# Solar America Initiative Update

## Strategy, R&D Pipeline, Industry Trends, Next Steps


DOE Solar Energy Technologies Program

For More Information:
http://www.eere.energy.gov/solar/solar_america/funding_opportunities.html
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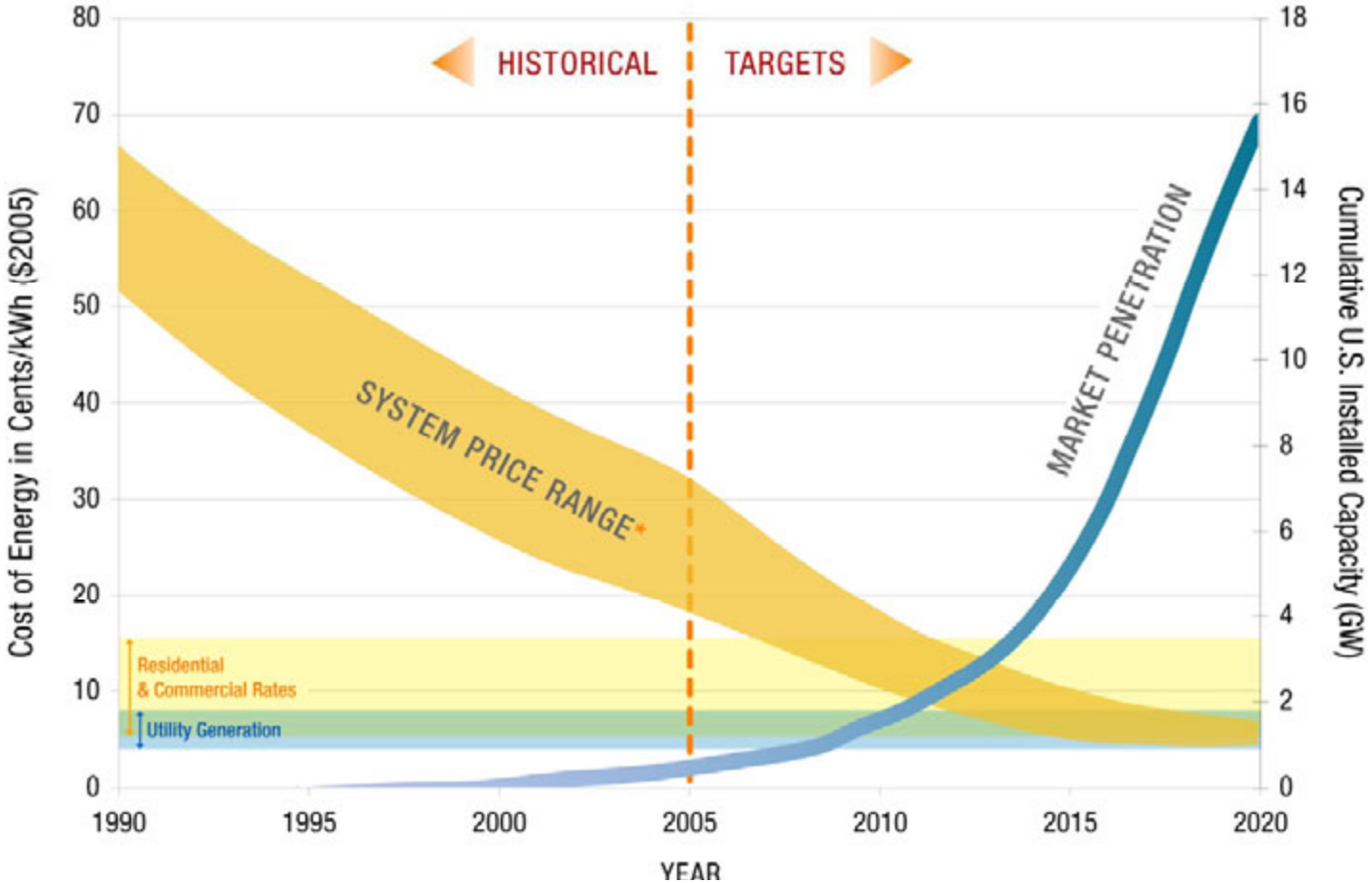
# The goal of the President's Solar America Initiative is to make PV cost-competitive by 2015




| 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 |

# Evolution of technical performance and industry structure lead to evolution in program goals & strategy

| | PRE-SAI | SAI |
|---|---|---|
| Research Focus | Technical improvements to individual components | Technical improvements to integrated PV systems |
| Performers, R&D Agenda | • National Labs drive R&D to enabling efficiency/cost requirements<br>• Companies and universities get help maturing technology | • Companies develop products for priority market applications<br>• Industry influences Lab/university research agenda |
| Program Goal Date | 2020 | 2015 |
| Pace of Progress | Incremental progress through stable laboratory funding | Substantial progress driven by large competitive solicitation and aggressive downselect process |
| R&D Funding Approach | Individual projects at National Labs, Universities, and Companies | System projects with multiple value-chain partners, Individual projects for earlier-stage technologies |
| Technology Acceptance | Large number of small-scale projects that generate local interest | Small number of large-scale, high-visibility projects that will help lower PV market barriers |

***Lab improvements to module efficiency and fabrication provided a basis for the industry product/processes that will drive the program in the future.***

# PV R&D pipeline will support technologies/companies, with funding opportunities calibrated to maturity

| PHASES | Material & Device Concepts | Device & Process Proof of Concept | Component Prototype & Pilot Scale Production | | System Development & Manufacturing | |
|---|---|---|---|---|---|---|
| SOLICITATION | Solar Energy Utilization | Future Generation PV Devices & Processes | PV Component / System Incubator | Advanced Inverters & Energy Management Systems | University Product & Process Development Support | Technology Pathway Partnerships |
| FUNDING SOURCE | DOE/O/S, BES | DOE / SETP | DOE / SETP | DOE / SETP | DOE / SETP | DOE / SETP |
| DESCRIPTION | New materials and pathways for solar to electric conversion | Novel devices or processes with potentially significant performance or cost advantages | Prototype PV components or systems produced at pilot-scale with demonstrated cost, reliability, or performance advantages | Design, test, and produce advanced inverters and energy management systems with improved reliability, enhanced value, and reduced costs | Universities perform targeted materials science and process engineering research in support of industry-led teams developing new PV systems for commercialization in 2010-2015 | PV systems and components ready for mass production delivering energy at target costs |
| PROJECT LIFECYCLE | 3 years | 3 years | 1.5 years w/ 9 mo. On/Off Ramp | 3 years | 3 Years | 3 years |
| ANNUAL FUNDING LEVEL | $0.3 - 1.5 Million | ≤ $300K | $1 - 2 Million | $1 - 2 Million | Up to $300,000/year | $2 - 7 Million |
| TEAM LEADS | Universities or Laboratories* | Businesses or Universities* | U.S. Commercial Entity | U.S. Commercial Entity | Universities | U.S. Commercial Entity |
| ELIGIBLE PARTICIPANTS | All | All | Universities / Laboratories* | All | Universities | Universities / Laboratories* |
| ENTRANCE CRITERION | Basic science properties conceived/simulated | Materials synthesized; properties observed | Coupon-scale PV cell; process demonstrated in lab; proof of concept demo | Power electronics and control system manufacturing capability | Identification of manufacturing process or component improvements possible through targeted research investigations. | Prototype components; pilot production demo; business case established |
| EXIT CRITERION | Materials synthesized; properties observed | Coupon-scale PV cell; process demonstrated in lab; proof of concept demo | Prototype components; pilot production demo; business case established | Pre-commercial inverters / energy management systems submitted for product certification | Incorporation of research results into commercial manufacturing operations or product designs. | Commercial PV systems and subsystems; scaled production demonstrated >25MW |
| TOPICS | • Single-crystal, poly-crystalline, amorphous, and nanostructured inorganic and organic materials<br>• Electronic structure<br>• Single or multiple junction solar cells | • New devices and structures using materials such as thin-film silicon, microcrystalline/amorphous silicon, polycrystalline metal chalcogenides and oxides, nanocrystalline materials, biomimetic concepts, organic materials, photoelectrochemical cells, dye-sensitized materials, materials with low-dimensionsal quantum structures<br>• Very-high efficiency epitaxial solar cells or other concepts | • Modules: multiple technologies (including CPV) seeking efficient material use, better performance, or improved manufacturing<br>• BOS Components: higher reliability inverters, CPV trackers, rapid installation features, storage systems<br>• Systems: controls and smart monitoring, integration of components, factory diagnostics | Lower cost, higher value systems resulting from:<br>• integrated circuitries,<br>• advanced thermal management,<br>• advanced transient overvoltage protection,<br>• micro-grid-ready controls,<br>• replacement of unreliable components,<br>• integration with storage or UPS,<br>• compatibility with buildings applications,<br>• communications options,<br>• customer-friendly energy monitoring,<br>• reduction in parts and installation steps,<br>• standards compliance,<br>• innovative packaging,<br>• self diagnostics, and<br>• incorporation of other new enabling technologies | Identifying and developing:<br>• Fabrication processes to improve material properties during manufacture<br>• Improved solar cell materials<br>• Innovative device designs to improve solar cell efficiency<br>• Simpler, lower cost manufacturing processes<br>• New electrical contacting techniques for improved efficiency and reliability<br>• Diagnostic techniques to identify properties and quality of solar cells materials during manufacturing<br>• Improved materials utilization processes<br>• Understanding of chemistry between encapsulants and solar cell materials<br>• Providing careful long term field testing of modules and systems in support of product improvement | • Partnerships with U.S. industry for projects that focus on development, testing, demonstration, validation, and interconnection of new PV components, systems, and manufacturing equipment<br>• Technology improvements in PV system and component design, integration, and installation will be a focus<br>• Cost reductions, performance enhancements, and reliability improvements are sought for all aspects of PV systems |

*NOTE: The NREL and SNL teams that are part of the SETP program will continue to provide technical support for these activities through the SETP but will not be direct participants*

# Future Generation PV Device & Process FOA bridges the "gap" between materials science and first devices

| PHASE | Device & Process Proof of Concept |
|---|---|
| SOLICITATION | Future Generation PV Devices & Processes |
| FUNDING SOURCE | DOE / SETP |
| DESCRIPTION | Novel devices or processes with potentially significant performance or cost advantages |
| PROJECT LIFECYCLE | 3 years |
| ANNUAL FUNDING LEVEL | ≤ $300K |
| TEAM LEADS | Businesses or Universities* |
| ELIGIBLE PARTICIPANTS | All |
| ENTRANCE CRITERION | Materials synthesized; properties observed |
| EXIT CRITERION | Coupon-scale PV cell; process demonstrated in lab; proof of concept demo |
| TOPICS | • New devices and structures using materials such as thin-film silicon, microcrystalline/amorphous silicon, polycrystalline metal chalcogenides and oxides, nanocrystalline materials, biomimetic concepts, organic materials, photoelectrochemical cells, dye-sensitized materials, materials with low-dimensionsal quantum structures |

# PV Module Incubator LOI carries early-stage companies from first devices to prototypes & pilot production

| PHASE | Component Prototype & Pilot Scale Production |
|---|---|
| SOLICITATION | PV Component / System Incubator |
| FUNDING SOURCE | DOE / SETP |
| DESCRIPTION | Prototype PV components or systems produced at pilot-scale with demonstrated cost, reliability, or performance advantages |
| PROJECT LIFECYCLE | 1.5 years with 9 mo. On/Off Ramp |
| ANNUAL FUNDING LEVEL | $1 - 2 Million |
| TEAM LEADS | U.S. Commercial Entity |
| ELIGIBLE PARTICIPANTS | Universities / Laboratories* |
| ENTRANCE CRITERION | Coupon-scale PV cell; process demonstrated in lab; proof of concept demo |
| EXIT CRITERION | Prototype components; pilot production demo; business case established |
| TOPICS | • **Modules:** multiple technologies (including CPV) seeking efficient material use, better performance, or improved manufacturing |

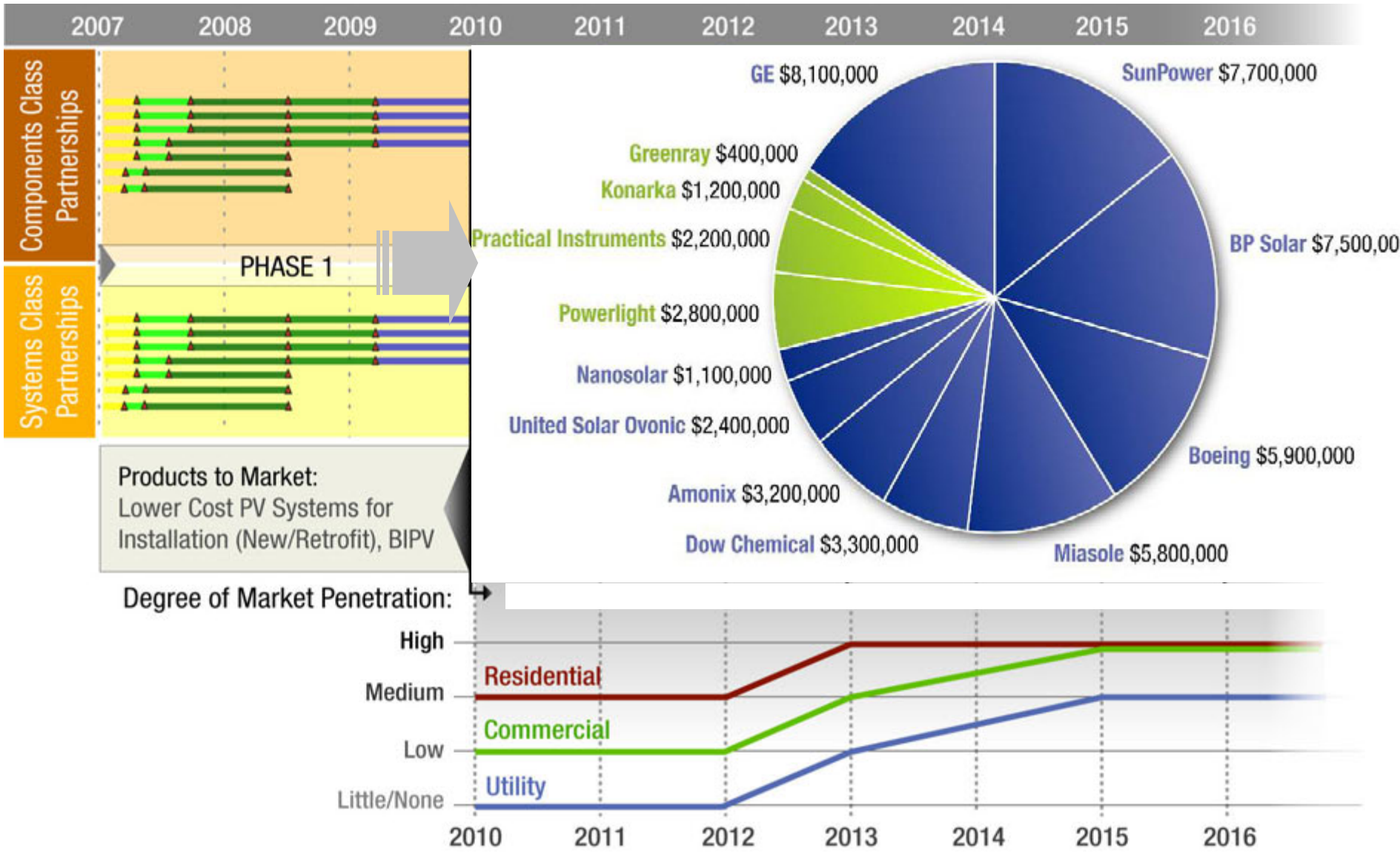
# Advanced Inverters & Energy Management Systems FOA will address reliability, new functionality, lower costs

| PHASE | Component Prototype & Pilot Scale Production |
|---|---|
| SOLICITATION | Advanced Inverters & Energy Management Systems |
| FUNDING SOURCE | DOE / SETP |
| DESCRIPTION | Design, test, and produce advanced inverters and energy management systems with improved reliability, enhanced value, and reduced costs |
| PROJECT LIFECYCLE | 3 years |
| ANNUAL FUNDING LEVEL | $1 - 2 Million |
| TEAM LEADS | U.S. Commercial Entity |
| ELIGIBLE PARTICIPANTS | All |
| ENTRANCE CRITERION | Power electronics and control system manufacturing capability |
| EXIT CRITERION | Pre-commercial inverters / energy management systems submitted for product certification |
| TOPICS | Lower cost, higher value systems resulting from:<br>• integrated circuitries,<br>• advanced thermal management,<br>• advanced transient overvoltage protection,<br>• micro-grid-ready controls,<br>• replacement of unreliable components,<br>• integration with storage or UPS,<br>• compatibility with buildings applications,<br>• communications options,<br>• customer-friendly energy monitoring,<br>• reduction in parts and installation steps,<br>• standards compliance,<br>• innovative packaging,<br>• self diagnostics, and<br>• incorporation of other new enabling technologies |

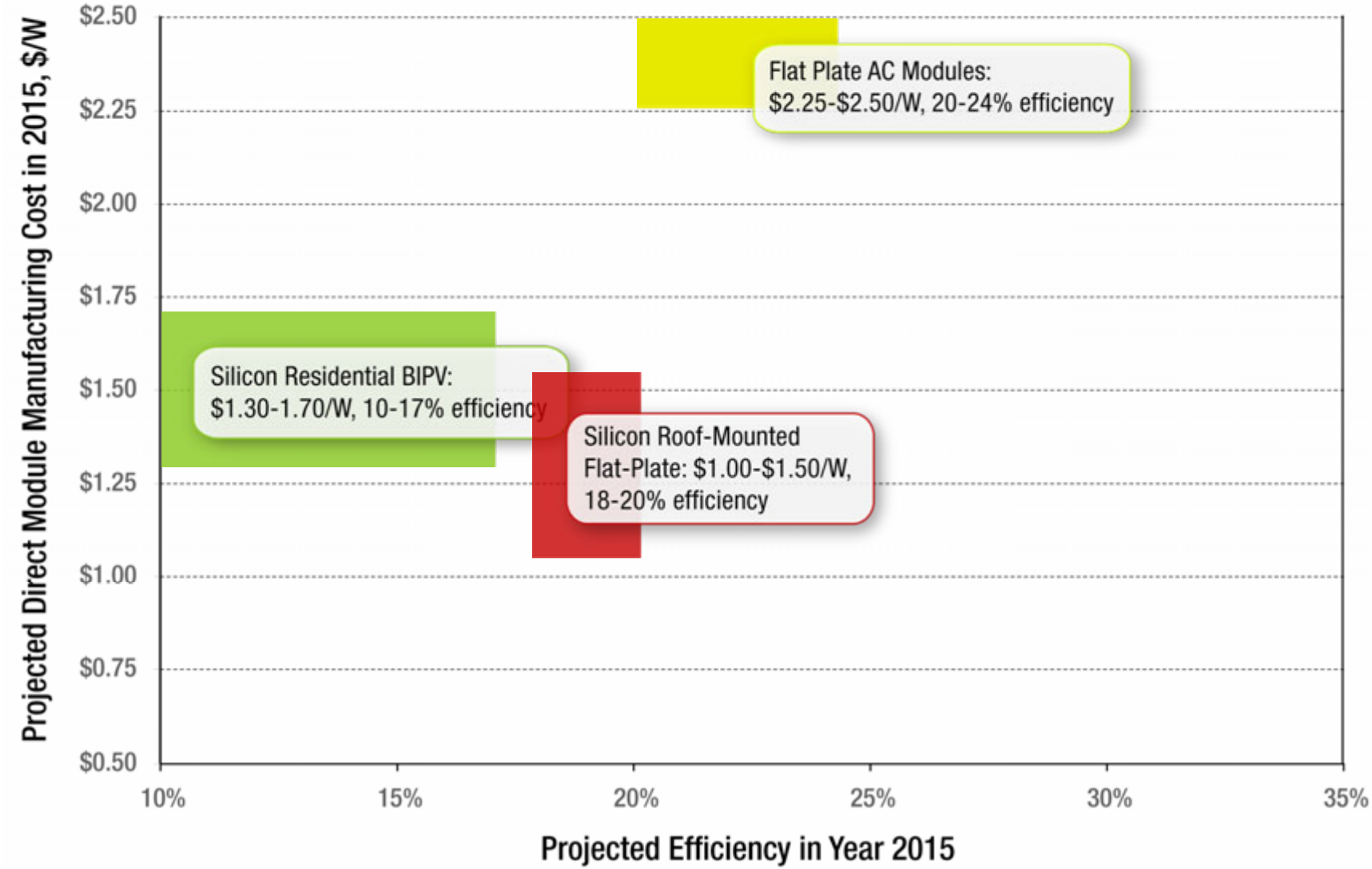
# University Product/Process Dev't Support FOA will get universities solving near-term problems for industry

| PHASE | System Development & Manufacturing |
|---|---|
| SOLICITATION | University Product & Process Development Support |
| FUNDING SOURCE | DOE / SETP |
| DESCRIPTION | Universities perform targeted materials science and process engineering research in support of industry-led teams developing new PV systems for commercialization in 2010-2015. |
| PROJECT LIFECYCLE | 3 Years |
| ANNUAL FUNDING LEVEL | Up to $300,000/year |
| TEAM LEADS | Universities |
| ELIGIBLE PARTICIPANTS | Universities |
| ENTRANCE CRITERION | Identification of manufacturing process or component improvements possible through targeted research investigations. |
| EXIT CRITERION | Incorporation of research results into commercial manufacturing operations or product designs. |
| TOPICS | Identifying and developing:<br>• Fabrication processes to improve material properties during manufacture<br>• Improved solar cell materials<br>• Innovative device designs to improve solar cell efficiency<br>• Simpler, lower cost manufacturing processes<br>• New electrical contacting techniques for improved efficiency and reliability<br>• Diagnostic techniques to identify properties and quality of solar cells materials during manufacturing<br>• Improved materials utilization processes<br>• Understanding of chemistry between encapsulants and solar cell materials<br>• Providing careful long-term field testing of modules and systems in support of product improvement |

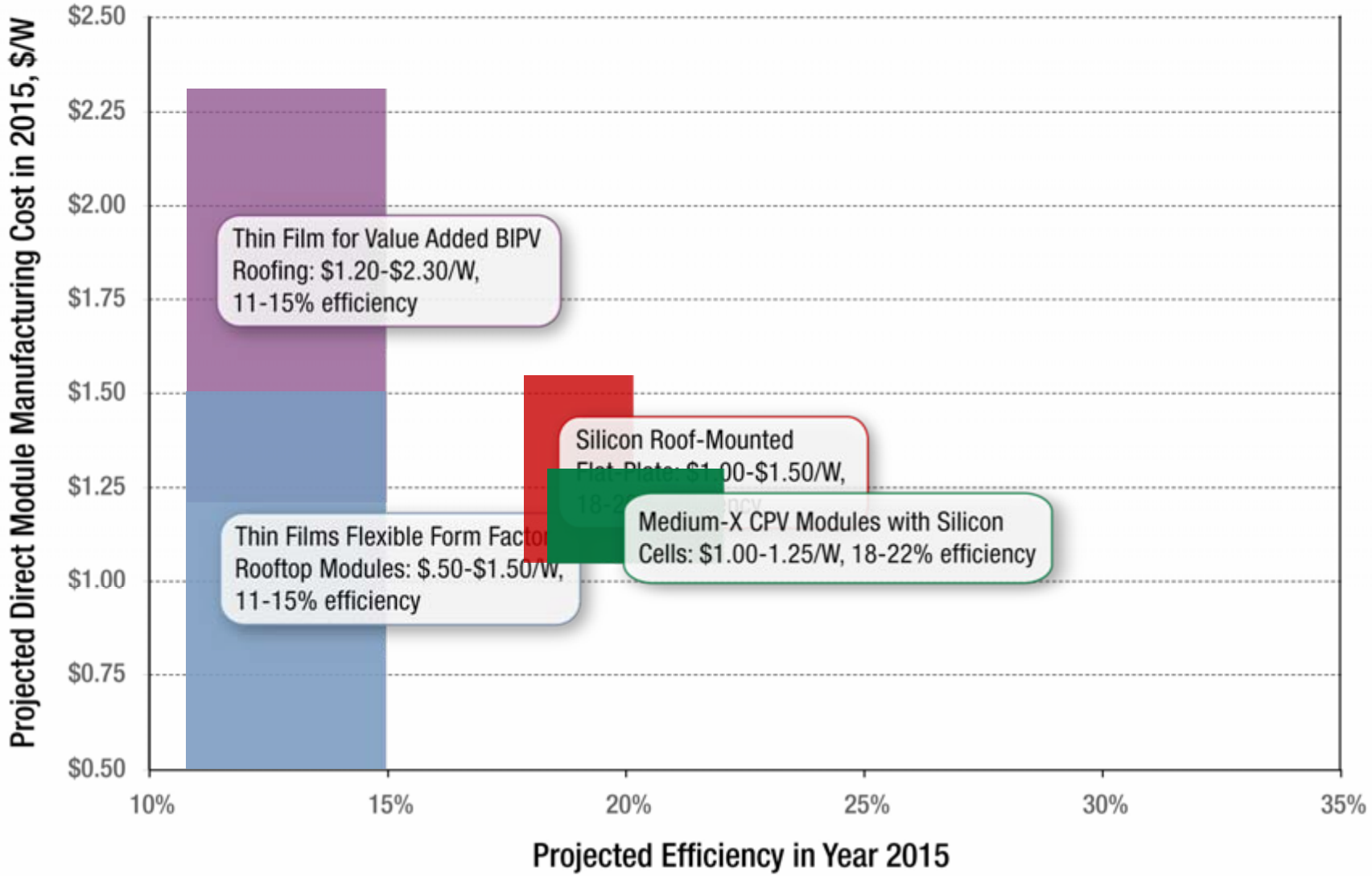
# TPP awards are first installment on near-term results in PV pipeline; next round in 2009, sooner if budget allows



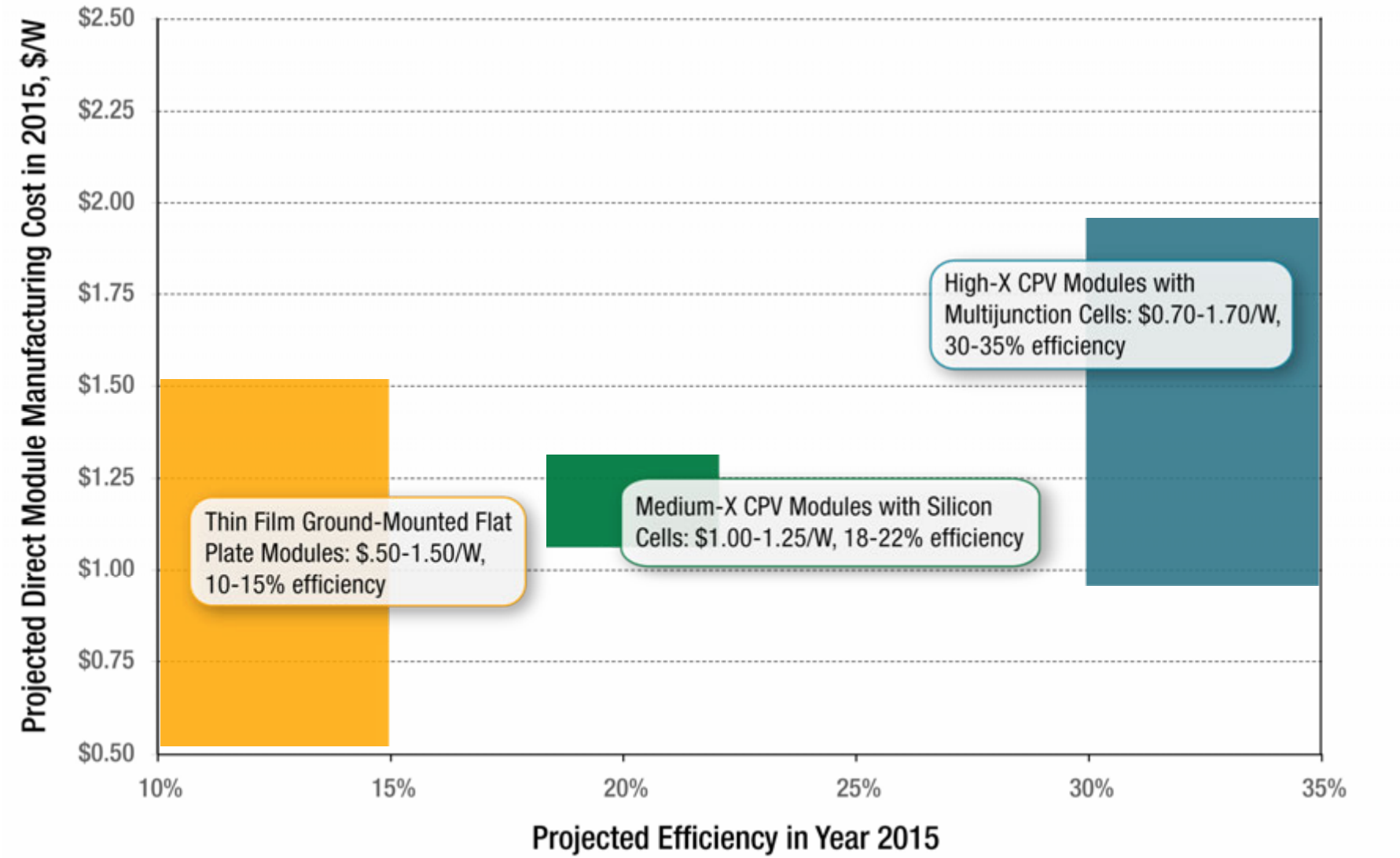
# Area-constrained residential applications will require high efficiencies, but value-add can accommodate higher $/W



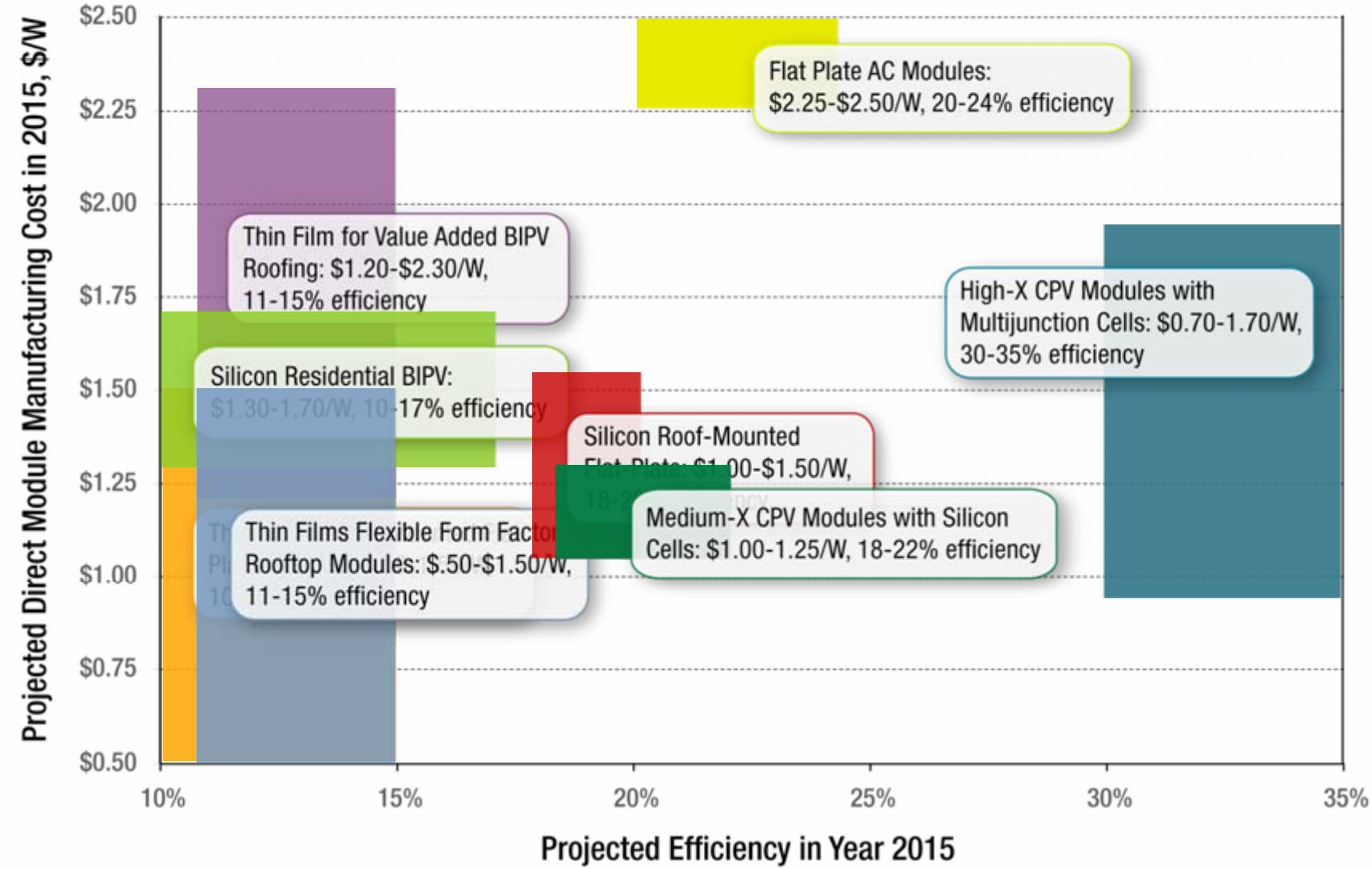
# Commercial app's may accept lower efficiencies if $/W is lower and if form factor/BIPV reduce installation cost; c-Si and med-X CPV will play to customers seeking max kWh's



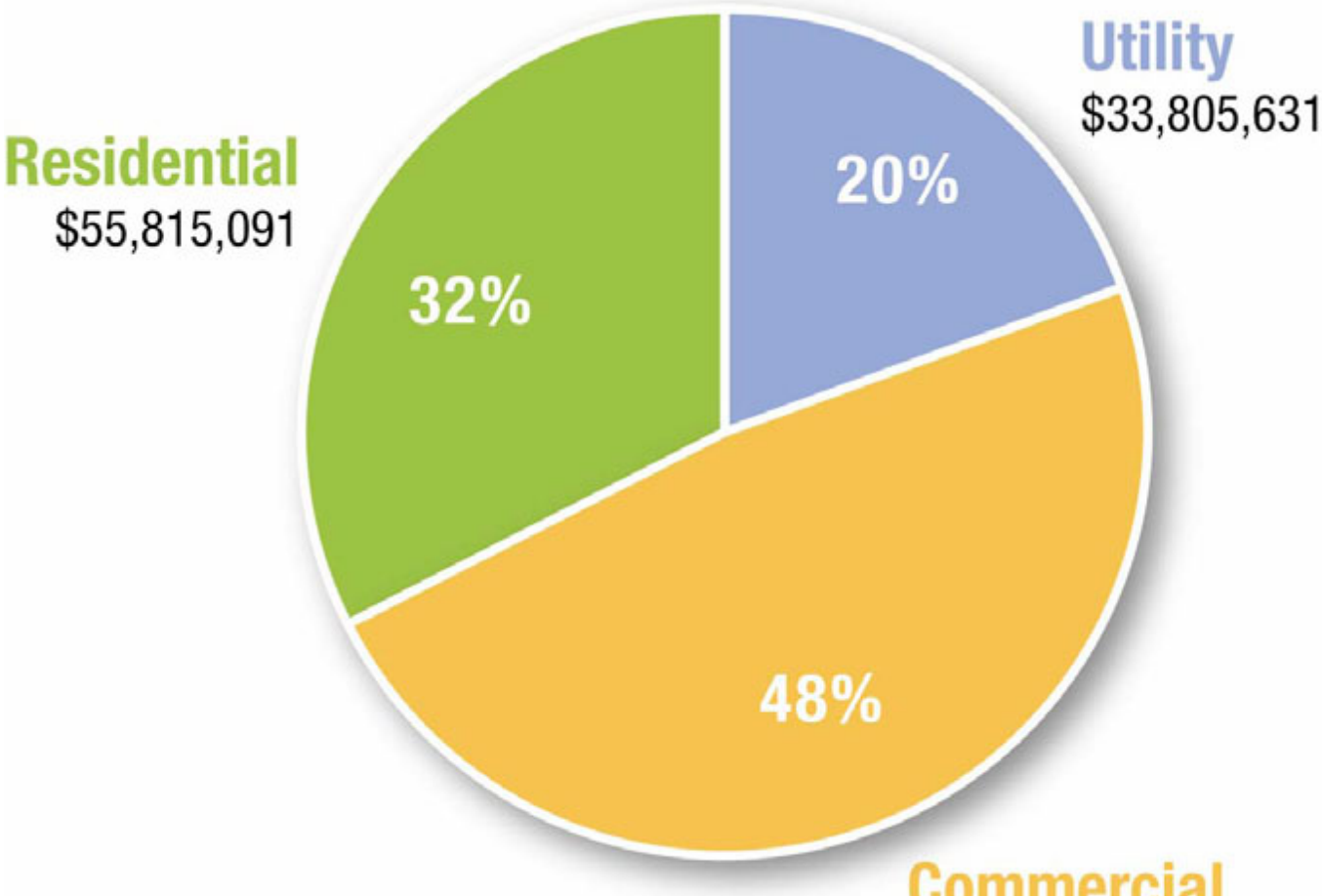
# No consensus requirements for U.S. utilities yet – CPV seeing strongest interest but European-like flat plate TF module approach may play in certain circumstances



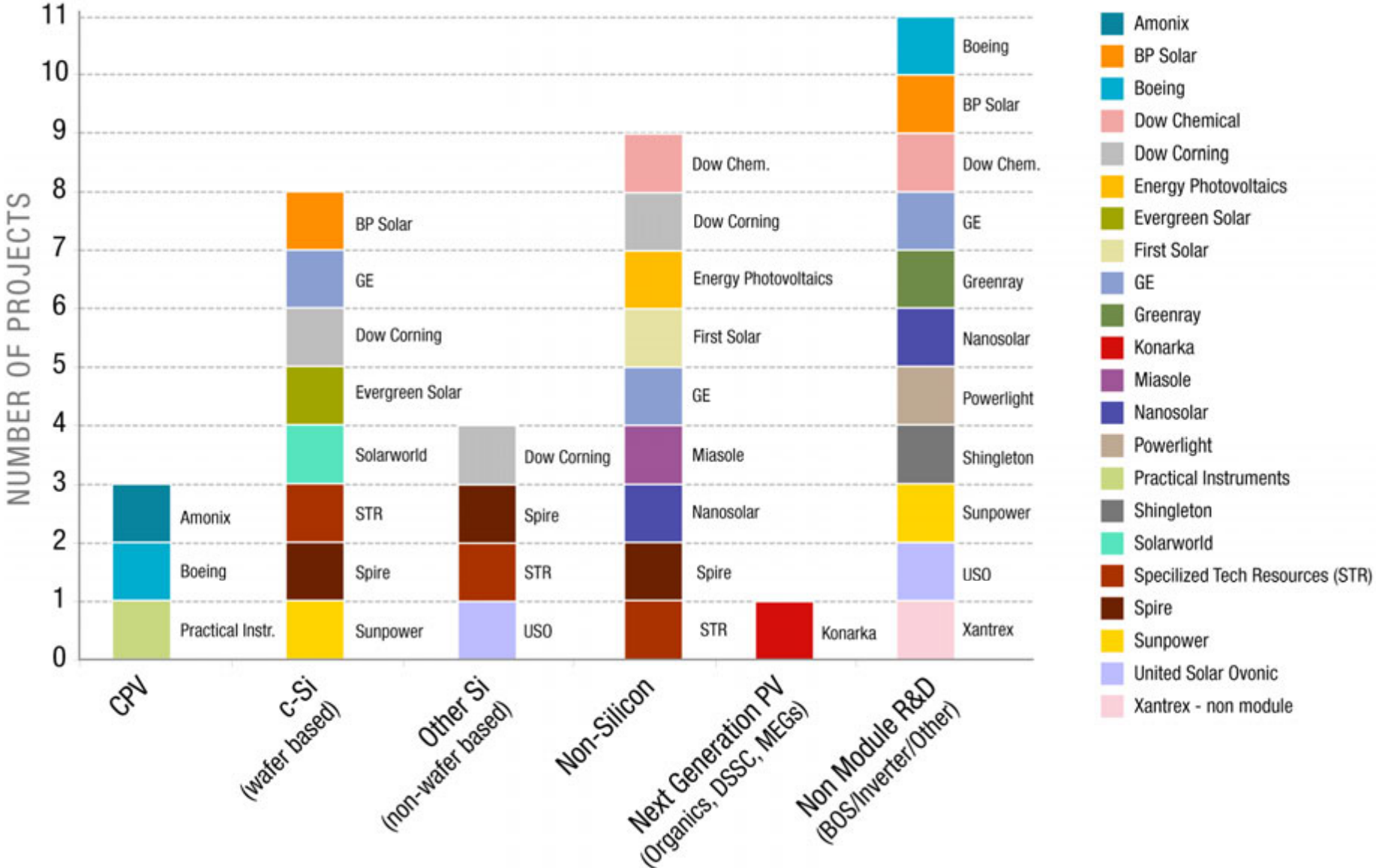
# DOE will drive its industry R&D agenda towards optimal solutions for major markets – while consensus remains unclear, multiple pathways will be supported



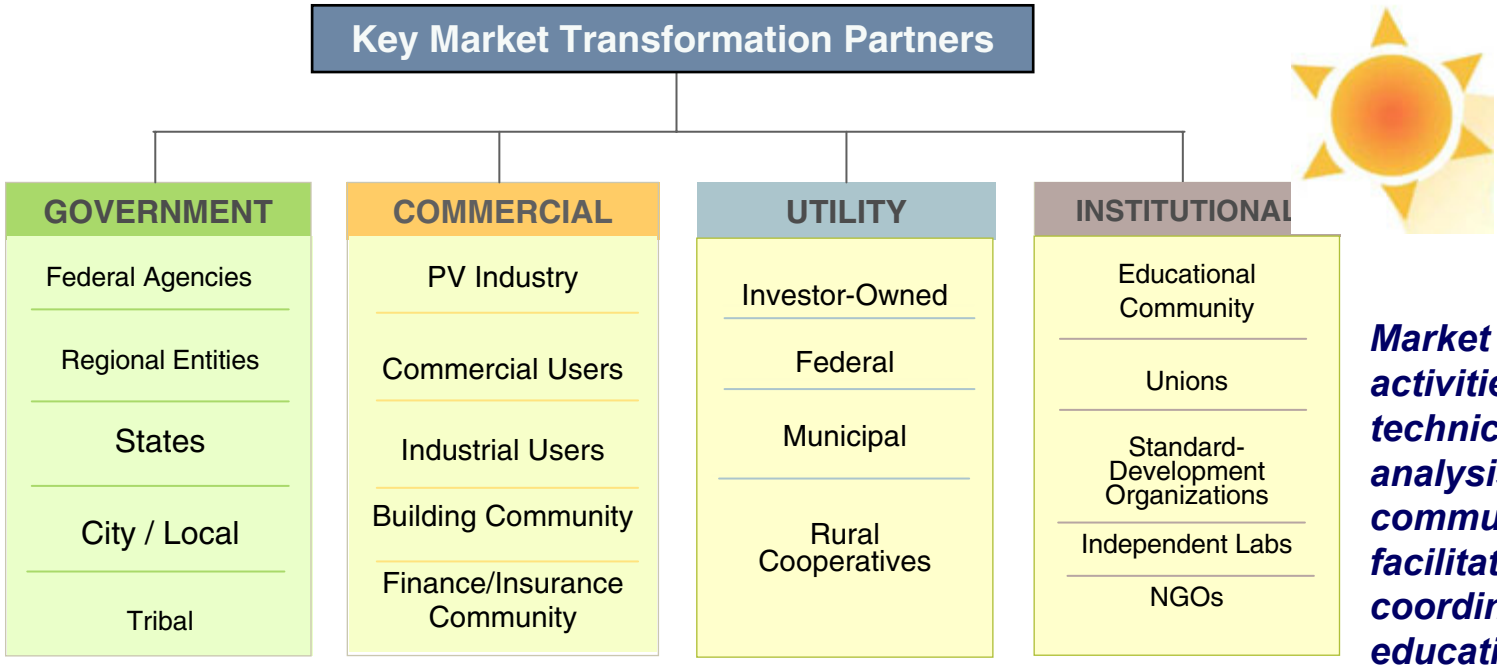
# Funding portfolio is intended to deliver on near-term potential in commercial/residential markets – with utilities as long-term play for PV and CSP as well



# Current portfolio continues historical investment in thin films, increases support to CPV & c-Si…hope to fill in more organics, non-wafer Si, high-eff, power electronics



# DOE is also addressing market barriers that can't be beaten through cost reduction and production scale-up




***Market Transformation activities include technical outreach, analysis, communication, facilitation, coordination, and educational efforts with key partners***

- **Provide key partners with technical assistance on codes, standards and regulations.**
- **Promote the education and certification of solar installers and code officials.**
- **Promote improved financing and insurance options for solar systems.**
- **Support large showcase projects with installations of solar systems using advanced or novel solar products or installation methods.**

# 2007 Priorities for the Solar America Initiative

1. Fill out the industry R&D pipeline for next generation products
   - Innovative module designs & manufacturing approaches
   - Increased reliability and functionality for power electronics
   - Next generation of low-cost, scaleable PV devices
2. Establish framework for university involvement in SAI
   - Initiate TPP tasks, projects for new devices and for industry support
3. Calibrate NREL research portfolio and role for the future
4. Ramp-up test & evaluation for development & qualification
   - Develop new accelerated testing for reliability/lifetime prediction
   - Provide T&E services needed for growing industry
5. Catalyze collaboration on industry-wide issues (e.g. standards)
6. Expand U.S. demand “pull” through policy & regulatory measures
   - Engage on Federal-level policies (tax policy, government PPAs, etc)
   - Engage on State-level policies (metering, interconnection, rates, rebates)