Photovoltaics Subprogram

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Price/cost reduction targets provide guidance for R&D focus

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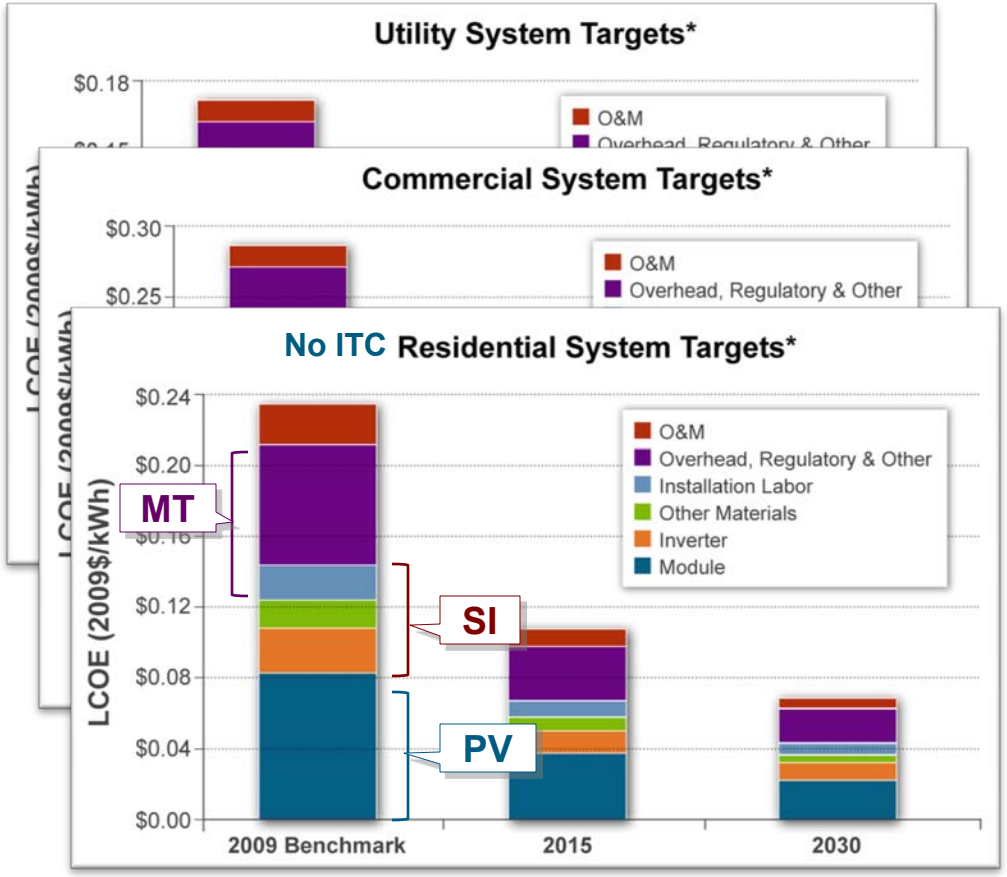
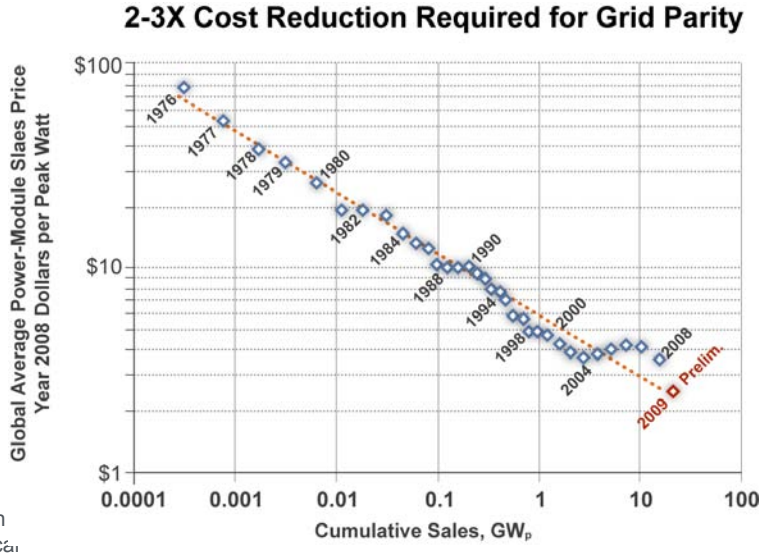


*Assumptions: Targets calculated using 30 year system life and solar insolation of Phoenix, AZ. For Residential PV, system is 80% financed with a 30-year fixed mortgage at 6.0% (nominal). Does not include the 30% ITC or state, local or utility incentives.

For Commercial and Utility PV, system is 60% financed with a 15-year loan at 6.0% (nominal) and 40% with equity at 15%. Includes the 10% ITC as well as 5-year MACRS depreciation, but does not include state, local, or utility incentives. Assumes the system is developer-owned, and so the levelized costs include the taxes that must be paid on the electricity generated.

- PV module prices are 30-50% of installed system cost
- PV module efficiency is a <u>significant lever</u> into the rest of the system
- BOS being addressed in PV as well as SI and MT subprograms



Solar Cell & Module Efficiency Progress

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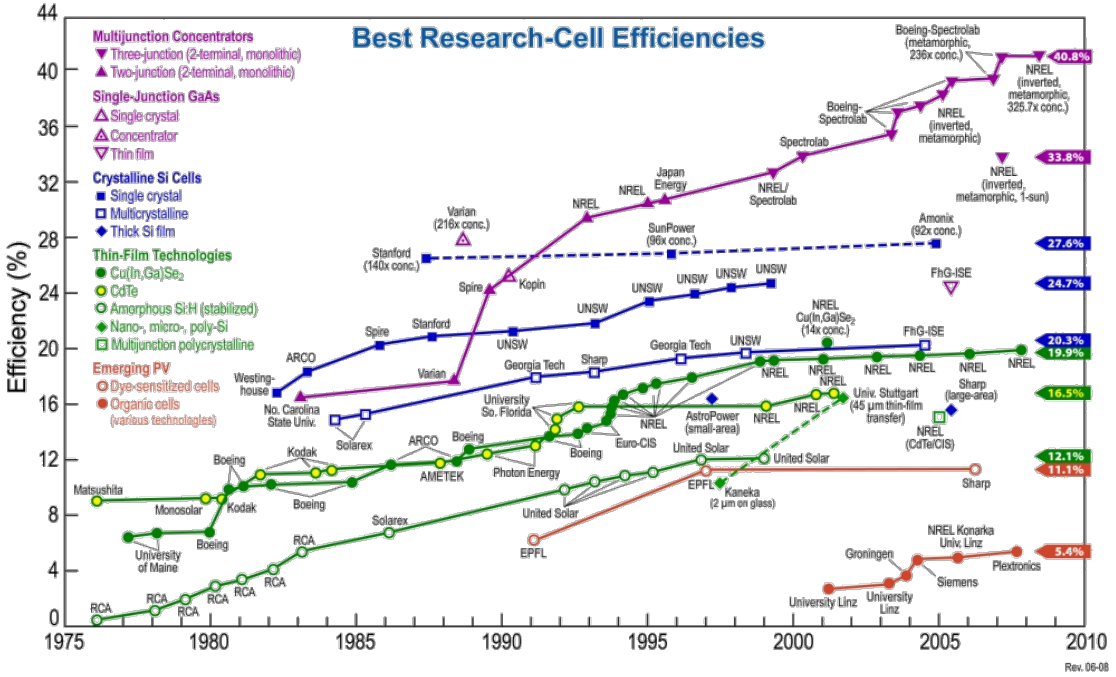

	Laboratory Cell Efficiency	Best in Class Production Module	Typical Production
CPV	~40%	~30%	
c-Si	~24%	~20%	~17%
mc-Si	~20%	~17%	~14%
CIGS	~20%	~11%	~11%
CdTe	~16%	~11%	~11%
a-Si	~12%	~8%	~7%
OPV	5-8%	~4%	

Cell and Module Efficiency has been improving

- Need more progress in closing the cell to module delta in thin films

Module efficiency is a major contributor to overall system costs

- More efficient panels › less labor to install

SETP Programs cover all parts of the RDD&D Pipeline

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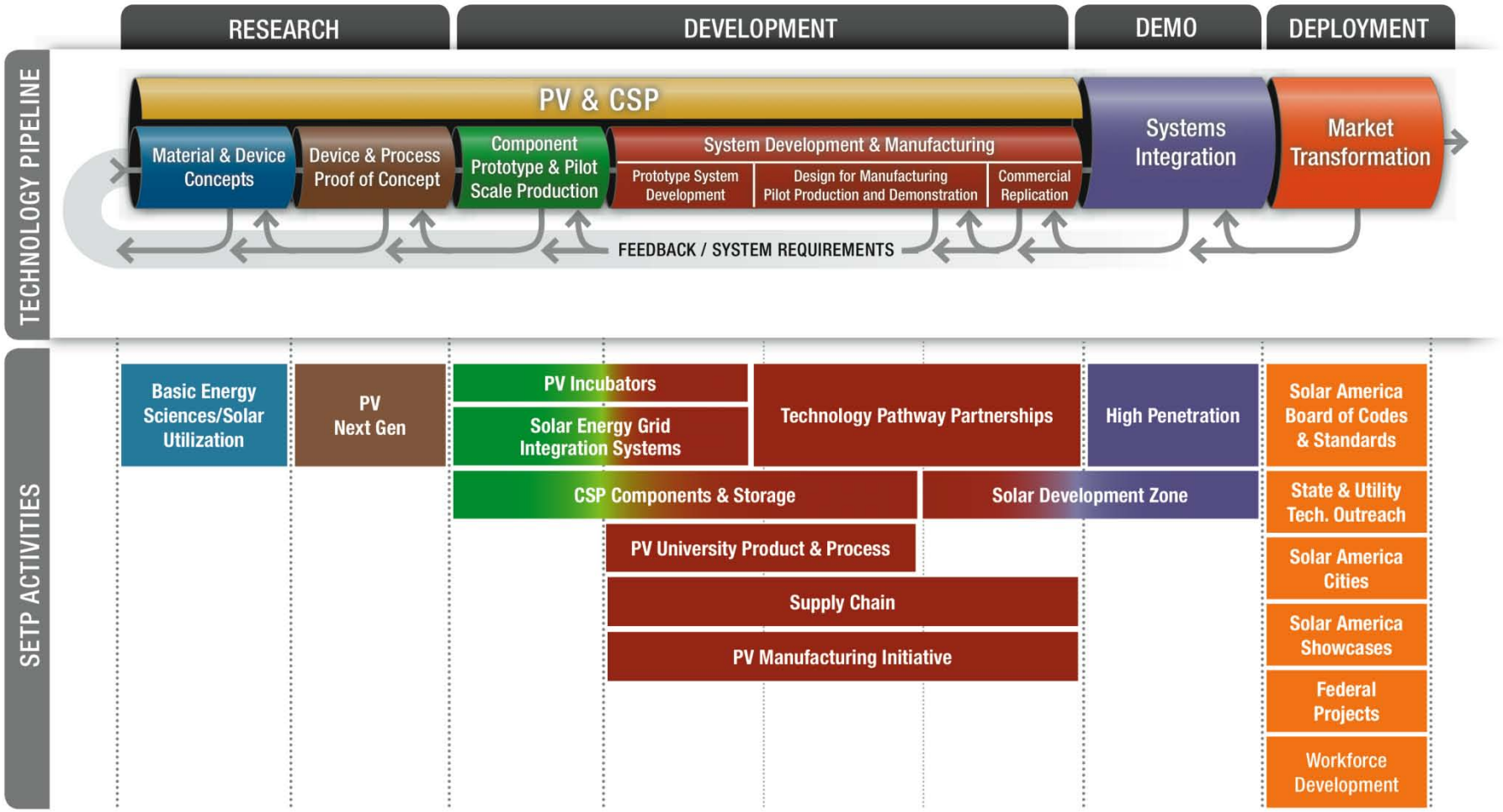

Technology Maturity

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CPV
- Triple Junction • IMM • Systems

Emerging
- OPV • SSC/DSSC

Thin Films
- CdTe • CIGS/CZTS/CIS
- a-Si/nc-Si • III/V

Silicon
- c-Si • mc-Si • Film-Si

TRL	TRL Definition
TRL 1	Basic principles observed and reported
TRL 2	Technology application formulated
TRL 3	Analytical and experimental proof of concept
TRL 4	Component validation in laboratory
TRL 5	System validation in relevant environment
TRL 6	Engineering/pilot-scale, similar (prototypical) system validation in relevant environment
TRL 7	Full-scale, similar (prototypical) system demonstrated in relevant environment
TRL 8	Actual system completed and qualified through test and demonstration.
TRL 9	Actual system operations

Research › **Development** › **Demonstration** › **Deployment**

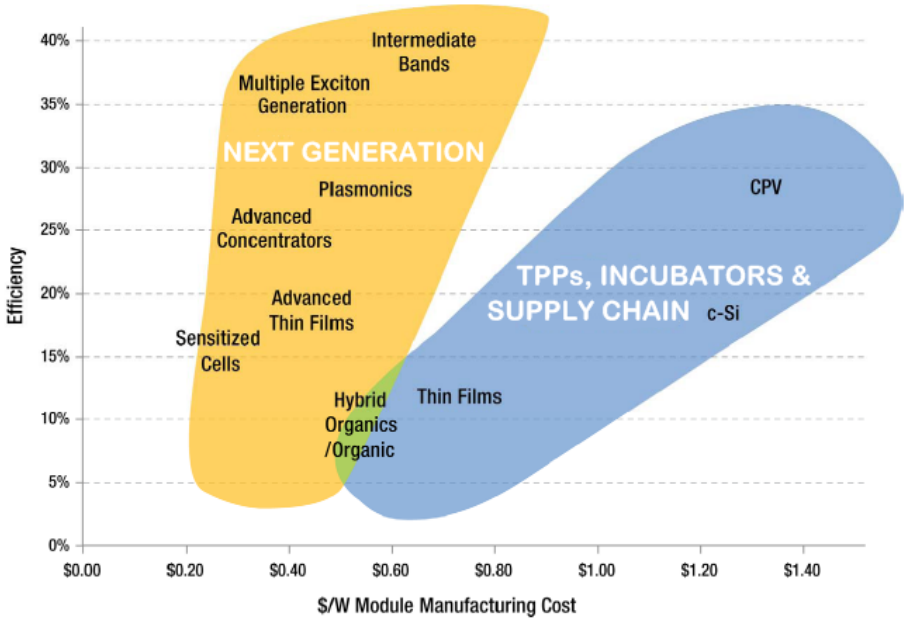
- NextGen
- Seed Funds
- National Labs Research

- Pre-Incubator
- Incubator
- Core Labs Research
- Technology Pathway Partnerships
- PV manufacturing Initiative

Early- to Mid-Stage

Next Generation

- **Goal:** Development of revolutionary, and highly disruptive next-generation PV technologies, expected to produce prototype PV cells and/or processes by 2020, with full commercialization by 2025-2030.



Pre-Incubator/Incubator

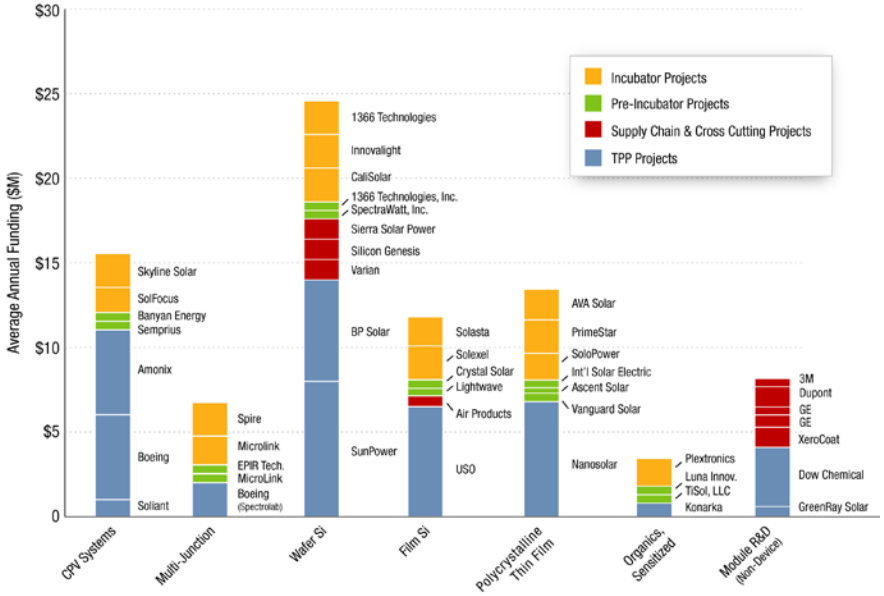
- **Goal:** Support transition of verified PV devices to prototype products and early pilot production by leveraging NREL R&D resources and mitigating risk through fixed firm pricing contracts.

AVA SOLAR
CALISOLAR
innovaLIGHT
Tetra Sun
ALTA Devices
SEMPRIUS
MicroLink Devices, Inc.
SOLO POWER
PLEXTRONICS Light. Power. Circuitry.™
Solar Junction
spire semiconductor
1366 technologies
SOLEXEL
SolFocus
Solasta
PrimeStar Solar Making It Happen

Mid- to Advanced-Stage

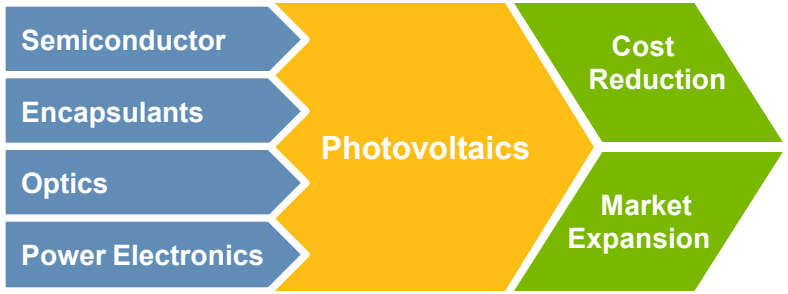
Technology Pathway Partnership

- **Goal:** TPPs are industry-led projects that emphasize the development, testing, demonstration, validation, and interconnection of new PV components, systems, and manufacturing equipment. Clear LCOE metrics to address Total System Costs



Supply Chain and Cross Cutting Technologies

- Development of component and/or manufacturing technologies with near-term impact on a substantial portion of the PV industry
  - Examples: processing steps to improve throughput or yield
  - Material solutions to improve reliability or enhance optical, thermal, or electrical performance
  - System components that streamline installation, or supporting diagnostic tools



National Labs Research

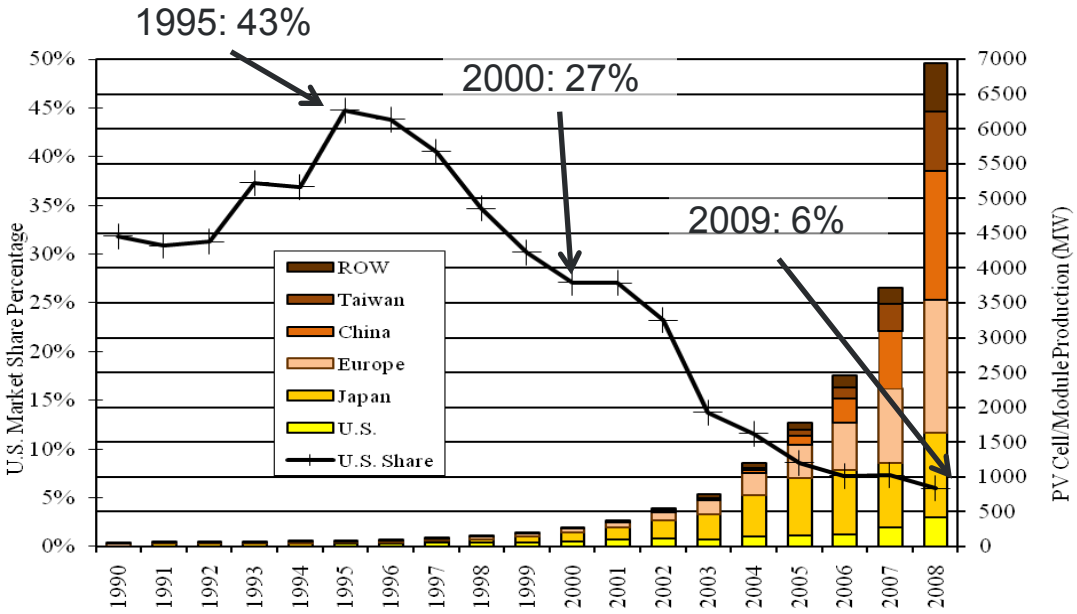
- **Goal:** Develop national labs expertise in PV aligned with industry needs
  - Establish leadership in next generation high risk/high impact technologies
  - Support industry with evaluation characterization, reliability, and resources
- **Major Programs**:
  - Research in Si, CdTe, CIGS, OPV, CPV, …
  - T&E – Reliability, Testing, Regional Experiments
  - M&C – New characterization techniques to support science and industry
  - Seed Funds and CRADAs – help industry commercialize labs technology
  - PDIL – Rapid prototyping and advanced process development

New Programs Under Development

PV Manufacturing Initiative

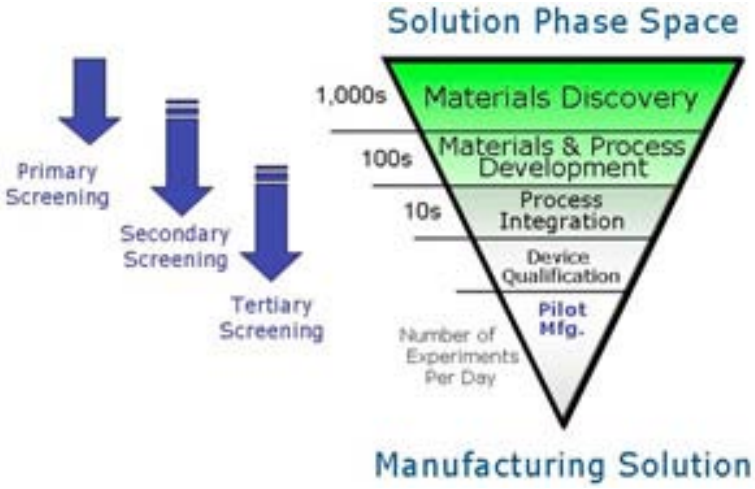
- **Goal:** Accelerate development and commercialization of PV manufacturing and process technologies by close partnerships between companies, universities and other stakeholders.

Global & U.S. annual PV module Production by region



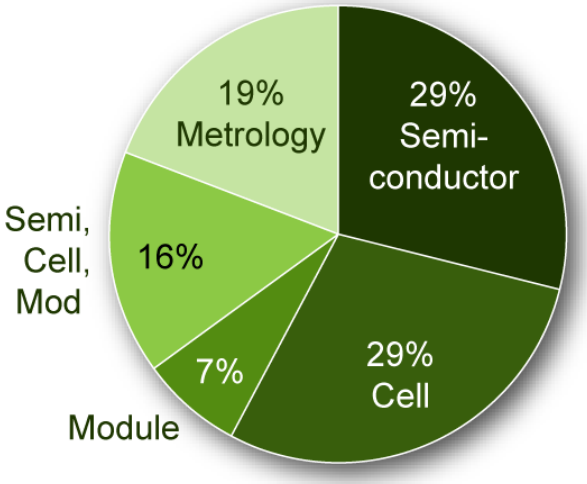
Foundational PV

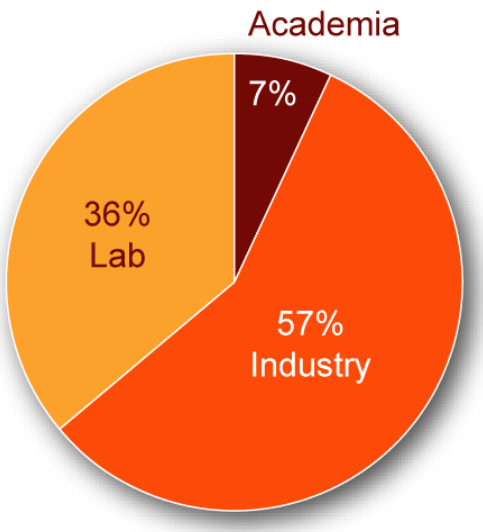
- **Goal:** Understand and overcome fundamental barriers to improved efficiency of commercial and near commercial semiconductors
- Sample Approaches:
  - **Combinatorial** techniques to rapidly screen materials and processes – Reduce time to final solution
  - **Defect engineering** to control defects in semiconductors to improve efficiency

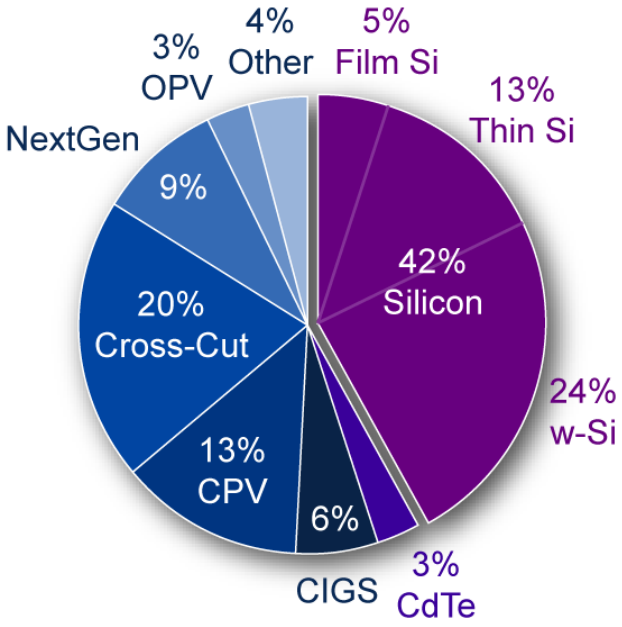


Graphic courtesy of Intermolecular

SETP budget areas – PV R&D ARRA & 2010 projects (~ $123 M)







Budget numbers above:

- contain line item projects classifiable with shown categories
- omit some Lab Support activities

Use as relative measure only

Programmatic Changes for FY11 & FY12

	Proposed Changes
Next Gen	Staggered 4 year programs with 2 year stage gate. Create structure for cyclic program to develop next generation ideas and next generation of researchers.
Incubator	Merged Pre-incubator and Incubator. To be released
	Topic 1: Pre-Incubator
	Topic 2: Incubator
Foundational	New program under development to address fundamental barriers of commercial and near commercial semiconductors.
	Topic 1: close the gap between lab and theory
	Topic 2: close the gap between production and lab
System Development Collaborative	Total systems approach to cost reduction. Evolution of TPP
	Topic 1: Products/Processes/Technology that make systems quicker and cheaper to install
	Topic 2: Module integrated power electronics
	Topic 3: BIPV
Supply Chain	Largely unchanged – FOA released
PVMI	New program to support collaborative manufacturing focused R&D – FOA released