Solar Energy Technologies Program

DOE Solar Energy Technologies Program
Accelerating the U.S. Solar Industry

State and Regional Innovation Initiatives:
Partnering for Photovoltaic Manufacturing in the United States

Academies National Academy of Sciences
Washington, DC
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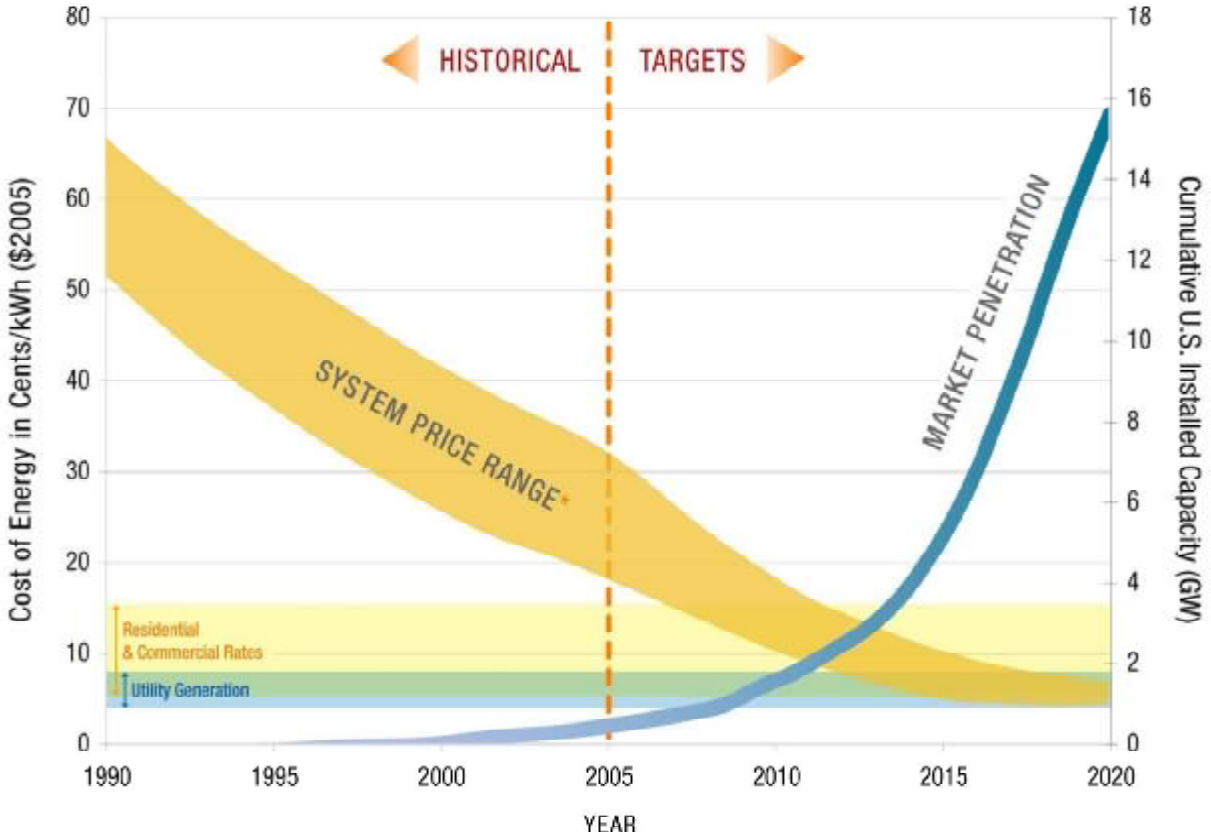
Acting Deputy Assistant Secretary
Energy Efficiency

Department of Energy
Office of Energy Efficiency and Renewable Energy

The SETP is focused on enabling high penetration of solar energy technologies and achieving grid parity by 2015 cost reduction goals



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

LCOE varies strongly with insolation, market, and financing

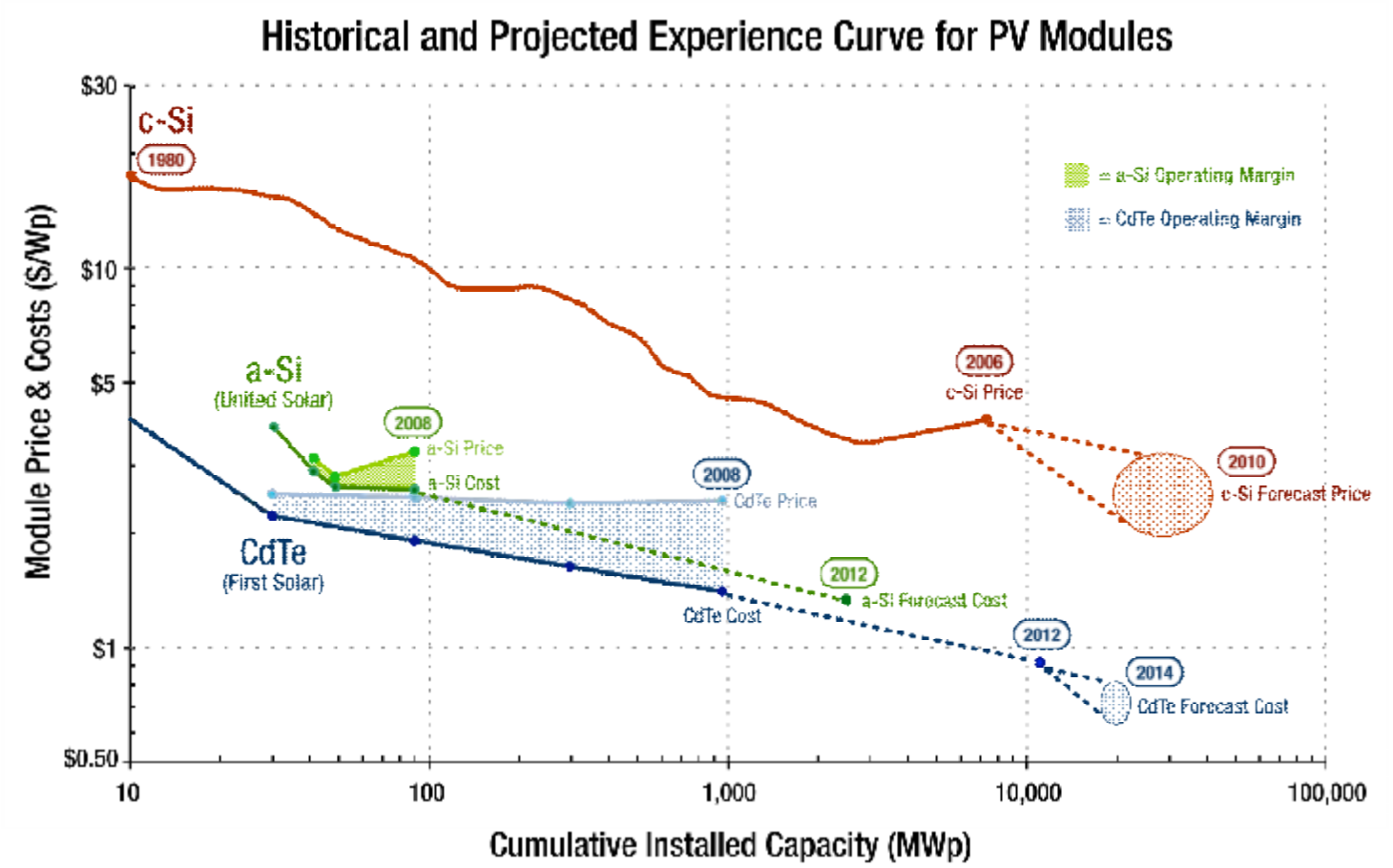
Almost 2x difference between Phoenix mortgage and Kansas HELOC (15 vrs 26¢/kWh)

Fortunately there exists strong product differentiation

DOE sees multiple technology pathways to meet grid parity by 2015

Aim is to allocate funds to maximize and accelerate penetration in a dynamic and differentiated market

PV costs have been dramatically reduced across different technologies



- Public data from SEC, analysts, etc. (already out-of-date in the case of c-Si prices)
- Fundamentals: resource and modularity
- Industry is fortunate to have this "balance" (compared to internal combust. engines, wind turbines, etc.)
- DOE has short and long term PV objectives

The mission of DOE's Solar Program is to accelerate the wide-spread adoption of solar electric technologies across the United States

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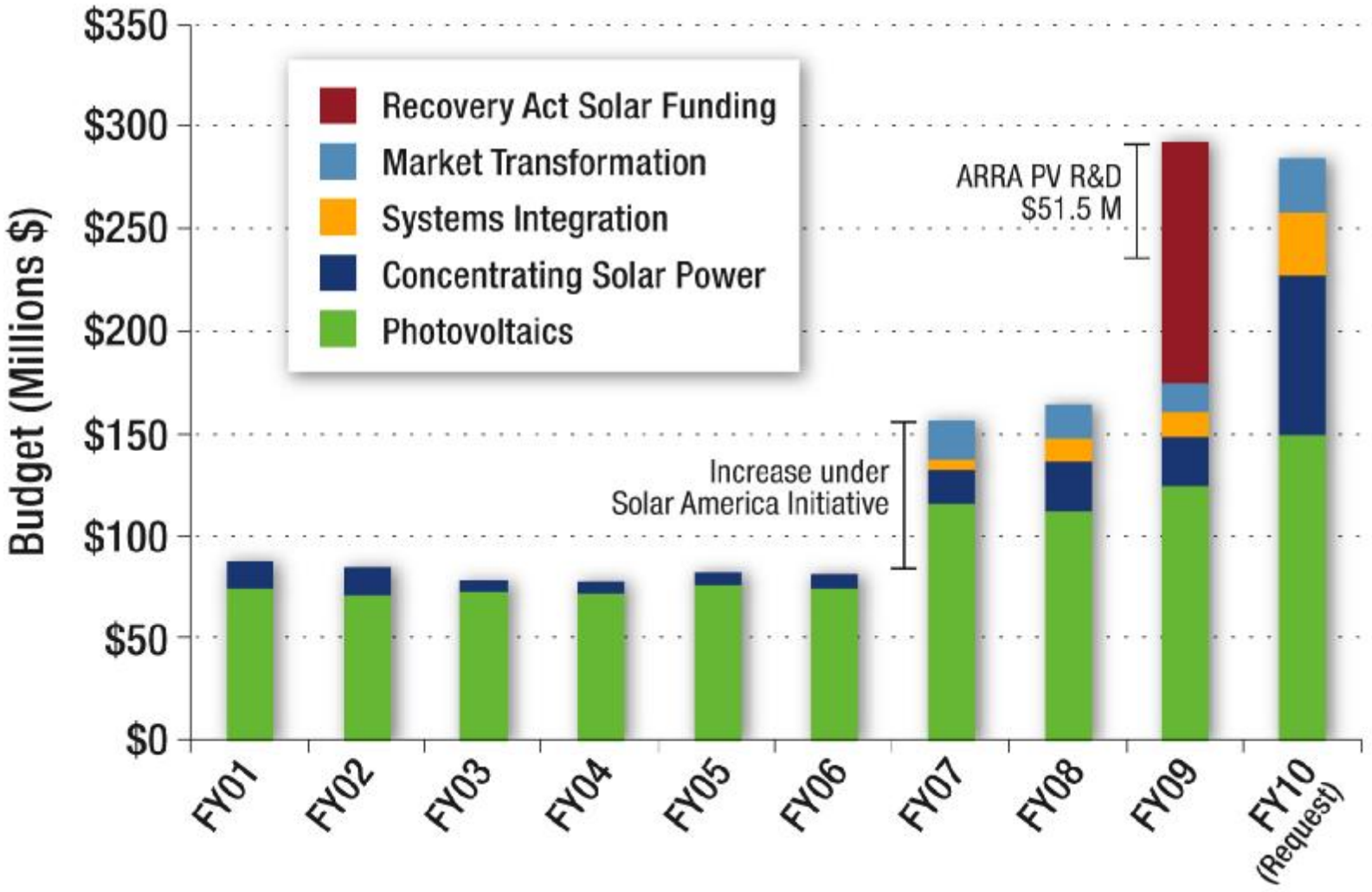
Increasing budgets have allowed SETP to respond with new and timely programs



FY09 Projected Solar Budget

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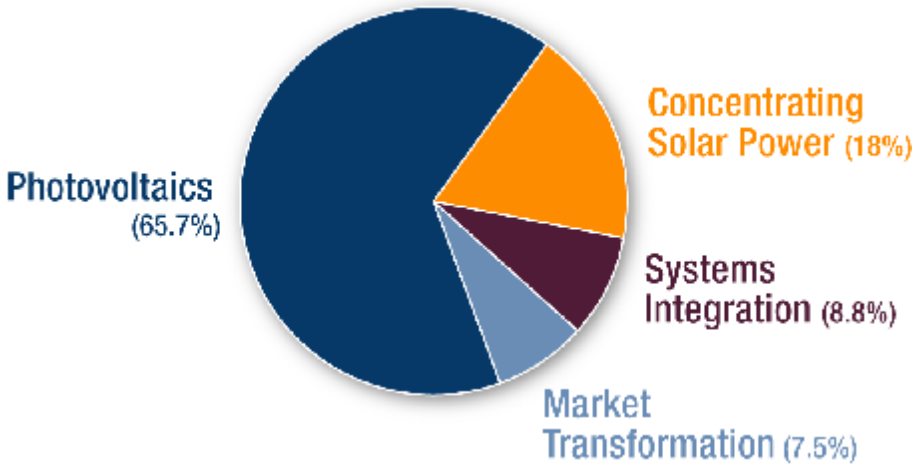
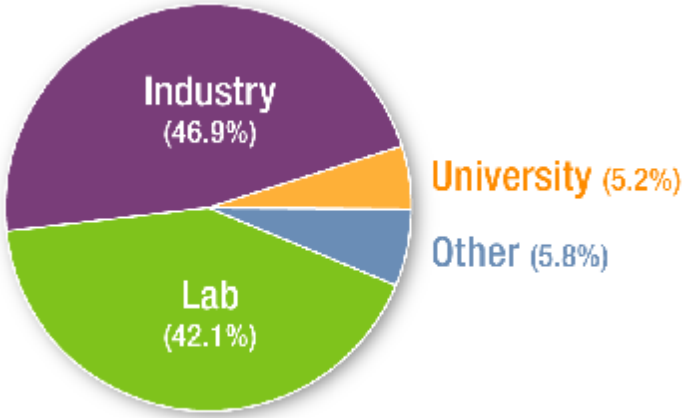
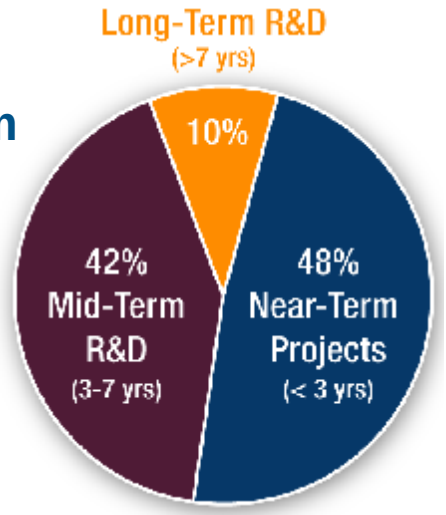
By Technology



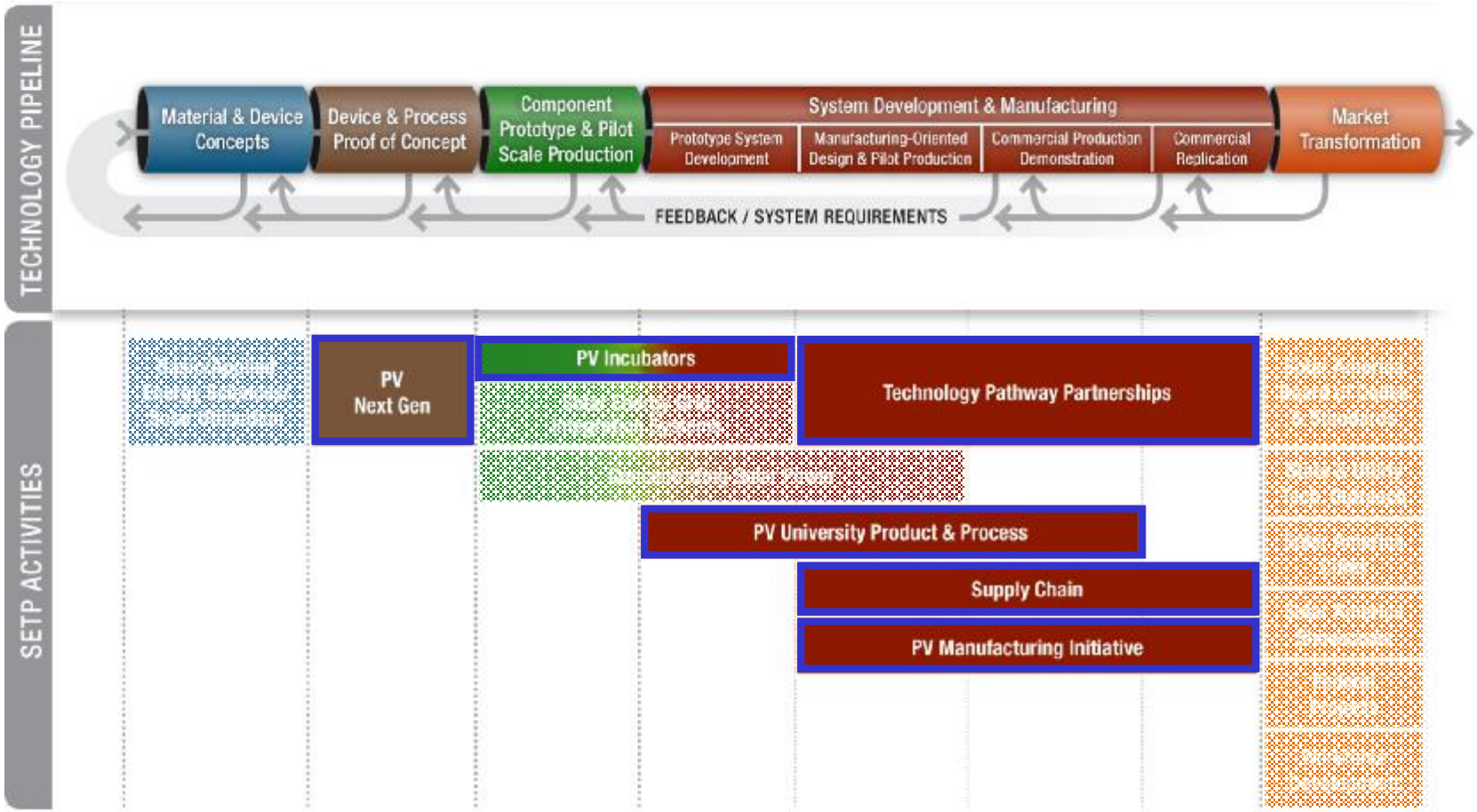
By Recipient



By Term



SETP's pipeline approach aims to balance near- and long-term research



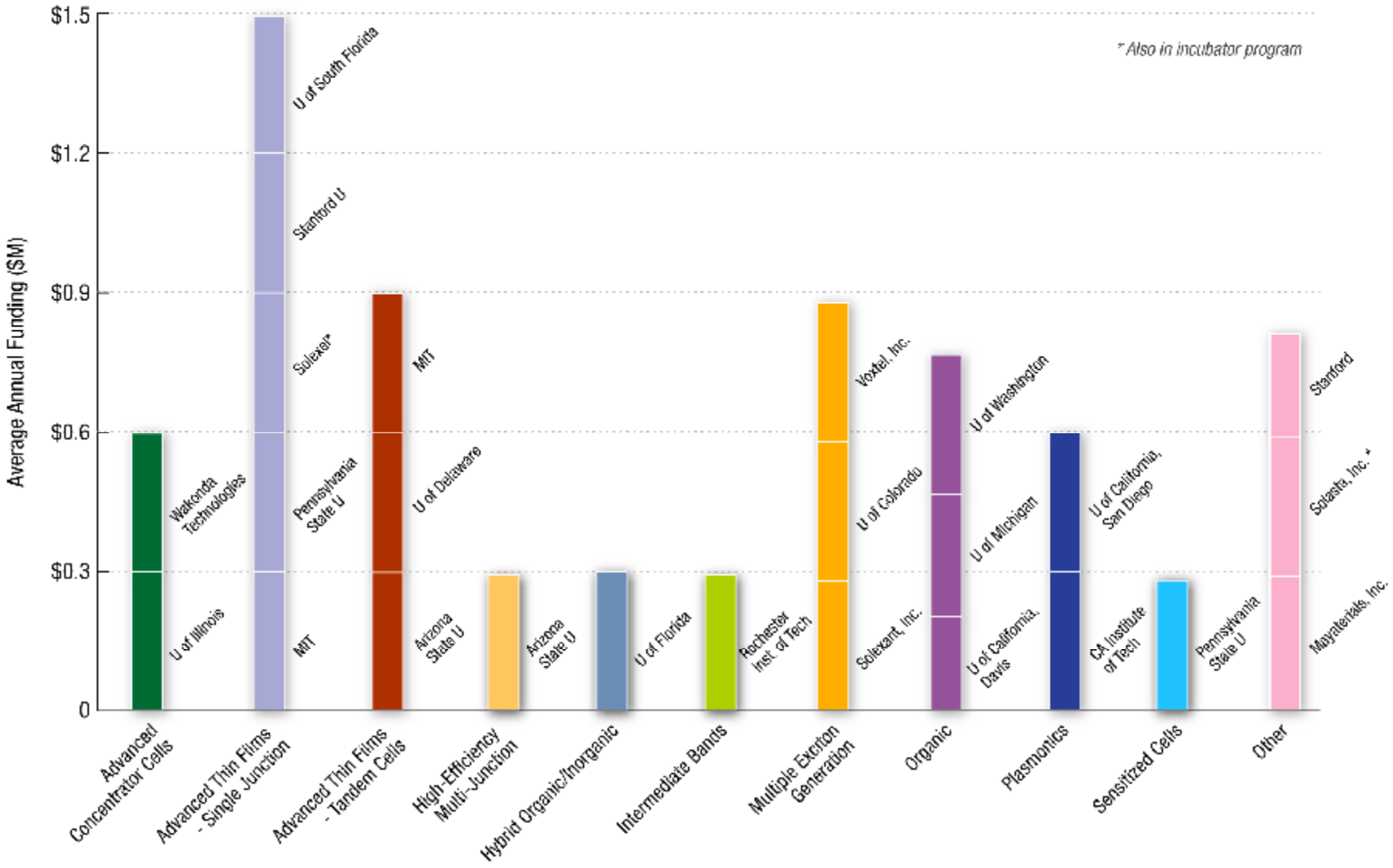
The lag between a funding idea and award announcements is often > 12 months. Dynamics in the commercial market forces DOE to anticipate industry needs, cycle funding opportunities, hold stage gate reviews, and be creative or opportunistic.

Other expanding programs (BES, ARPA-E, Loan Guarantee, etc) have allowed SETP to focus on its core role of technology incubation and transfer.

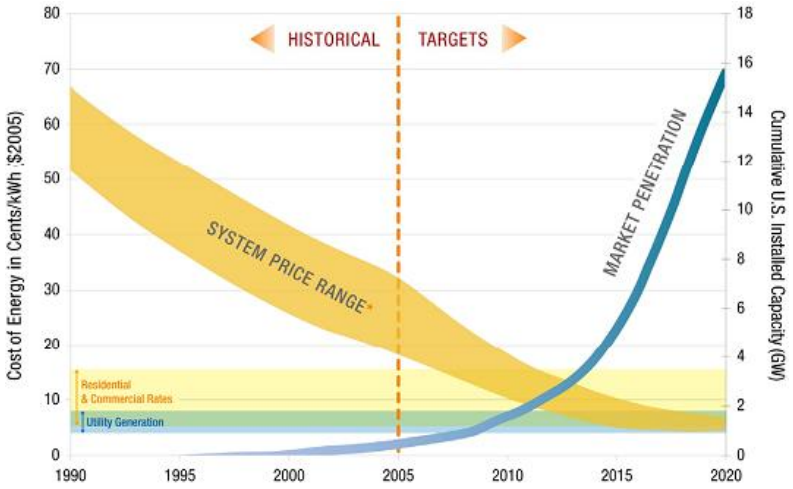
DOE Solar Program received $117.6M under ARRA for New Projects and New Funding Opportunities

- Supply Chain and Cross-cutting Technologies
  - $22 million for industry and university projects
  - Announced June 11, 2009
- Pre-Incubator Projects
  - $6.5 million in funding for 13 projects
  - Announced June 9, 2009
- PV Technology Incubators
  - $10 million in funding
  - Closing Date: July 13, 2009
- High Penetration Solar Deployment
  - $37.5 million
  - Closing Date: July 30, 2009
- Market Transformation (closing July 30, 2009)
  - Solar America Cities Special Projects
    - Funding Amount, up to $10 million
  - Solar Installer Instructor Training Network
    - Funding Amount, up to $27 million over five years

Next Gen program focuses on demonstrating advance device and process concepts

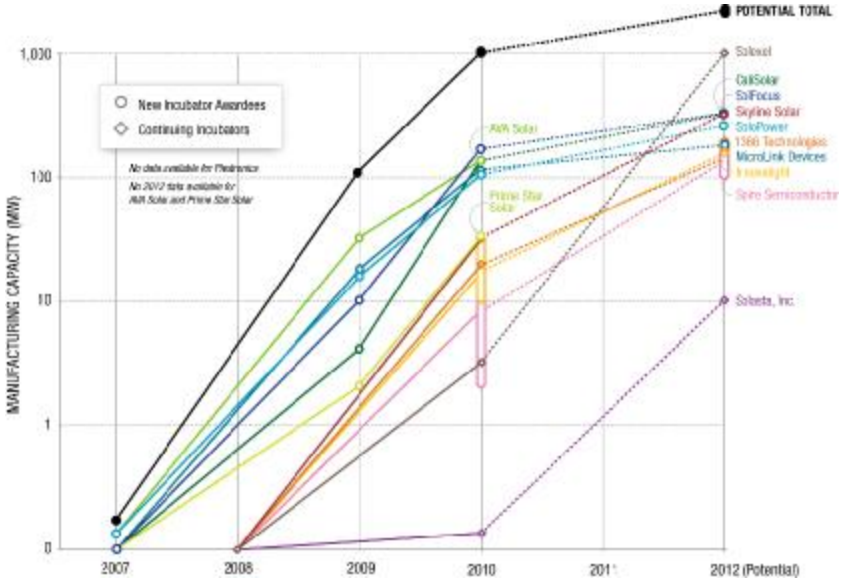


SETP's Industry Focused Programs



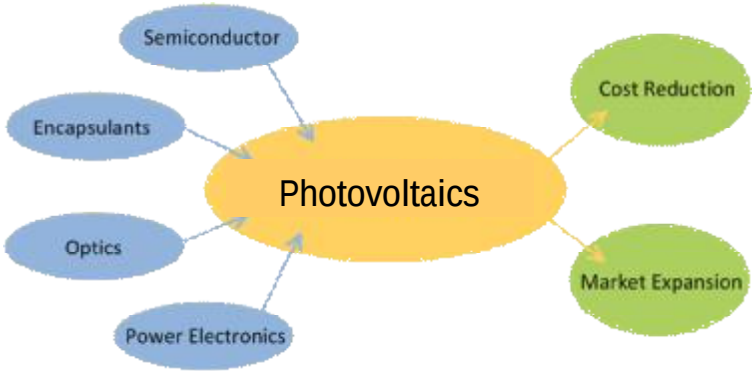
Technology Pathway Partnerships

Collaborative programs focused on LCOE reductions



PV Technology Incubators

quickly ramp new technologies into commercial production



Supply Chain and Cross-Cutting Technologies

develop and transfer high-impact near-term component and manufacturing technologies to the PV industry

The TPP Contracts were designed to drive industry to assess total PV System Life Cycle Costs

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	*(Under Consideration)*				
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.

Photovoltaic Technology Incubator Objectives

- Leverage NREL's device expertise to help small business scale to pilot production.
  - Mitigate technology risks associated with rapidly expanding manufacturing
- Foster innovation and growth in the domestic PV industry
  - Accelerate a diverse set of promising technologies which have been proven on a laboratory scale.
- Establish an efficient and cyclic funding opportunity
  - Annual funding opportunity is responsive to a dynamic industry.
  - Fixed firm pricing and stage gate review encourage companies to reach milestones ahead of schedule

Selected PV Technology Incubator Projects:

First Phase Projects (2008)

- 1366 Technologies
- Innovalight
- Skyline Solar
- Solexel
- Solasta
- Spire Semiconductor

Second Phase Projects (2007)

- AVA Solar
- CaliSolar
- MicroLink Devices
- Plextronics
- PrimeStar Solar
- SolFocus
- SoloPower

Supply Chain and Cross-Cutting Technologies Program

- Focus is on high impact technologies which provide cost reductions broadly application across the industry
- Projects leverage significant expertise from related fields to develop and optimize technologies for PV
- Program emphasizes near term technologies which can be inserted into current manufacturing processes to accelerate progress towards grid parity.

Module Components

- Flexible Barriers
- TCOs
- Optical Films / Coatings

Non-Module Components

- Integrated System Design
- Module-level Power Management

Manufacturing

- Kezrfless c-Si wafering
- High Rate Deposition
- Advanced coatings
- Materials reuse

Supply Chain Awardees (partial list):

Large R&D Projects (~$1M/yr)

- 3M – Flexible polymeric film
- Air Products – High rate silanes
- DuPont – Flexible Ultra-Barrier Film
- GE – Module power controllers
- GE – Down-shifting glass coating
- Sierra Solar – High rate epi tool
- Silicon Genesis – Wafer cleaving

Feasibility Studies (1 year, ~$150k)

Optical:

- Photonic Glass Corp
- Fraunhofer USA
- SiOnyx Inc.

Advanced Deposition / Device Design

- Texas Engineering
- University of Houston
- Advanced Cooling

Electrical

- University of Texas (Arlington)
- Palo Alto Research Center

Metrology

- Accustrata Inc.
- University of Missouri

Module/System Design

- Solar Red

NREL and SNL provide a strong base for solar development partnerships with industry

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Over 200 scientists and engineers with deep understanding of all solar technologies

Areas of expertise

- Crystalline silicon and thin-film PV
- Flat-plate and concentrator PV
- Process development and engineering
- System development and testing
- Measurement and characterization
- Reliability engineering
- Next-generation PV technologies
- CSP components and testing
- Grid integration and power electronics
- Policy, market, and financial analysis

Collaboration Types

- Cooperative R&D Agreements (CRADA)
- Work-for-Others
- Technical Service Agreements
- Technology Licensing

The NREL PDIL accelerates the transition from development to scale-up

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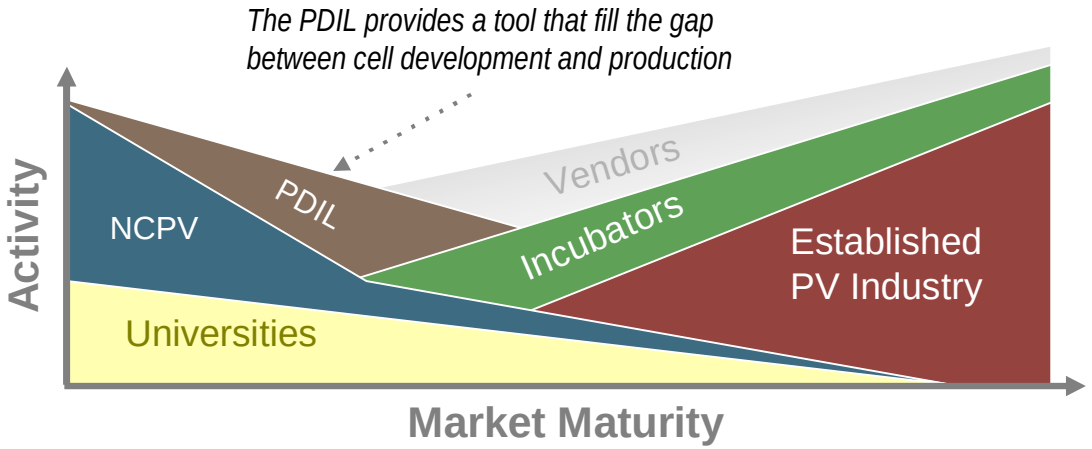
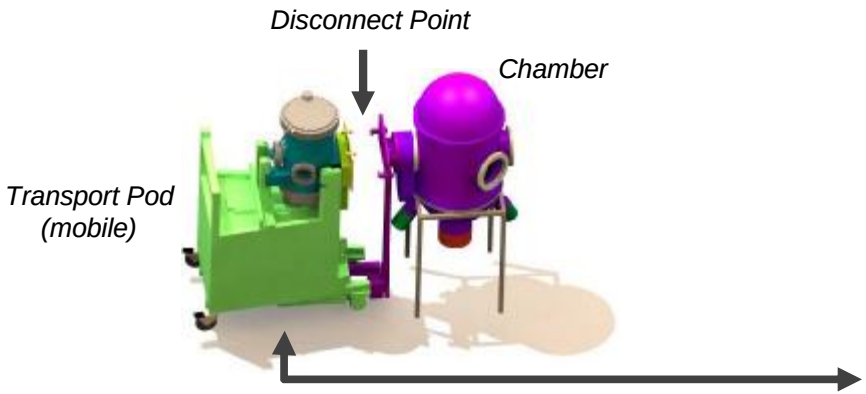
PDIL provides

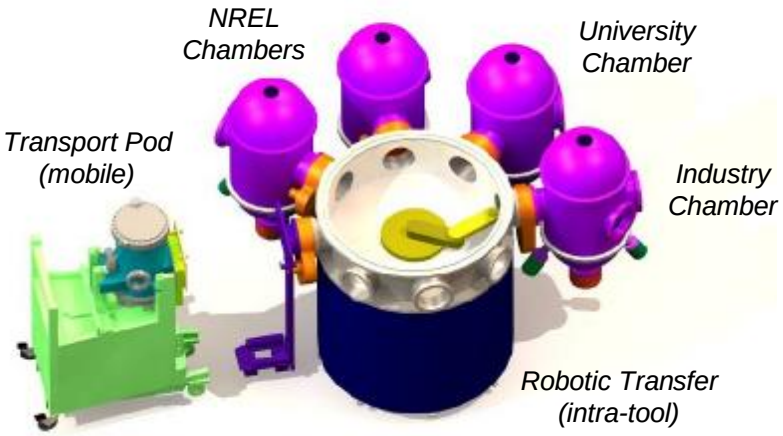
- commercially viable sample size (6”)
- integrated, flexible equipment
- controlled ambient between steps
- automated data systems
- accelerated throughput
- Tools for a-Si, tf-Si, CIGS, CdTe, and TCO’s and multiple M&C techniques



Stand-Alone Tools



Integrated Tools: Robotic Transfer



For more information see http://www.nrel.gov/pv/pdil.html

The U.S. is rich in PV technology innovation

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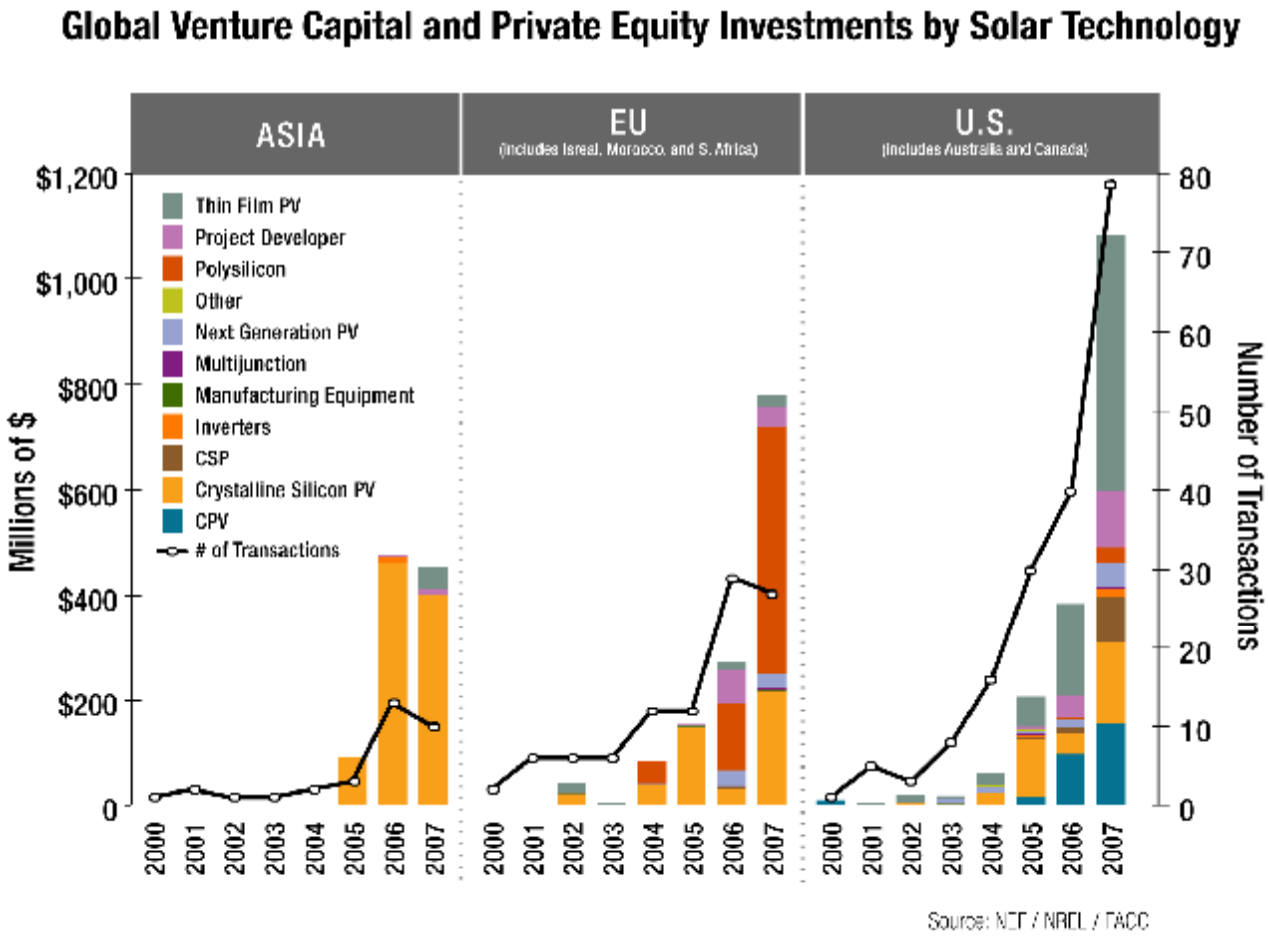
The US is the most diversified in solar technologies receiving VC and PE financing, with substantial investment in thin film PV, as well as CPV and CSP

- **In Europe**, most of the funding has been to polysilicon and c-Si PV companies
- **In Asia**, almost all investment has gone to c-Si PV



Thank You

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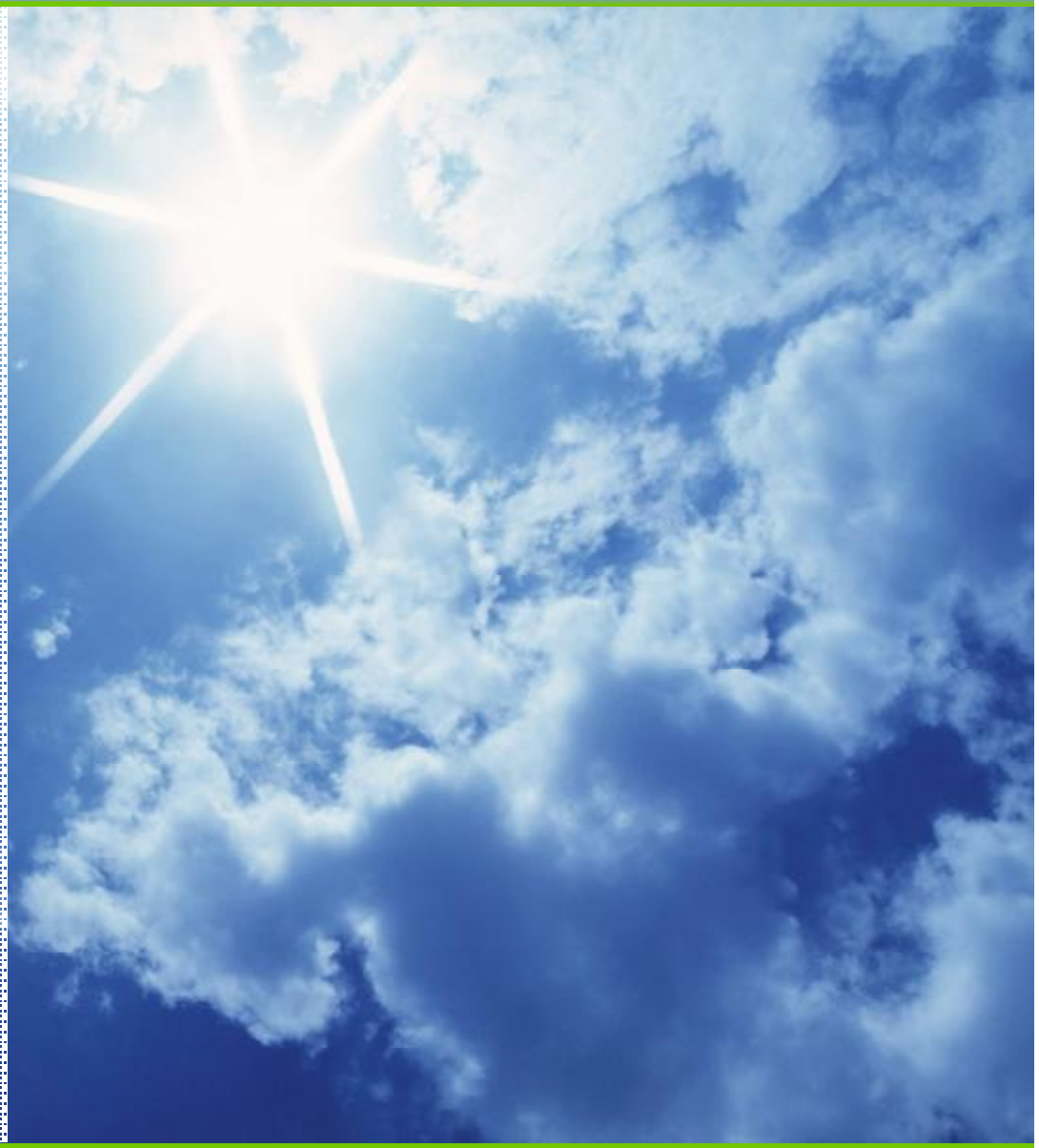
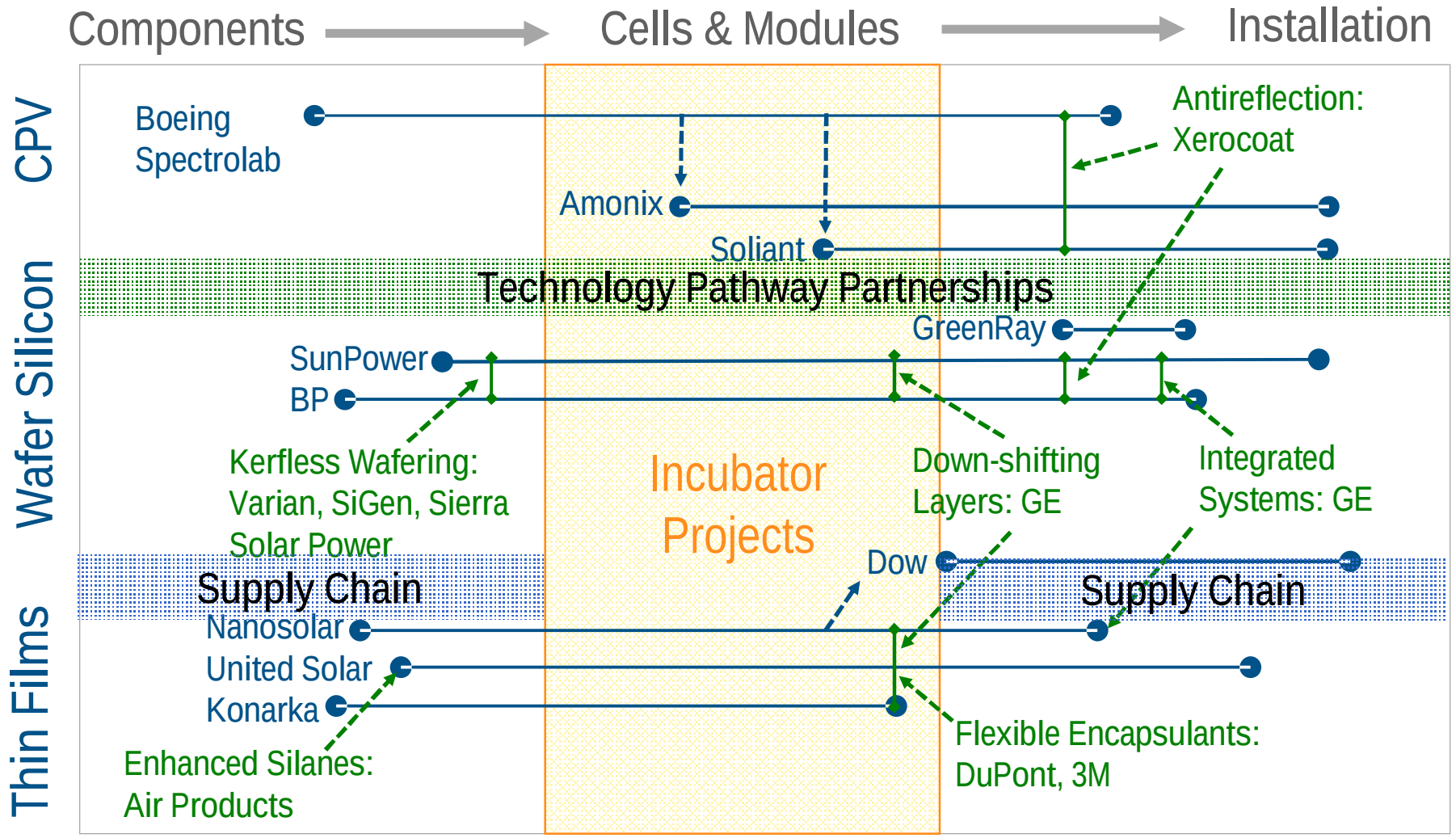


Supply Chain Projects Mitigate Portfolio Risk



SETP is uniquely positioned to facilitate collaboration and drive supply chain developments