



U.S. DEPARTMENT OF  
**ENERGY**

Energy Efficiency &  
Renewable Energy



## Solar Energy Technologies Program

# PV Manufacturing Initiative

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Funding Opportunity Announcement (FOA) Release Webinar  
April 29, 2010

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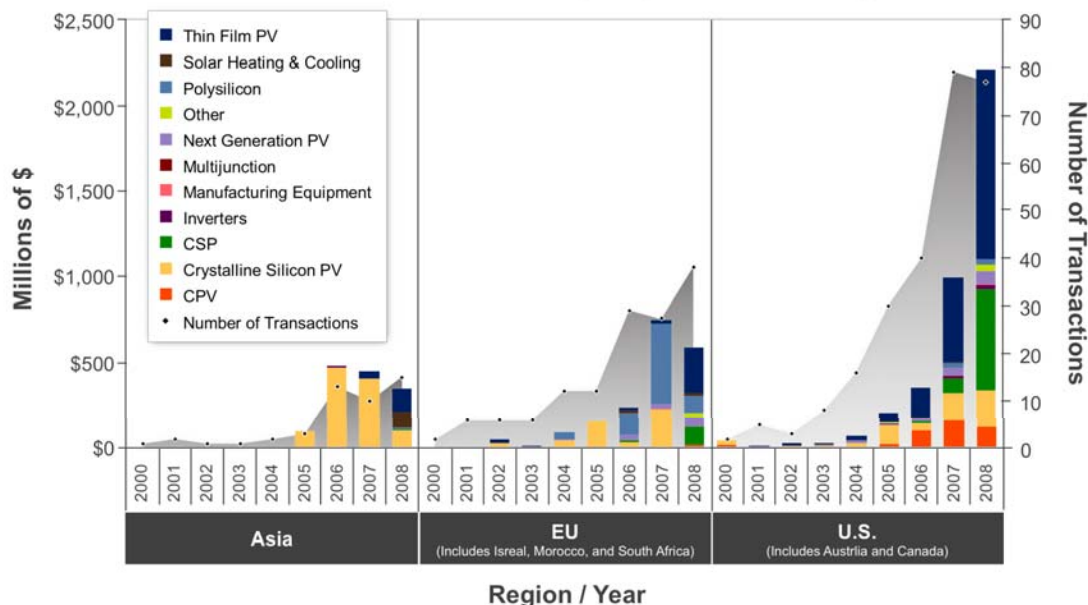
AAAS Science & Technology Policy Fellow  
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U.S. Department of Energy  
Office of Energy Efficiency and Renewable Energy

- Context and purpose
- Structure of FOA and solicited organizational approaches
- Examples of technology areas
- Concept paper and full application
- Selection criteria
- Registration and application process

# The U.S. has led the world in investment in PV technologies

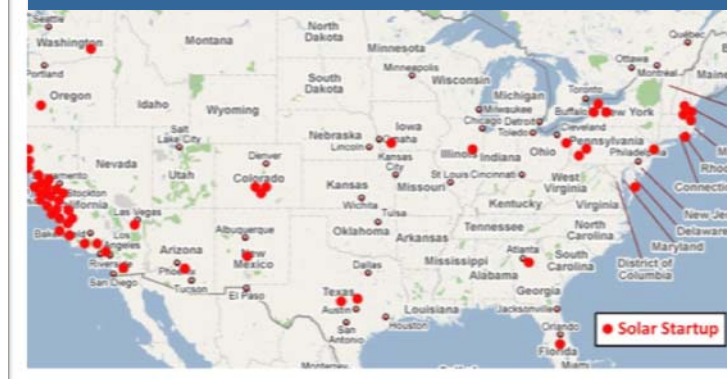
VC & PE Solar Investments by Region and Technology\*



\* Does not include VC or PE investments to project developers

Source: New Energy Finance

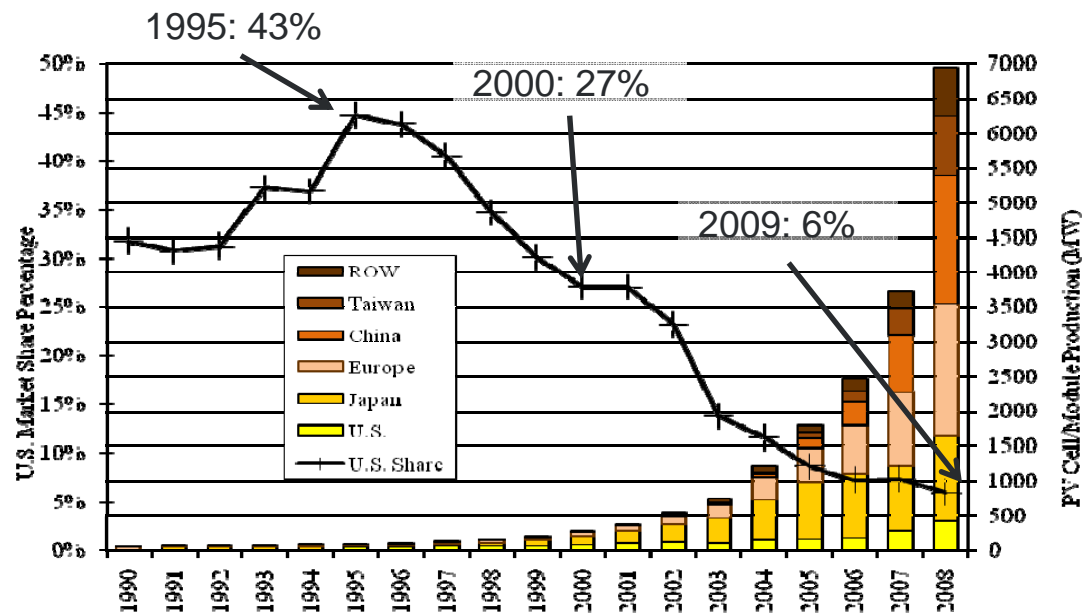
## More than 100 U.S. Solar Companies



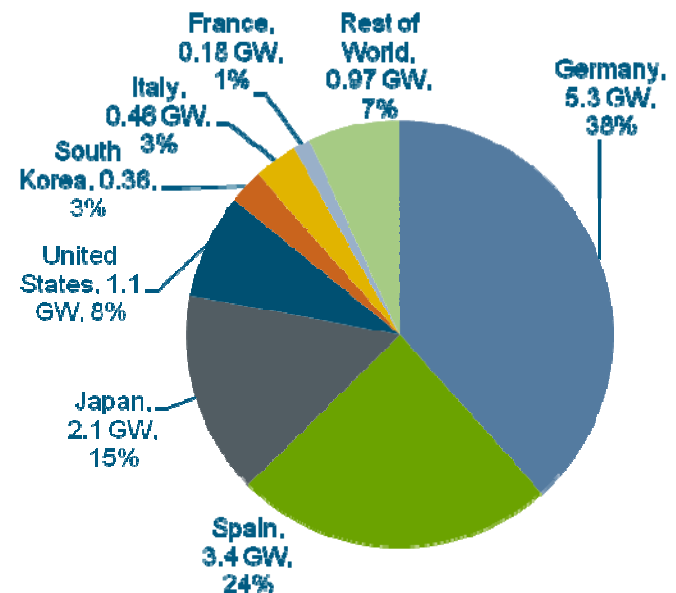
- The US is the most diversified in solar technologies receiving VC and PE financing, with substantial investment in thin film PV, as well as CPV and CSP
- More than 100 U.S. solar start-ups and \$2.5B in commercial investment in 2008 alone
- Supply chain companies also have a strong presence in the U.S.:
  - Equipment manufacturers
  - Polysilicon producers
  - Materials and specialty chemical suppliers
  - Glass companies
- Leading solar research universities

U.S. share of PV production has fallen significantly over the last 10 years to 6% of global output

### Global & U.S. annual PV production by region



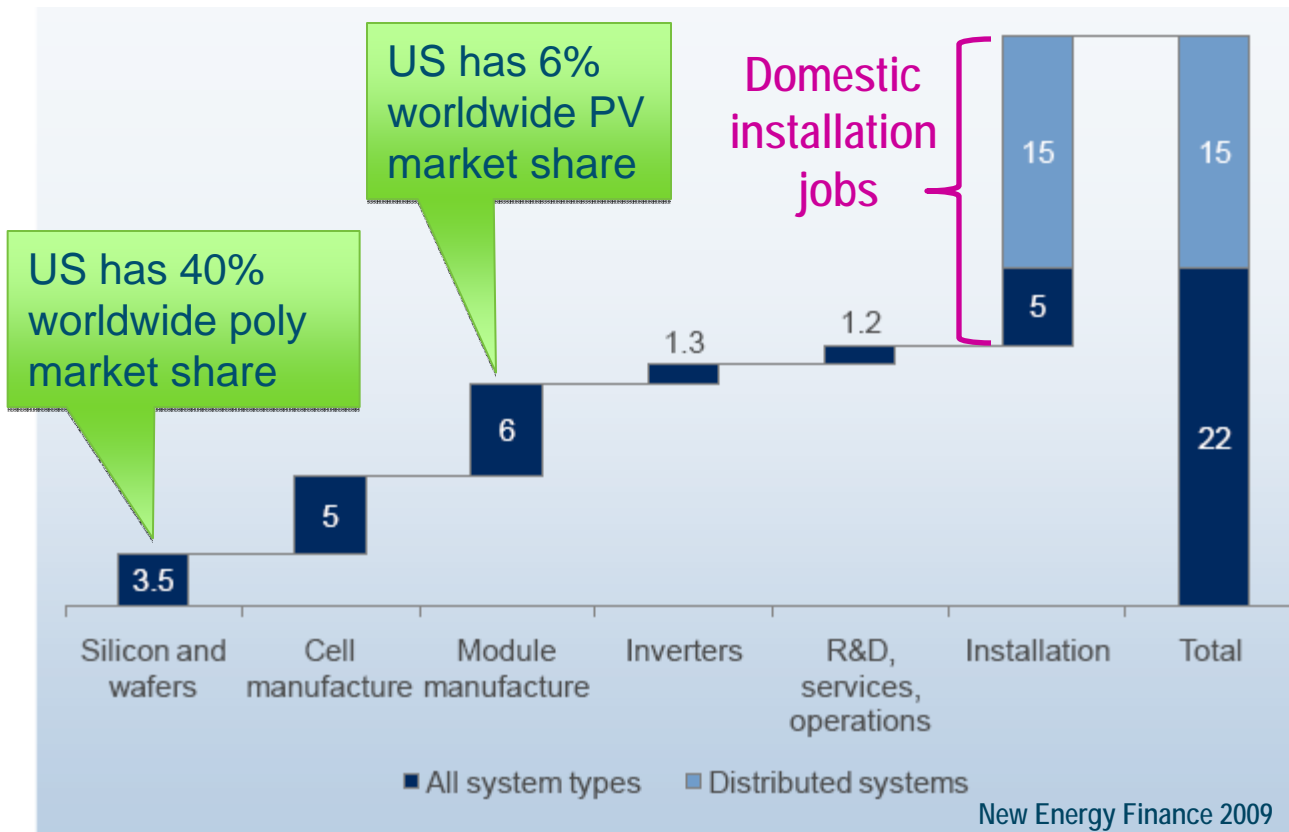
### Cumulative Installed PV (thru 2008)



- U.S. is not currently a major manufacturer of PV products
- Dramatic growth in PV manufacturing in China, Taiwan, Malaysia, and the Philippines
- Many PV companies that started in the U.S. have moved most of their manufacturing overseas

# Domestic manufacturing will drive green jobs growth in the U.S.

## Jobs per MW of PV installed



- 22-37 direct jobs per MW installed in the US
- 2X multiplier when factoring entire value chain

- U.S. is a **net exporter** – in 2008, U.S. installed 0.34GW and produced 0.41GW
- For residential PV systems, 54% of the jobs are in installation – which must be in the U.S.

# PV Manufacturing Initiative background

- The PV Manufacturing Initiative evolved in response to:
  1. Requests by industry to do more to help start-up PV companies succeed.
  2. Requests by universities to fund additional applied research as an integral part of PV workforce development.
  3. Expectations that reaching cost targets for PV will require additional collaboration and some standardization.
- DOE has developed the concept through:
  - National Academies' Workshops
    - “The Future of PV Manufacturing in the United States”
    - “Partnering for Photovoltaic Manufacturing in the United States”
    - Links at <http://sites.nationalacademies.org/PGA/step/index.htm>
  - Request for Information (RFI)
    - Link to summary report at [http://www1.eere.energy.gov/solar/pdfs/rfi\\_pv\\_manufacturing\\_initiative.pdf](http://www1.eere.energy.gov/solar/pdfs/rfi_pv_manufacturing_initiative.pdf)
  - National Renewable Energy Laboratory (NREL) report
    - “Consortia Focused on Photovoltaic R&D, Manufacturing, and Testing: A Review of Existing Models and Structures”
    - Link at <http://www.nrel.gov/docs/fy10osti/47866.pdf>
  - Direct discussions with industry and other potential stakeholders

# Examples of consortia in other fields



**SEMATECH (Semiconductor MANufacturing TECHnology)**



**Crystal Clear Consortium - 6<sup>th</sup> Framework Program of the European Union**



**Center for Advanced MicroElectronics Manufacturing (Camm)**

**Semiconductor,  
PV, Electronics  
Manufacturing**



**FlexTech Alliance (former U.S. Display Consortium)**



**National Center for Manufacturing Sciences (NCMS)**



**Hollings Manufacturing Extension Partnership**

**General  
Manufacturing**



**Technology Innovation Program**



**FreedomCAR and Fuel Partnership**



**Partnership for a New Generation of Vehicles (PNGV)**

**Automotive:  
Fuels, Systems,  
Materials**



**US Advanced Battery Consortium (USABC)**



**NGLIA (Next Generation Light Industry Alliance)**

**Other**



**Joint BioEnergy Institute (JBEI)**



# SEMATECH initially focused on clear, defined goal for photolithography



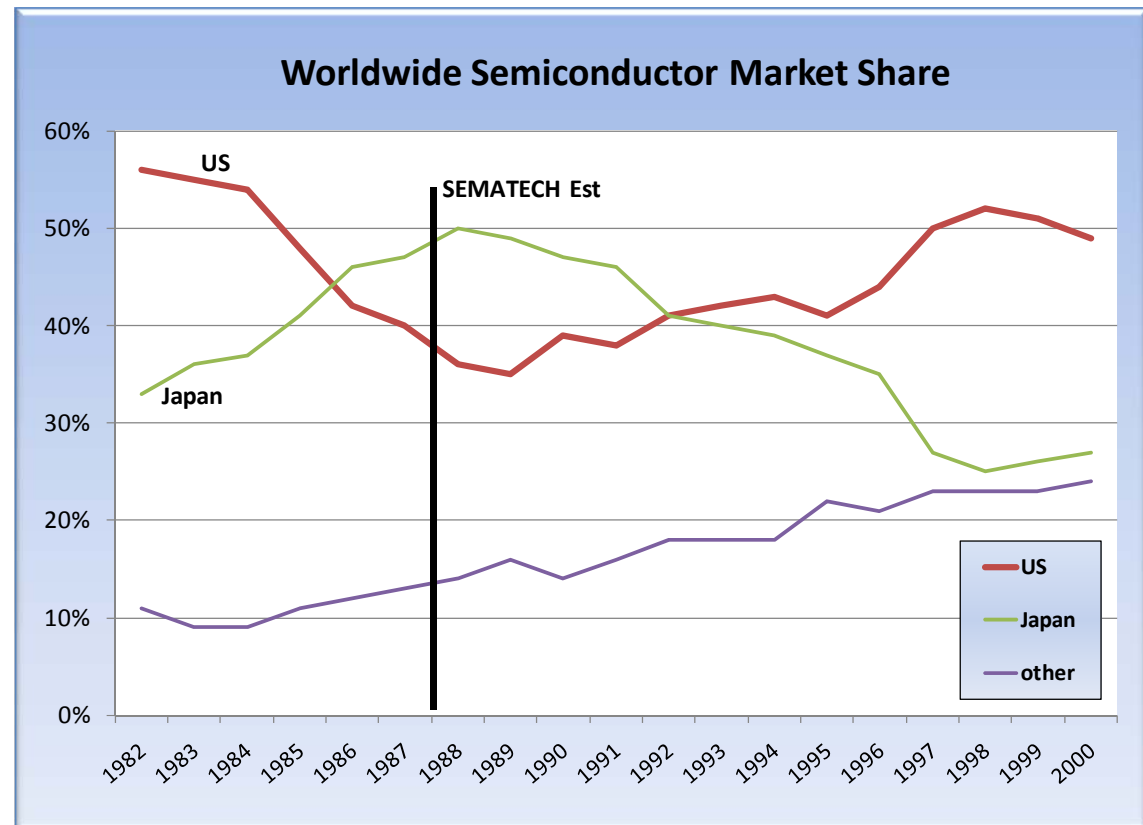
## SEMATECH (SEmiconductor MAnufacturing TECHnology)

### Consortia Purpose:

Established in 1987 to address the loss of U.S. market share in semiconductor manufacturing to Japan through the early 1980's

### Goals:

- ♦ Improve product quality and process yields
- ♦ Strengthen U.S. suppliers of capital equipment
- ♦ **Demonstrate 0.35 micron line width capability on "all-American" made equipment by 1992 (achieved in 1993)**

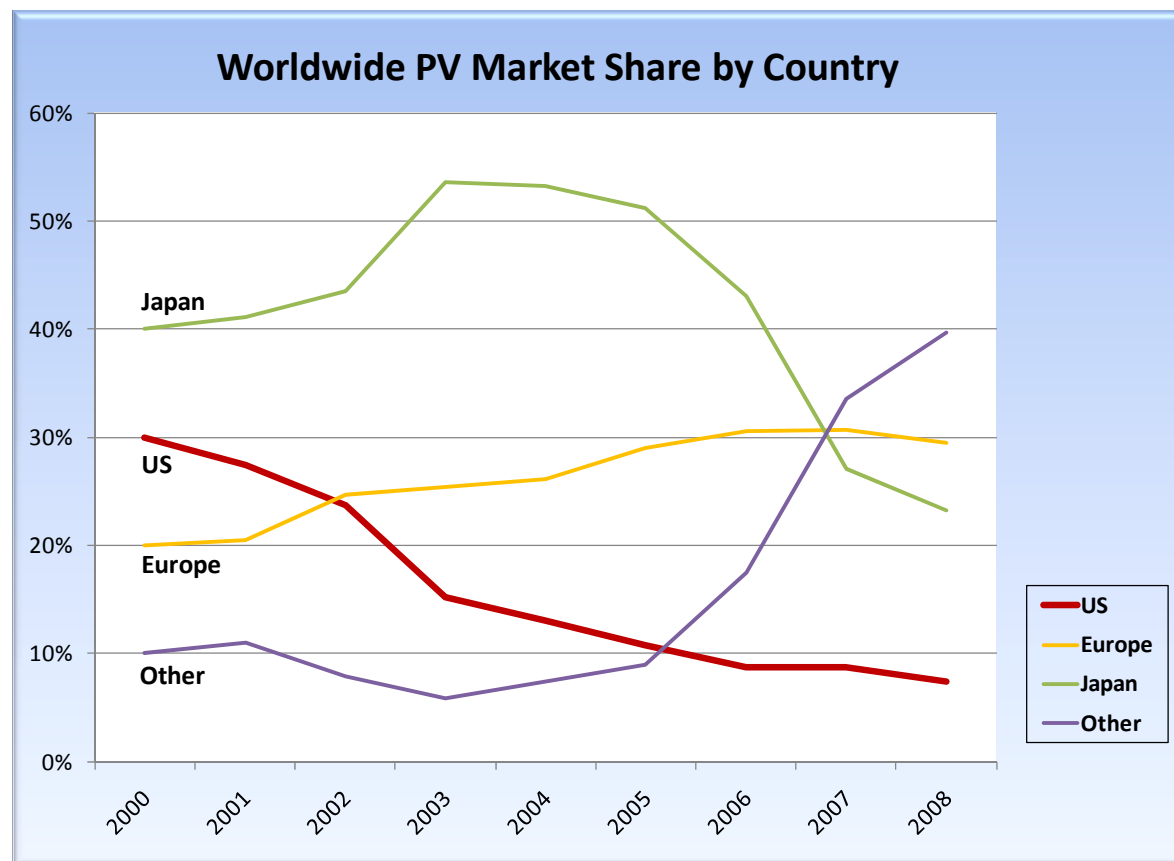


Worldwide Semiconductor Market Share: 1982: 2000, Source: SIA



# U.S. PV industry can benefit from increased collaboration and coordination

- PV industry differs from IC industry – multiple cell processes and technologies
- Identification of common needs and developing technologies that will enable competitive advantage for U.S. companies are still important and relevant goals for the PV industry



**Worldwide PV Market Share by Country: 2000-2008. Based on PV cell/module shipments**

Source: Mints and Tomlinson / Navigant

# PV Manufacturing Initiative goals

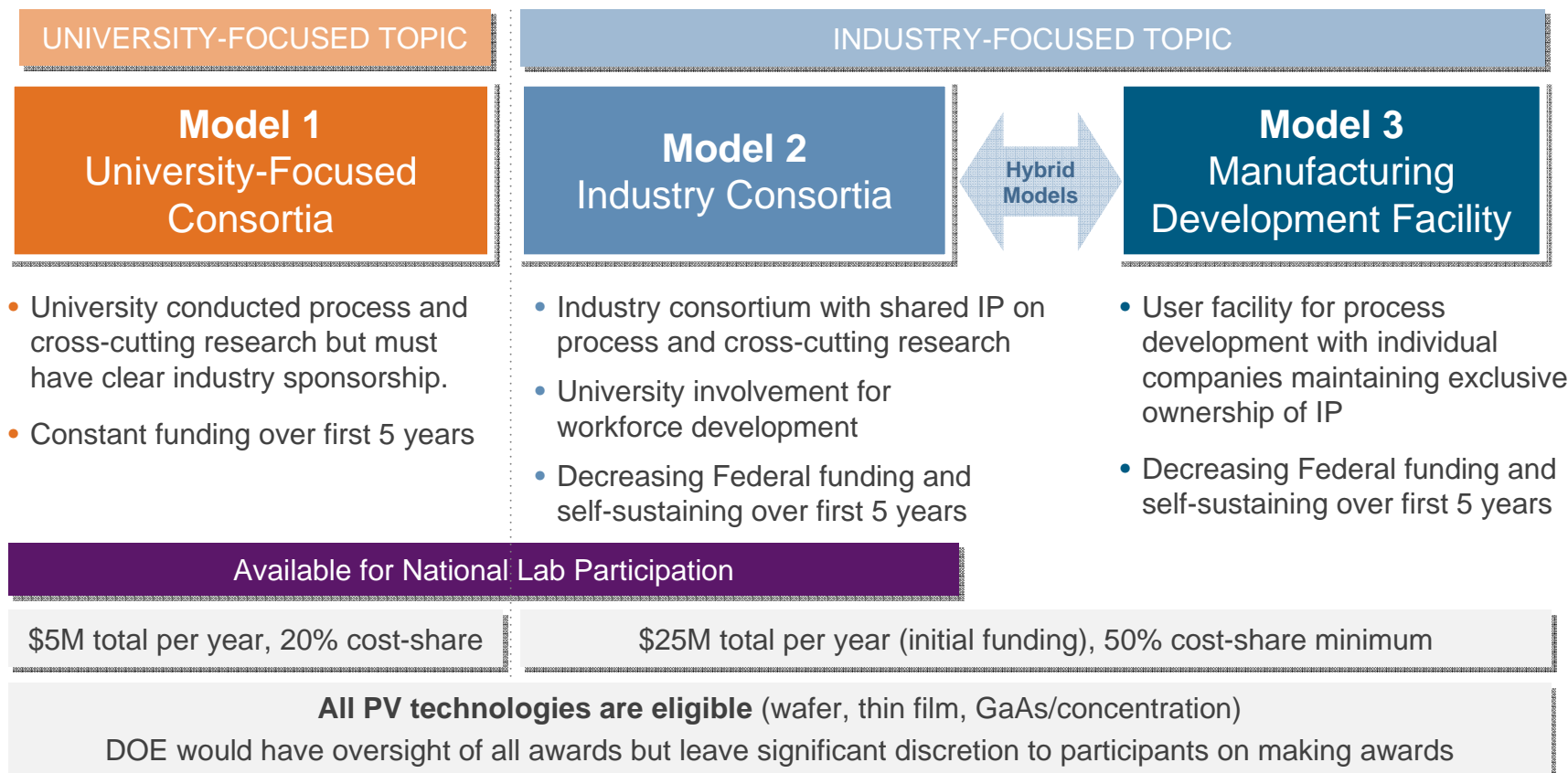
- A FOA for a multi-year effort of up to \$125M has been designed, in which consortium, user facility, and hybrid approaches are being solicited
- The FOA includes both University-Focused and Industry-Focused topics



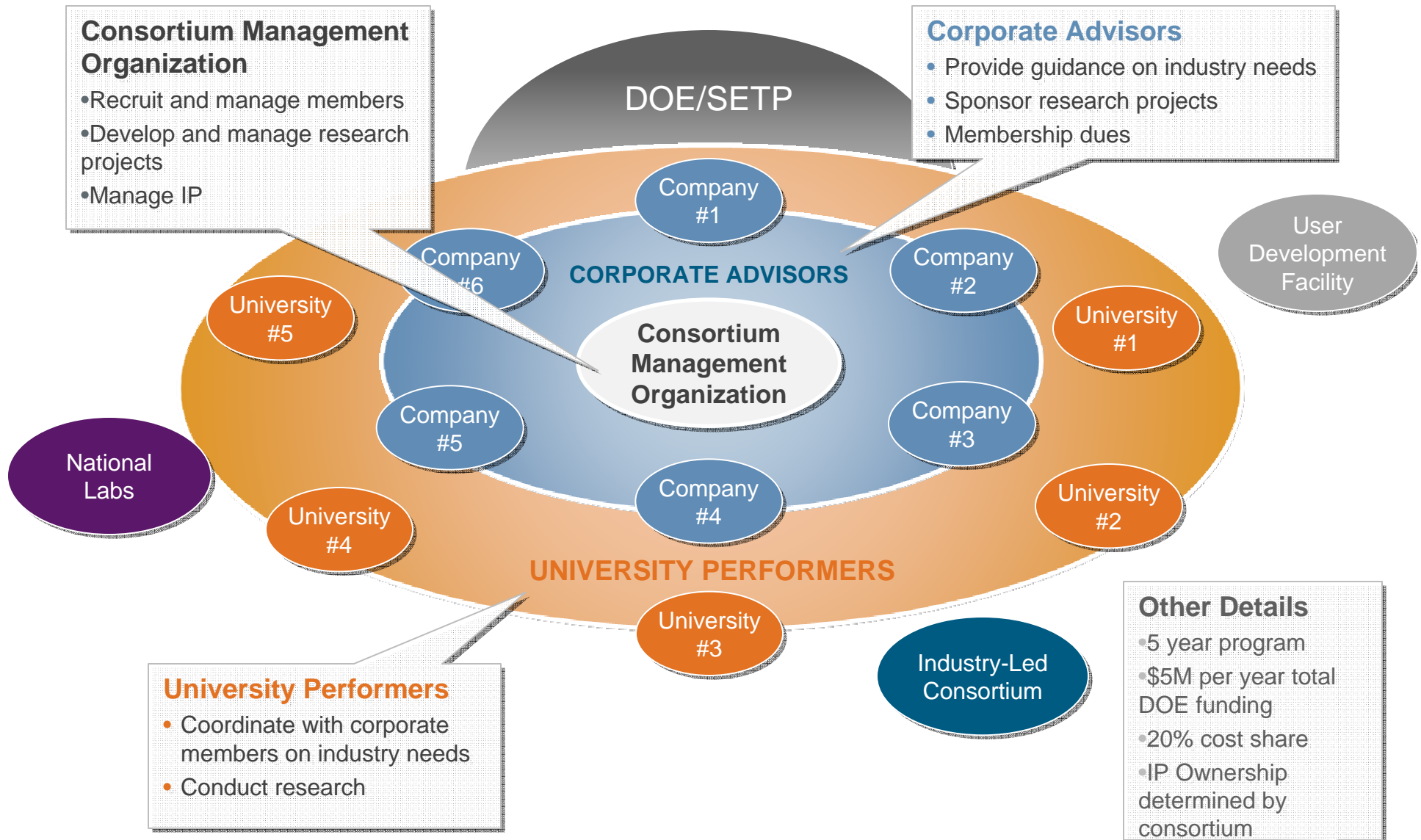
- **To ensure a strong and coordinated domestic PV industry, and to accelerate:**
  - the creation of a robust U.S. PV manufacturing base, including differentiated technologies and a strong infrastructure and supply chain
  - the development of a highly trained PV manufacturing workforce
  - the commercialization of cutting edge technologies
- **To support collaborative approaches in order to:**
  - leverage limited R&D budgets (industry & Federal), and to offer pooled risks & benefits for partners
  - improve responsiveness to industry needs and market conditions
  - catalyze coordination within industry, including collaborative research and shared resources and facilities
  - accelerate development and commercialization of PV manufacturing and process technologies through close partnerships between companies, universities, and other non-Federal stakeholders
- **To translate domestic PV innovation into domestic manufacturing**
  - off-take strategy for commercializing successful R&D outcomes will be required

# The PVMI solicitation will have two topics – University-Focused and Industry-Focused

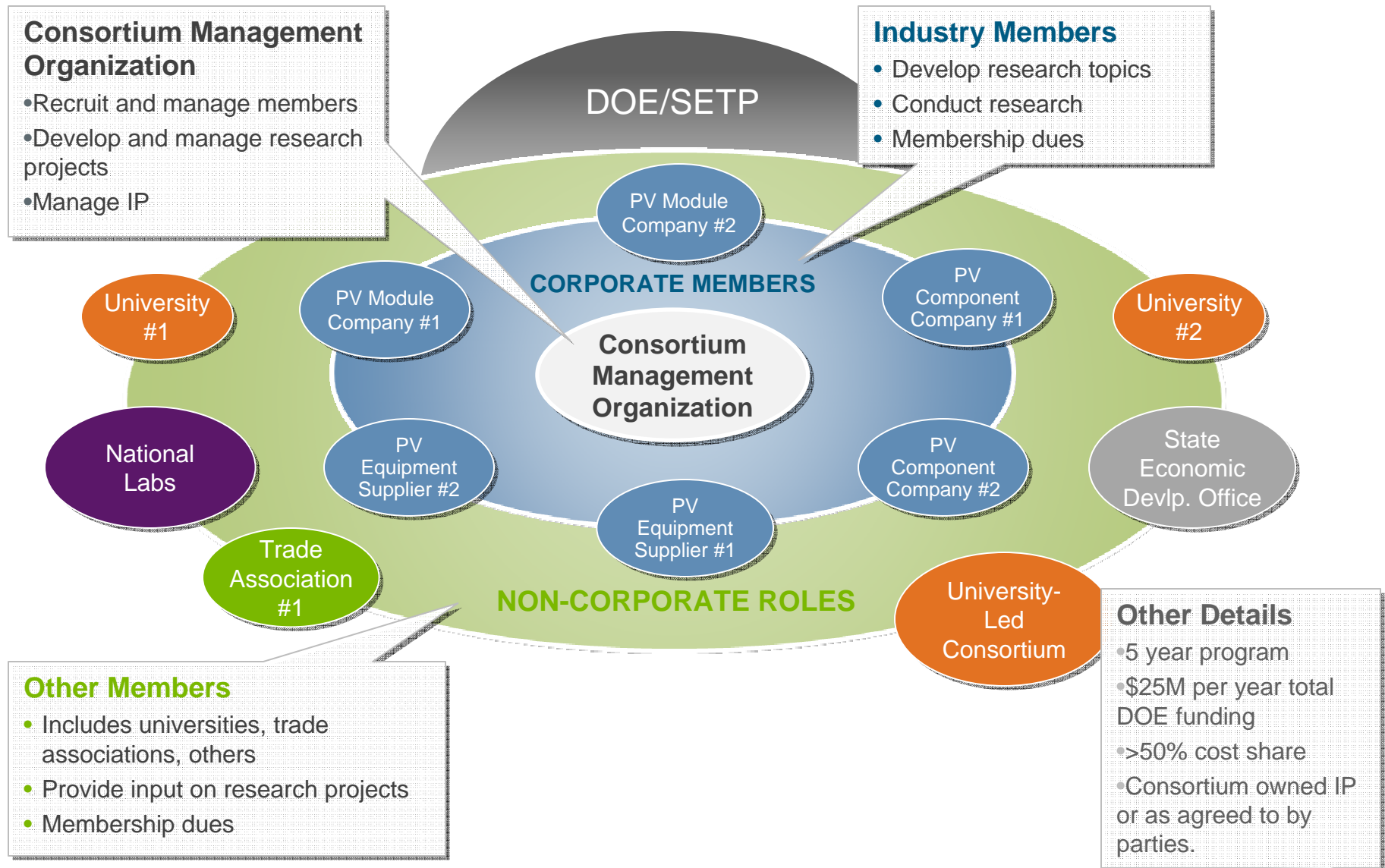
**Goal is to support and fund an organizational and/or facility structure that will identify manufacturing R&D needs and solicit, select, coordinate, monitor, and/or otherwise enable R&D projects**



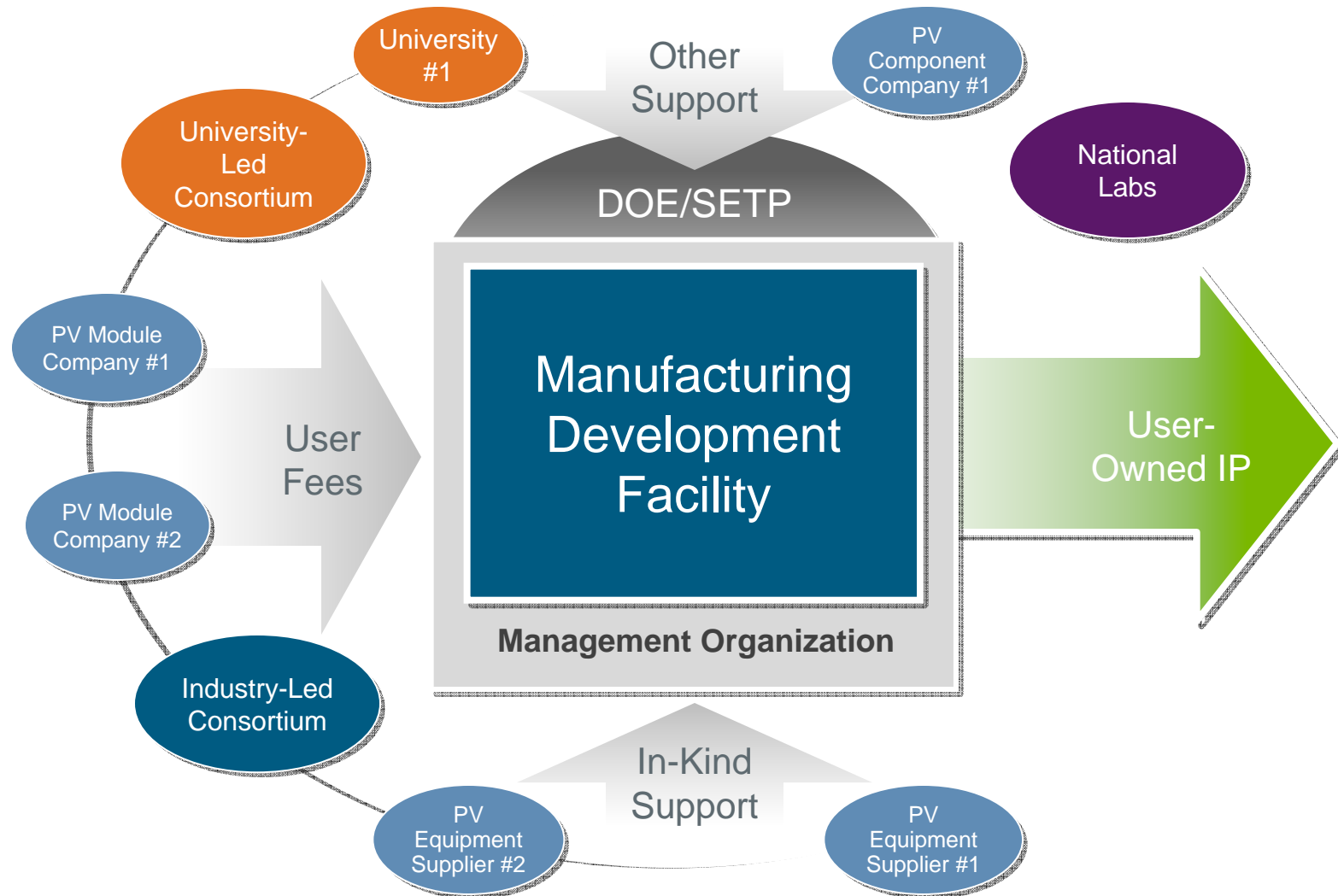
# University-Focused Initiative: Consortium Model



# Industry-Focused Initiative: Consortium Model



# Industry-Focused Initiative: Manufacturing Development Facility Model



# Comparison of Three Models

	University-Focused Consortium	Industry-Focused Consortium	Manufacturing Development Facility
Management	Consortium Management Organization (not-for-profit)	Consortium Management Organization (not-for-profit)	Single company (not-for-profit or for-profit)
Primary Performers	Universities	Industry companies – module companies, component companies, equipment suppliers	Primary customers are industry companies – startups and established companies
Additional Partners	Industry companies, others	Universities, State Economic Dev Organizations	Equipment and material suppliers
IP Ownership	University conducting research (or shared with corporate sponsor as determined by consortium)	Consortium	Company using facility
Non-DOE Revenue sources	Universities, Corporate Members	Corporate Members, Economic Dev Organizations, Equipment or Material Suppliers	Investors, User Fees, Equipment or Material Suppliers
DOE Funding	\$5M year total for 5 years	\$25M per year initial with decrease over 5 years	
Cost-Share	20% non-Federal	50% non-Federal, with higher cost-share judged favorably	



Examples of potential areas of R&D need – industry to determine critical barriers to improved efficiency, lifetime, cost, uniformity, throughput, etc.

## Manufacturing and Fundamentals

### PV Manufacturing-Scale Equipment and Processing

Large-area, high-throughput deposition – process uniformity, reproducibility, and control (incl. stoichiometry, phase, doping, defects)

Continuous / roll-to-roll processes

Advanced atmospheric deposition and printing processes

Material handling

### Metrology and Test Equipment

Rapid, in-line, large-area sensors, diagnostics, and feedback control

### Reliability and Durability

Understanding of degradation mechanisms

Accelerated aging – test methodologies and tools

### Defect Fundamentals, Modeling, and Control

Grain size and boundaries, dislocation densities

Dopants, impurities, and diffusion (incl. gettering)

Carrier and recombination dynamics

Heterogeneous interfaces and properties

Passivation

Feedstock / precursor purity and quality

## Cell, Module, and Device Innovations

### Optical Layers

Anti-reflective coatings

Transparent conductors – new materials or deposition

Light trapping surfaces and layers

### Contacts and Metallization

Advanced contacts – high aspect ratio, low barrier, low interfacial recombination

Alternative non-silver materials

Interconnect / soldering processes

### Encapsulants and Protective Coatings

Flexible, transparent moisture barriers

Tedlar, EVA, and edge sealing improvements and alternatives

### Alternative Substrates and Approaches

Improved wafering

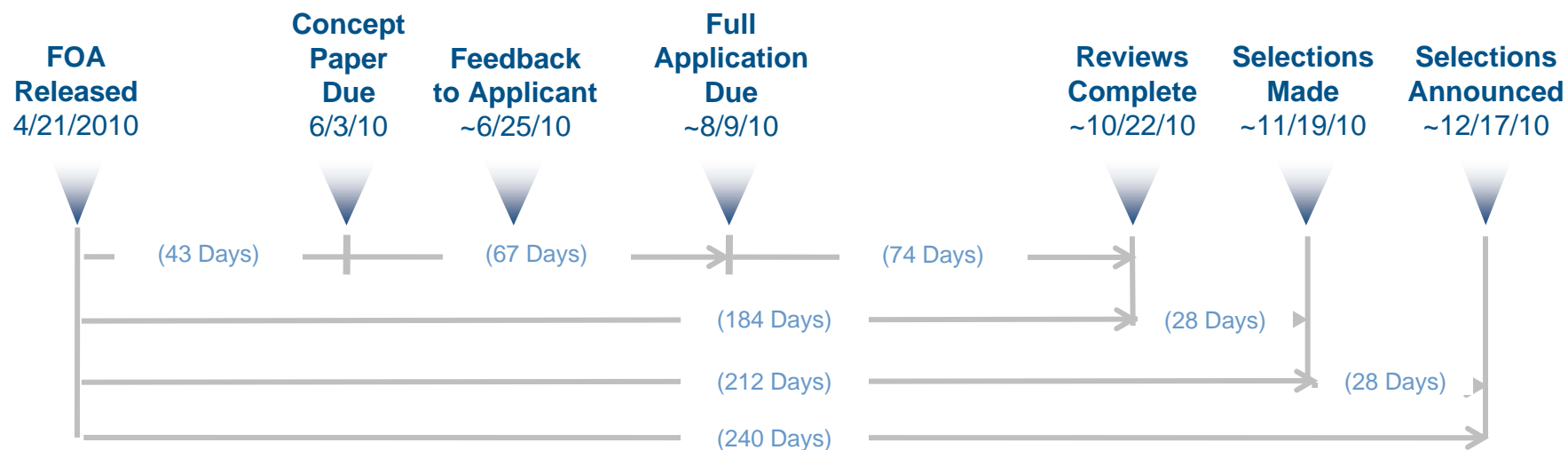
Film silicon

### Physics of novel / next gen device designs

Selective architectures and fabrication processes

Tandem cells, intermediate-band cells

# Approximate timeline for PV Manufacturing Initiative



**Concept Paper – due 43 days after FOA issue date**

**Full Application – due 45 days after concept paper feedback**

**Selections likely announced in December 2010**

# Concept papers required as part of application process

- Final input on feasibility of approaches and go / no-go decision on full FOA
  - Technical objectives and business model to achieve manufacturing impact and self sufficiency.
- Feedback to applicants
  - Encouraging / discouraging full application
  - Suggested areas for improvement
- Due June 3, 2010, at 11:59 PM Eastern Time
  - Maximum 10 pages in length
  - Required for full application

## Concept Paper Requirements

- **Organizational Objectives**
  - Strategic technical objectives, the specific strategy and operational framework for meeting these objectives, and how meeting these objectives will address deficiencies in U.S. PV manufacturing.
    - Technically detailed at the sub-module, sub-cell materials, and/or process level
    - Linked to the structure and dynamics of the U.S. PV industry
    - Include quantifying activities and objectives in each specific area
  - The parts of the supply chain expected to be the main participants in the proposed organization, and how they will commercialize / implement the technologies or advancements developed through the organization
    - State any assumptions about future industry dynamics or structure
- **Capabilities and Resources**
  - Members that have committed or otherwise stated strong interest in sponsoring the proposed organization
    - Categorization of the level of interest
    - General capabilities, expertise, and/or resources of each member
  - Initial P/L estimate for the organization with expected funding sources and expenses
    - Sources of funding broken out by type – including member or user fees, DOE funding, funding from state organizations, and other sources
    - Expenses broken down between capital and operations
    - Any in-kind resources described and quantified

# Full application: merit review criteria

## Review Criteria

- Criterion 1 (20%):** Organization Objectives
- Criterion 2 (25%):** Management and Business Plan
- Criterion 3 (20%):** R&D Plan
- Criterion 4 (15%):** IP Plan
- Criterion 5 (20%):** Capabilities and Resources

## Scoring Criteria

- 9–10** Superior
- 7–8** Good
- 5–6** Satisfactory
- 3–4** Marginal
- 1–2** Unsatisfactory
- 0** Deficient

## Program Policy Factors

- Leveraging of projects to maximize programmatic objectives (best value to the government as evidenced by Cost Share or other contributions)
- Significance of Organizations' and Facilities' Impact (on the PV industry)
- Geographic Diversity
- Program Diversity

# Full Application Evaluation Criteria: All Topics



Energy Efficiency &  
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## Criterion 1: Organization Objectives (Weight: 20%)

- Degree to which the applicant demonstrates a **deep and technical understanding of the domestic PV industry's needs**. Adequacy of the description of technology barriers, scale-up challenges, and collaborative opportunities for the proposed technology focus.
- Extent to which the organization's objectives and technology development goals will meet industry needs, **strengthen the competitiveness of domestic PV manufacturing, and translate into increased PV and supply chain manufacturing and employment that remain in the U.S.** Degree to which the organization's technical objectives, strategy, and operational framework would successfully address deficiencies in U.S. PV manufacturing and thereby help develop a more robust domestic PV manufacturing base.
- Likelihood that the main participants in the proposed organization will be able to **commercialize or otherwise implement the technologies or advances developed through the organization**. Reasonableness of any assumptions about future industry dynamics or structure made in support of this commercialization or implementation plan.
- Extent to which the organization addresses potential **synergies among universities, the national labs, and the PV industry for advancing PV manufacturing innovation, education, and workforce development**.

## Criterion 2: Management and Business Plan (Weight: 25%)

- Extent to which the **management plan presents a thorough understanding of the issues and challenges** associated with the proposed organization structure.
- Extent to which the organization and membership structure **maximizes industry impact within the scope of the organization objectives**. Adequacy and appropriateness of plans for developing and optimizing membership.
  - **Topic I applications:** Extent to which how industry involvement will be maximized while still allowing research consistent with an academic environment. Credibility of plan to **solicit research participation from a broad range of academic institutions**. Likelihood of significant interaction, collaboration, and mentorship between university participants and industry technical leaders.
  - **Topic II applications:** Extent to which university involvement will be maximized and be supportive of industry research objectives.
- As appropriate, the extent to which **participation of foreign-based entities, in the context of supporting domestic manufacturing, has been addressed**.
- Adequacy and credibility of the **project timetable, including well-developed key milestones and decision points**.
- Effectiveness of **governance and leadership structures for achieving organization objectives**. Extent to which the roles within the organization, including lead organization(s) and executive officers, governing boards and/or advisory boards have been identified. Adequacy of structure and processes for supporting decision-making and ensuring responsiveness to members' needs.
- Strength of the management approach and of strategy for **communication and information exchange among management and membership**.
- **Adaptability of organization to changing industry conditions and needs**, including the adequacy of periodic review processes and decision criteria.
  - **For Topic II, appropriateness of the proposed budget, including capital equipment requirements** and the degree to which equipment manufacturer participation is leveraged.
- **Financial viability of applicant's business plan**. Extent to which plans for developing non-federal revenue streams are viable and achievable. **For Topic II, likelihood that the project can achieve financial self-sufficiency within 5 years**.

# Full Application Evaluation Criteria: All Topics

## Criterion 3: R&D Plan (Weight: 20%)

- Appropriateness of **methodology for selecting and prioritizing R&D projects** that will be funded by the organization and/or supported in a manufacturing development facility. Effectiveness of plan to manage R&D funding, including from multiple cost-share partners where relevant.
- Quality of **proposed R&D management plan**. Extent to which plan will **evolve to meet changing industry needs and market conditions**.
- For applications that include **Manufacturing Development Facilities**: Adequacy and appropriateness of **methodology for allocating facility time among different projects and users**.
- Robustness of the approach for **R&D project oversight and monitoring**, including the conduct of stage-gate reviews, implementation of review findings, and project termination. Appropriateness of metrics for gauging project success.

## Criterion 4: Intellectual Property (IP) Management Plan (Weight: 15%)

- Adequacy of the IP management plan for supporting the needs of the organization, its members, the broader PV manufacturing industry, and the Department of Energy. Viability of **approach to managing IP ownership, IP security, and IP licensing**. Appropriateness of approach for negotiating and settling IP concerns, creating IP agreements, and adding new members.
- Extent to which the IP agreements attached in Appendix 3 demonstrates that the **IP issues inherent with collaborations are addressed**.
- Extent to which the IP management plan will **support achievement of the organization's goals, including creating opportunities for collaborative R&D** and fostering an environment of trust amongst members.
- Extent to which the IP management plan will **minimize barriers to company involvement** and help provide an acceptable value proposition to members and/or facility users. Appropriateness of royalty distribution plan amongst organization members, former members, and new members.
- Appropriateness and viability of the **approach for disseminating results of research to organization members, the scientific community and the public**.

# Full Application Evaluation Criteria: All Topics

## Criterion 5: Capabilities and Resources (Weight: 20%)

- Extent to which the capabilities, experience, and qualifications of the organization and its members are consistent with and support the proposed scope of work and the organization's objectives. **Caliber, leadership capability, and successful track record of organization's primary executive officer(s) or director(s).** Extent to which the necessary **management, business, technical, and intellectual property personnel** for supporting a high likelihood of success have been identified. Adequacy of experience in successfully managing IP in a collaborative and/or multi-user facility environment.
- Adequacy of the **facilities, facility staffing and assignees and resources** for executing the proposed scope of work and their relevance for supporting high volume PV manufacturing and the evaluation of viability and scalability of new technologies.
- Degree of support as evidenced by **letters of commitment from anticipated organization members, suppliers, and customers.** Extent to which the application includes commitments from **multiple leading members from the PV industry** that indicate strong support and an increased likelihood of reaching self-sufficiency.



- **Application Download**

- Download Adobe Application Package at <http://www.grants.gov/>
- Click “Apply for Grants”, click “Download a Grant Application Package” link, enter CFDA Number OR FOA Number, click "Download Package" button

- **Application Submission**

- **MUST BE SUBMITTED THROUGH GRANTS.GOV TO BE CONSIDERED FOR AWARD.**
- Instructions in the Grants.gov User’s Guide
- Applicants are responsible for verifying successful transmission, prior to the due date and time

- **Questions and Answers About the FOA Content (before / after webinar)**

- Submit through the FedConnect Portal at <https://www.fedconnect.net/>
- Register as soon after FOA release as possible to have the benefit of all responses
- More info:  
[https://www.fedconnect.net/Fedconnect/PublicPages/FedConnect\\_Ready\\_Set\\_Go.pdf](https://www.fedconnect.net/Fedconnect/PublicPages/FedConnect_Ready_Set_Go.pdf)

# Critical registration requirements

- **Allow at least 21 days to complete the required registrations.**
- Dun and Bradstreet Data Universal Numbering System (DUNS) number
  - Obtain at <http://fedgov.dnb.com/webform>
- Central Contractor Registration (CCR) system
  - Register at <https://www.ccr.gov/> – update annually
  - Designate an E-Business Point of Contact (EBiz POC)
  - Obtain a special password called an MPIN
- Grants.gov
  - Register at <http://www.grants.gov/>
  - Organization Registration User Guide: <http://www.grants.gov/assets/OrgRegUserGuide.pdf>.
  - Applicant User Guide: <http://www07.grants.gov/assets/ApplicantUserGuide.pdf>.
- FedConnect
  - Register at <https://www.fedconnect.net/> – use “Register as a Vendor” link
  - Create an organization account, requiring your organization’s CCR MPIN

- Context and purpose
- Structure of FOA and solicited organizational approaches
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# Thank You



## Contact Information:

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