOE (\$/kWh)	Manufacturing Capacity (MW)
Baseline (2006)	\$0.1973	0
2009-2010	\$0.1122	5
2014-2015	\$0.0603	100

Resources (\$)

DOE Total	DOE Yr. 1	Cost Share (total)
\$9,400,000	\$3,300,000	\$9,600,000

Participants

Lead	Miasole / Santa Clara, CA SolFocus / Palo Alto, CA
Midland, MI	Fronius / Brighton, MI University of Delaware / Newark, DE IBIS Associates / Waltham, MA

System Project

A Value Chain Partnership to Accelerate U.S. PV Growth (GE Energy LLC)



Technologies Addressed

Crystalline Silicon (Wafer-based)
Thin Films – (Non-Si-Based)
Non-Module R&D

Description

GE will collaborate with a team of industrial partners to develop various solar technologies, simplifying the integration of PV systems into residential and commercial buildings. This program will help foster solar energy industry growth, resulting in reduced greenhouse gas emissions and favorable economics.



Key Metrics

	LCOE (\$/kWh)	Manufacturing Capacity (MW)
Baseline (2006)	\$0.1900	20
2009-2010	\$0.0890	300
2014-2015	\$0.0580	1500

Resources (\$)

DOE Total	DOE Yr. 1	Cost Share (total)
\$18,600,000	\$8,100,000	\$24,900,000

Participants

Lead

Newark, DE

REC / Moses Lake, WA
Xantrex / Burnaby, BC
Solaicx / Santa Clara, CA
Georgia Tech Research Corp / Atlanta, GA
North Carolina State University / Raleigh, NC
University of Delaware / Newark, DE

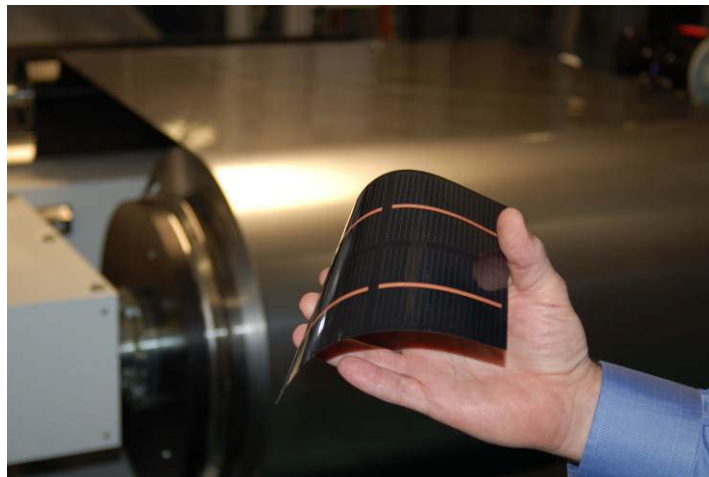


Technologies Addressed

**Thin Films (Non-Si-Based)
Non-Module R&D**

Description

In order to meet the DOE's goals for SAI, Miasolé is focused on driving significant cost reductions throughout the value chain. Specifically, Miasolé will focus on the following programs: roll to roll thin film solar cell manufacturing, roll to roll flexible module manufacturing, integration of module electronics, simplification of installation procedures and increased distribution efficiency.



Key Metrics

	LCOE (\$/kWh)	Manufacturing Capacity (MW)
Baseline (2006)	\$0.1900	85
2009-2010	\$0.0670	1200
2014-2015	\$0.0530	5000

Resources (\$)

DOE Total	DOE Yr. 1	Cost Share (total)
\$20,000,000	\$5,800,000	\$26,700,000

Participants

Lead	
Santa Clara, CA	Exeltech / Fort Worth, TX Carlisle-Syntec / Carlisle, PA University of Colorado / Boulder, CO University of Delaware / Newark, DE Sandia National Labs / Albuquerque, NM NREL / Golden, CO

System Project

Delivering Grid-Parity Solar Electricity on Flat Commercial Rooftops (Nanosolar, Inc.)



Technologies Addressed

Thin Films (Non-Si-Based)

Description

Grid-parity PV system for large-area, flat commercial rooftops. This project will work on cost-efficient components and system integration for commercial buildings with large-area, flat rooftops based on ultra-low-cost thin-film CIGS PV cells.



Key Metrics

	LCOE (\$/kWh)	Manufacturing Capacity (MW)
Baseline (2006)	\$0.0730	---
2009-2010	\$0.0600	---
2014-2015	\$0.0520	---

Resources (\$)

DOE Total	DOE Yr. 1	Cost Share (total)
\$20,000,000	\$1,100,000	\$20,000,000

Participants

Lead Palo Alto, CA	Conergy AG / Hamburg, Germany SunTechnics, Inc. / Sacramento, CA SunLink, LLC/ Larkspur, CA
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System Project

Grid-Competitive Residential and Utility Solar Power Generating Systems (SunPower Corporation)



Technologies Addressed

**Crystalline Silicon (Wafer-based)
Non-Module R&D**

Description

Grid-competitive residential solar power generating systems utilizing industry-leading modules already in production. This project will research lower-cost ingot and wafer fabrication, automated manufacture of back-contact cells, and new module designs, to lower costs while improving the aesthetics of residential PV installation and will provide the marketplace with a more streamlined sales/installation process.



Key Metrics

	LCOE (\$/kWh)	Manufacturing Capacity (MW)
Baseline (2006)	---	---
2009-2010	---	---
2014-2015	---	---

Resources (\$)

DOE Total	DOE Yr. 1	Cost Share (total)
\$17,900,000	\$7,700,000	\$18,200,000

Participants

Lead San Jose, CA	Solaicx / Santa Clara, CA MIT / Cambridge, MA NREL / Golden, CO Xantrex / Burnaby, British Columbia Other Partners
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System Project

Low Cost Thin Film Building-Integrated PV Systems (United Solar Ovonic)



Technologies Addressed

Other Si (Non-Wafer-Based)
Non-Module R&D

Description

Low-cost thin-film building-integrated PV systems. This project will focus on reducing the delivered cost of electricity by lowering the cost of multi-bandgap, flexible thin film PV modules, and by reducing system cost using innovative installation methods and by lowering the cost of balance-of-system components.



Key Metrics

	LCOE (\$/kWh)	Manufacturing Capacity (MW)
Baseline (2006)	\$0.1580	60
2009-2010	\$0.1280	300
2014-2015	\$0.0760	1000

Resources (\$)

DOE Total	DOE Yr. 1	Cost Share (total)
\$19,300,000	\$2,400,000	\$19,600,000

Participants

Lead

Auburn Hills, MI

SMA America / Grass Valley, CA
Sat Con Technology Corporation / Worcester, MA
PV Powered / Bend, OR
ABB Group / Zurich, Switzerland
Solectria Renewables / Lawrence, MA
Developing Energy Efficient Roof Systems / Ripon, CA
Turtle Energy / Linden, NJ
SunEdison / Baltimore, MD
University of Oregon / Portland, OR
Syracuse University / Syracuse, NY
Colorado School of Mines / Golden, CO
NREL / Golden, CO

Subsystem Project

Development of an AC Module System (GreenRay)



Technologies Addressed

Non-Module R&D

Description

Development of an AC module system. This team will design and develop a high-powered, ultra-high-efficiency AC module that contains an inverter, eliminating the need to install a separate inverter and facilitating installation by homeowners. Research will focus on increasing the lifetime of the inverter.



Key Metrics

	LCOE (\$/kWh)	Manufacturing Capacity (MW)
Baseline (2006)	\$0.34	1
2009-2010	\$0.18	4
2014-2015	\$0.09	180.25

Resources (\$)

DOE Total	DOE Yr. 1	Cost Share (total)
\$2,300,000	\$400,000	\$2,500,000

Participants

Lead	Sanyo Energy / Frisco, TX
Lincoln, MA	Tyco Electronics / Harrisburg, PA
	Coal Creek Design / Lafayette, CO
	BluePoint Associates / San Luis Obispo, CA
	National Grid / Westborough, MA

Subsystem Project

BIPV Dye Cell/Organics PV (Konarka Technologies, Inc.)

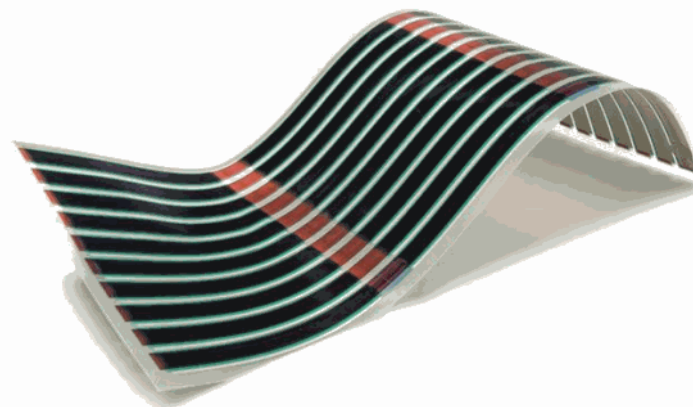


Technologies Addressed

Next Generation PV – Organics

Description

Building-integrated organic photovoltaics. This project will focus on manufacturing research and product reliability assurance for extremely low-cost photovoltaic cells using organic polymers that convert sunlight to electricity.



Key Metrics

	LCOE (\$/kWh)	Manufacturing Capacity (MW)
Baseline (2006)	---	---
2009-2010	---	---
2014-2015	<\$0.10	1,000-3,000

Resources (\$)

DOE Total	DOE Yr. 1	Cost Share (total)
\$3,600,000	\$1,200,000	\$5,200,000

Participants

Lead Lowell, MA	University of Delaware / Newark, DE NREL / Golden, CO
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Subsystem Project

Fully Automated Systems Technology: A Systems-Driven Approach to Cost Reduction (PowerLight)



Technologies Addressed

Non-Module R&D

Description

PV cell-independent effort to improve automated manufacturing systems. This project will focus on reducing non-cell costs through the design and manufacture of integrated PV products.

Deployment of these products will be facilitated by the development of automated system design tools.



Key Metrics

	LCOE (\$/kWh)	Manufacturing Capacity (MW)
Baseline (2006)	---	---
2009-2010	---	---
2014-2015	---	---

Resources (\$)

DOE Total	DOE Yr. 1	Cost Share (total)
\$6,000,000	\$2,800,000	\$6,300,000

Participants

Lead	Specialized Technology Resources, Inc. / Enfield, CT
Berkeley, CA	Autodesk / San Rafael, CA University partner Utility partner TBD, Location TBD Other Small Businesses or Consultants TBD / Location TBD

Subsystem Project

Concentrating Solar Panels: Bringing the Highest Power and Lowest Cost to the Rooftop (Practical Instruments)

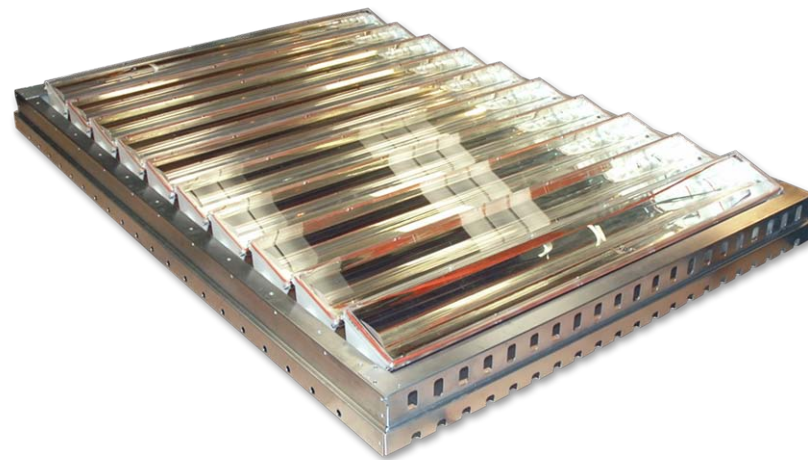


Technologies Addressed

Concentrating PV

Description

High-concentration CPV systems for commercial rooftop applications. This project will develop a combination of high-concentration optics and a practical approach to rooftop tracking to dramatically increase PV power density. The technology will be paired with high-efficiency multi-junction cells enabling exceptionally high power solar panels. The modules will have a flat panel configuration with fully integrated tracking for a conventional installation process.



Key Metrics

	LCOE (\$/kWh)	Manufacturing Capacity (MW)
Baseline (2006)	\$0.1470	1
2009-2010	\$0.0790	40
2014-2015	\$0.0560	600

Resources (\$)

DOE Total	DOE Yr. 1	Cost Share (total)
\$4,000,000	\$2,200,000	\$4,100,000

Participants

Lead

Pasadena, CA

SpectroLab / Sylmar, CA
Sandia National Labs / Albuquerque, NM
MIT / Cambridge, MA
SunEdison / Baltimore, MD