
The Solar Industry— DOE and National Lab Programs to Accelerate Growth



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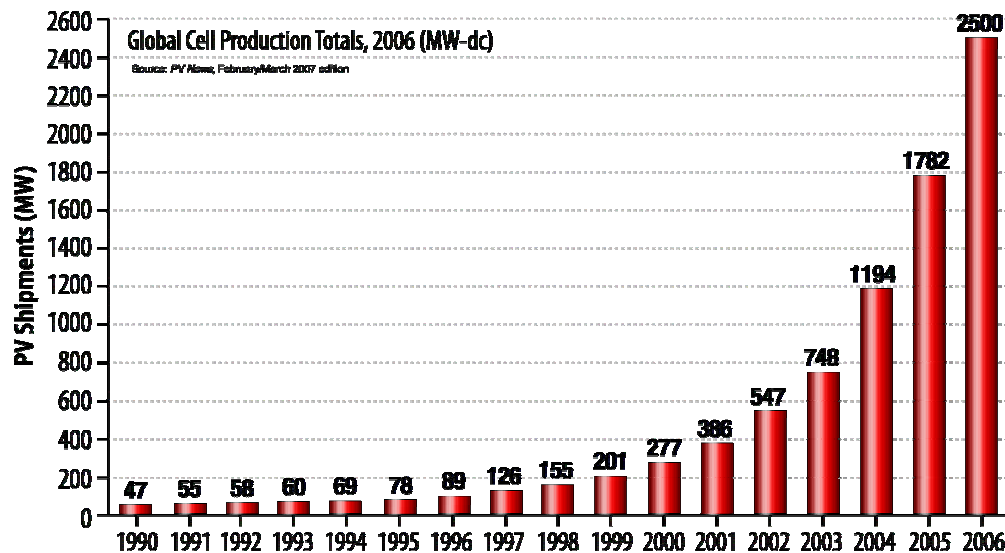


- The Changing Solar Industry
- The DOE Program
- Funding R&D
- Commercialization
- National Labs R&D and Tech Transfer

Motivation: Growth of Solar Industry

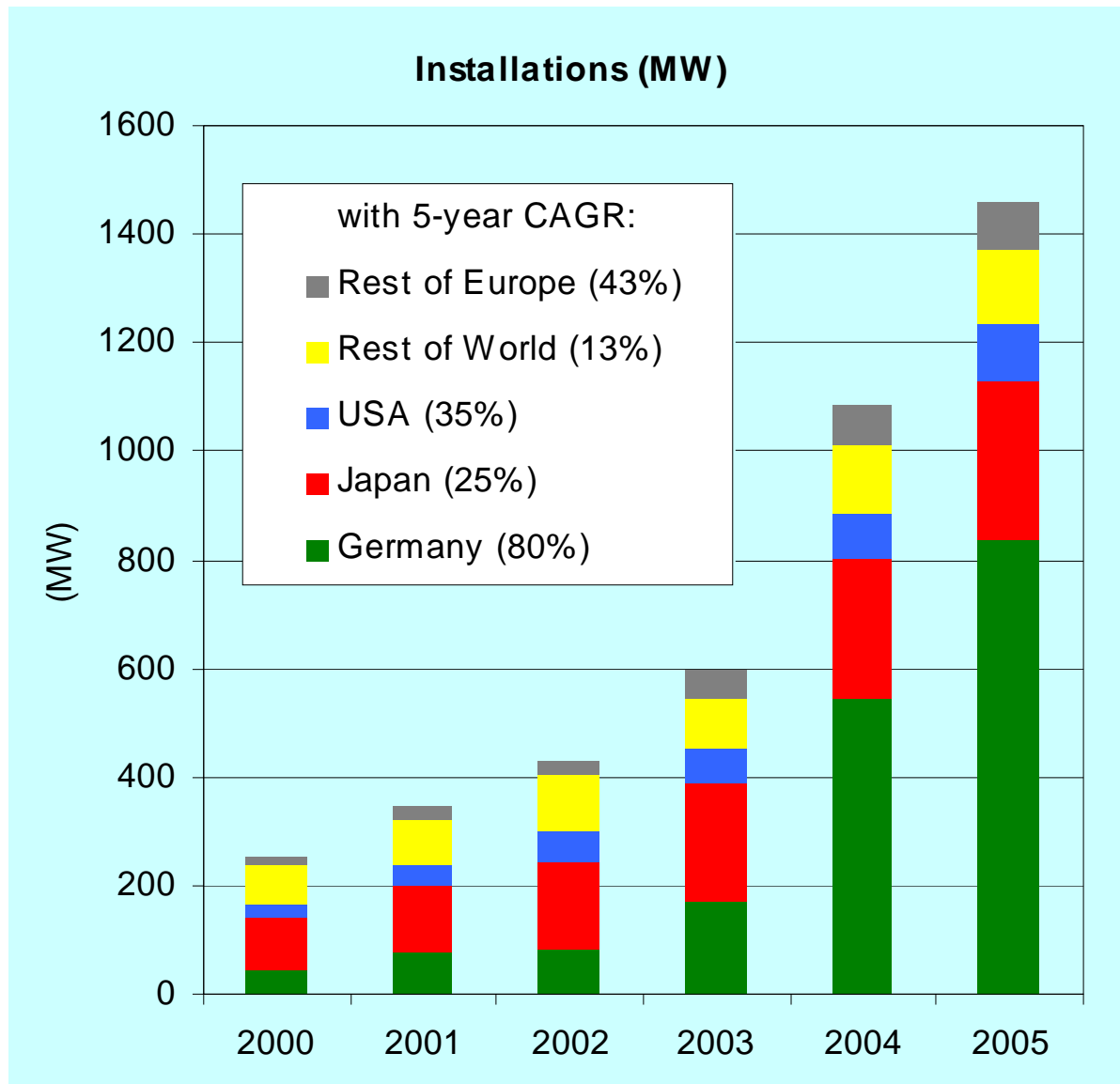


Shipments of PV

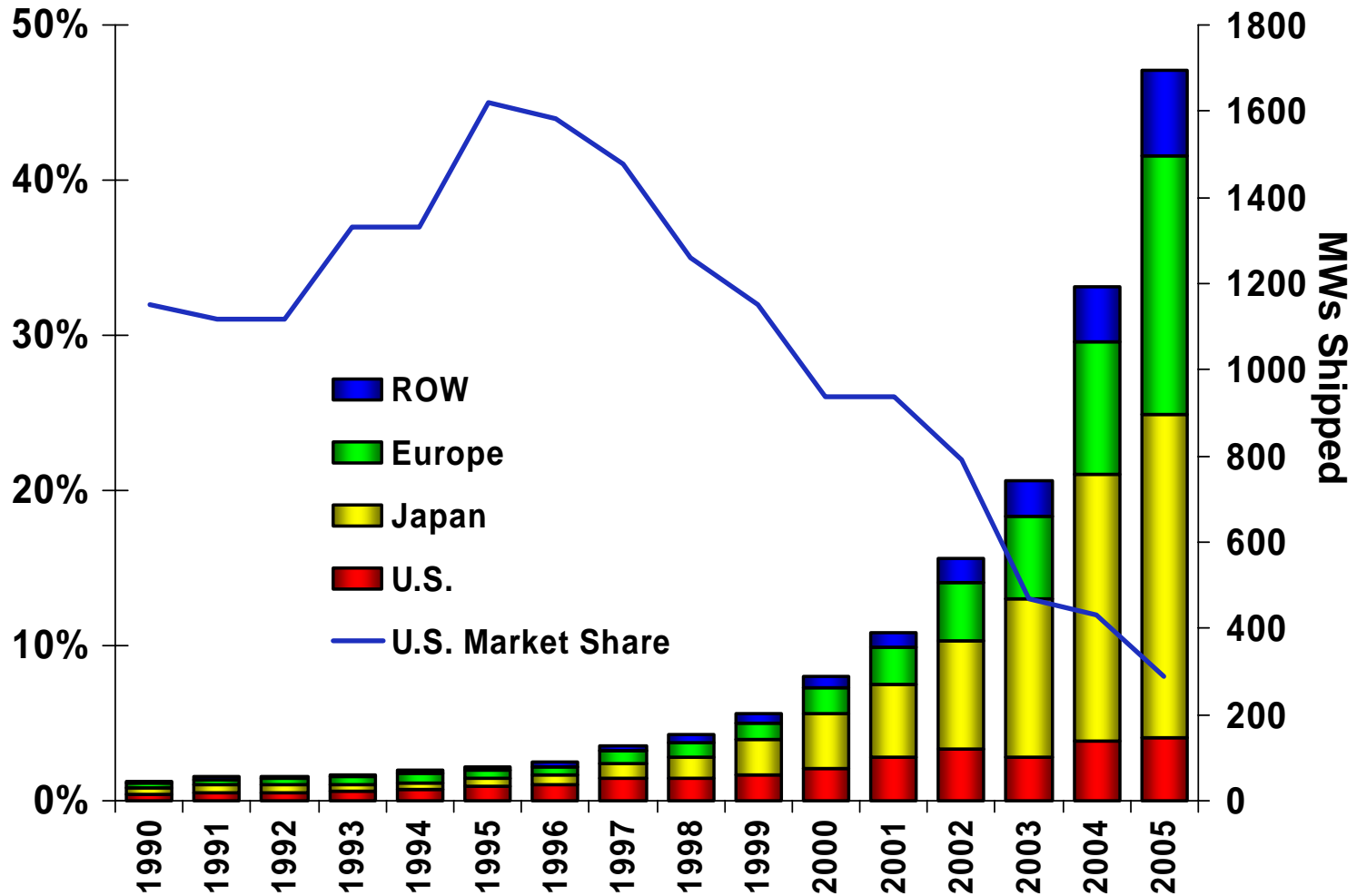


- High public interest in solar
- Constraints on carbon emission
- Currently \$12B annual revenue worldwide
- Venture capital investments in solar energy
\$160M (2005)
\$360M (2006)
- DOE FY07 solar budget \$160M

GERMAN MARKET DOMINATES CONSUMPTION



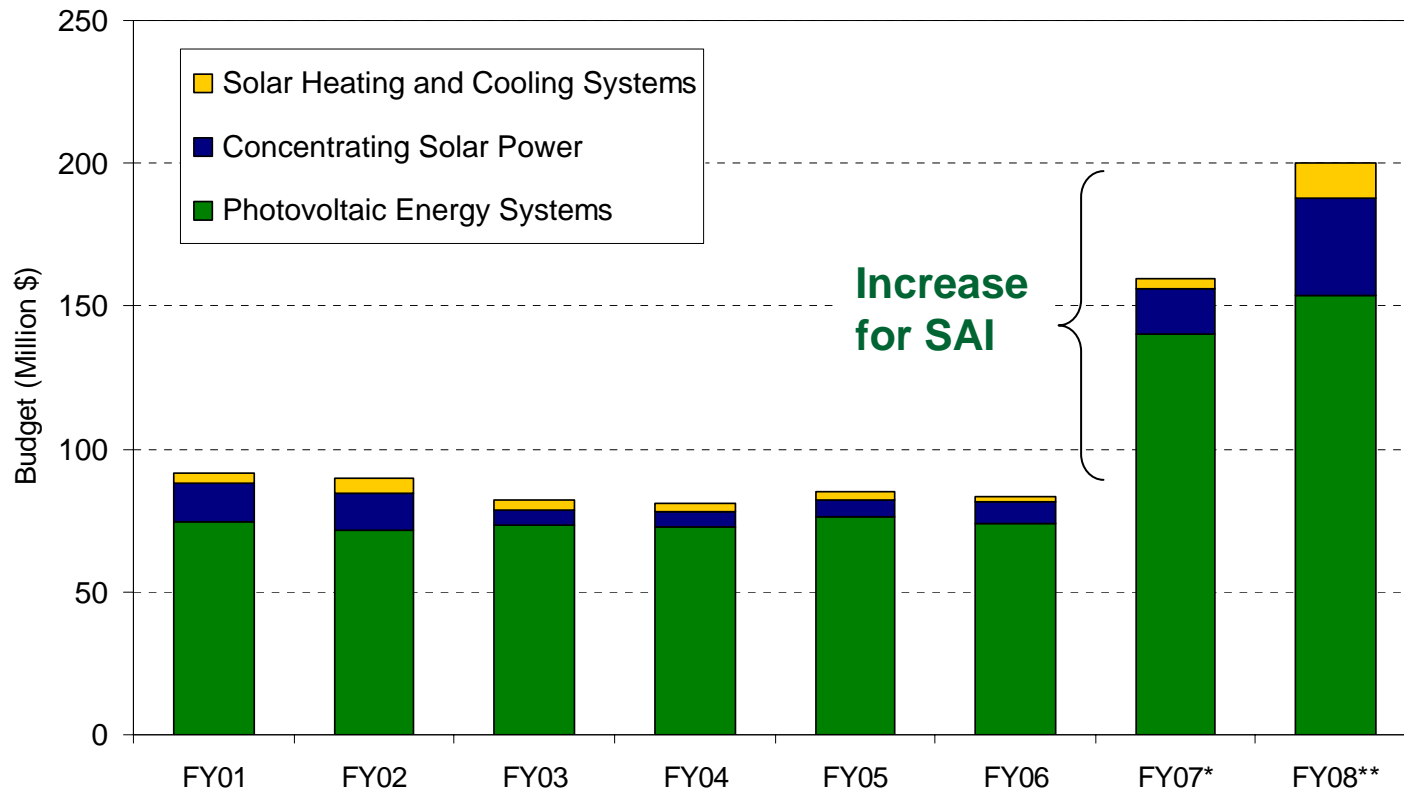
PV SHIPMENTS AND MARKET SHARE



Funding for the Solar America Initiative will accelerate supply growth & adoption of PV/CSP technologies



Solar Energy Technologies Funding, FY01 – FY08



With one last investment push, the Federal government will realize full value of 30-years of RD&D with a major new CLEAN energy source.

* President's Request for FY07 was \$148M, final FY07 CR provided \$159M.

** President's Request for FY08 was \$148M, current House mark for FY08 is \$200M.

DOE Solar Energy Goals



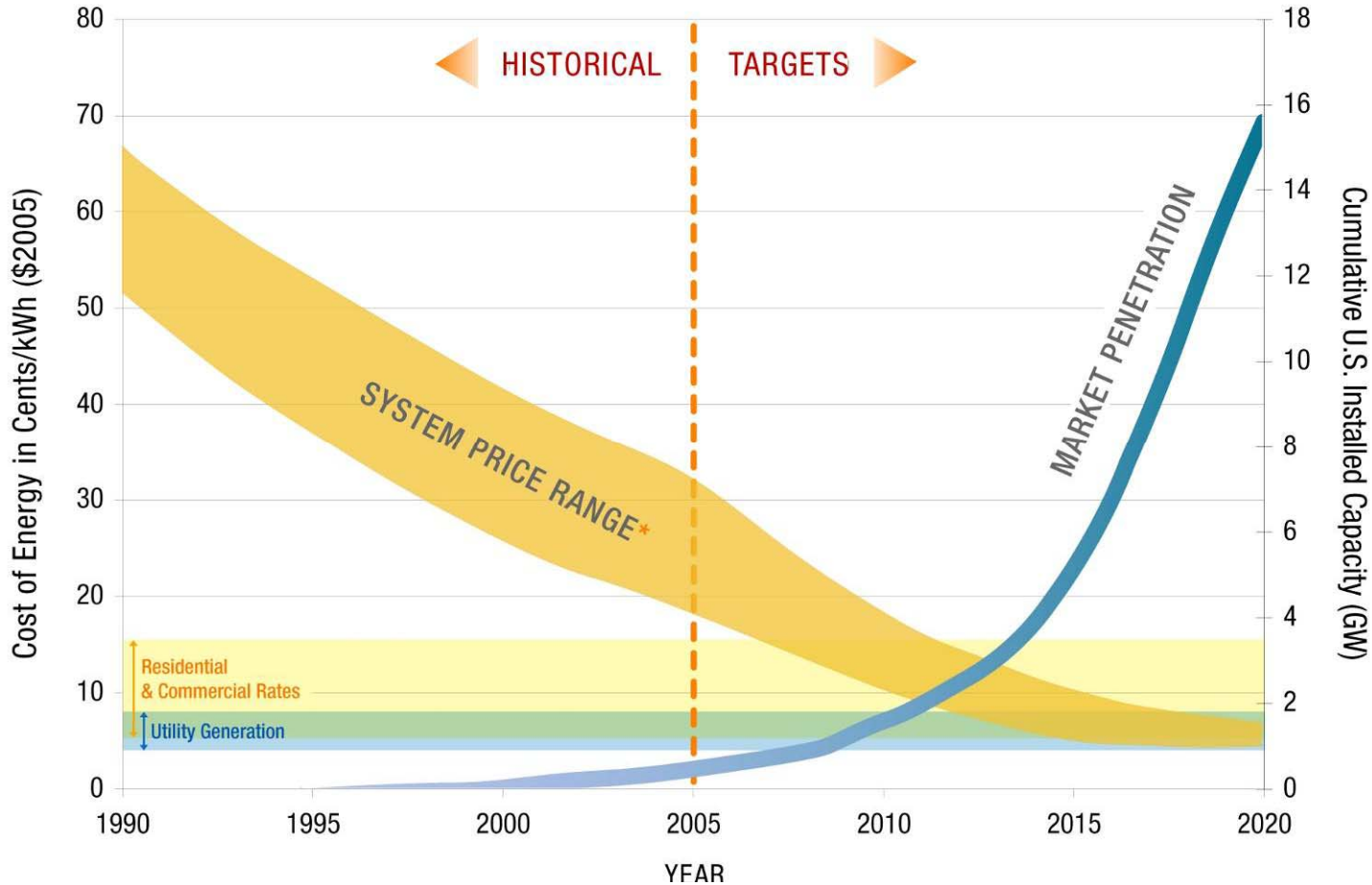
- Make PV cost-competitive by 2015
 - Reduce module cost (\$/W)
 - Increase energy yield (kWh/kW_p)
 - Extend MTBF (y)
- Increase manufacturing capacity
 - Stimulate investment (MW/y)
 - Improve throughput (MW/Mfg. Line)
 - Expand automation (FTE/MW)
- Address grid-integration and issues of scale
- Solar workforce development

Where does solar industry need to head during next 5 – 15 years?



Increase demand	→	Incentives and subsidies
Reduce cost	→	R&D
Eliminate barriers to deployment	→	Technology and policy

The goal of the President's Solar America Initiative is to make PV cost-competitive by 2015 across the U.S.



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

Specific DOE Initiatives



- Funding R&D
- Commercialization
- National Labs R&D and Tech Transfer

Specific DOE Initiatives Funding R&D



- TPPs
- Incubator
- University solicitations
- Future funding opportunities
 - Supply chain development

SAI 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)]

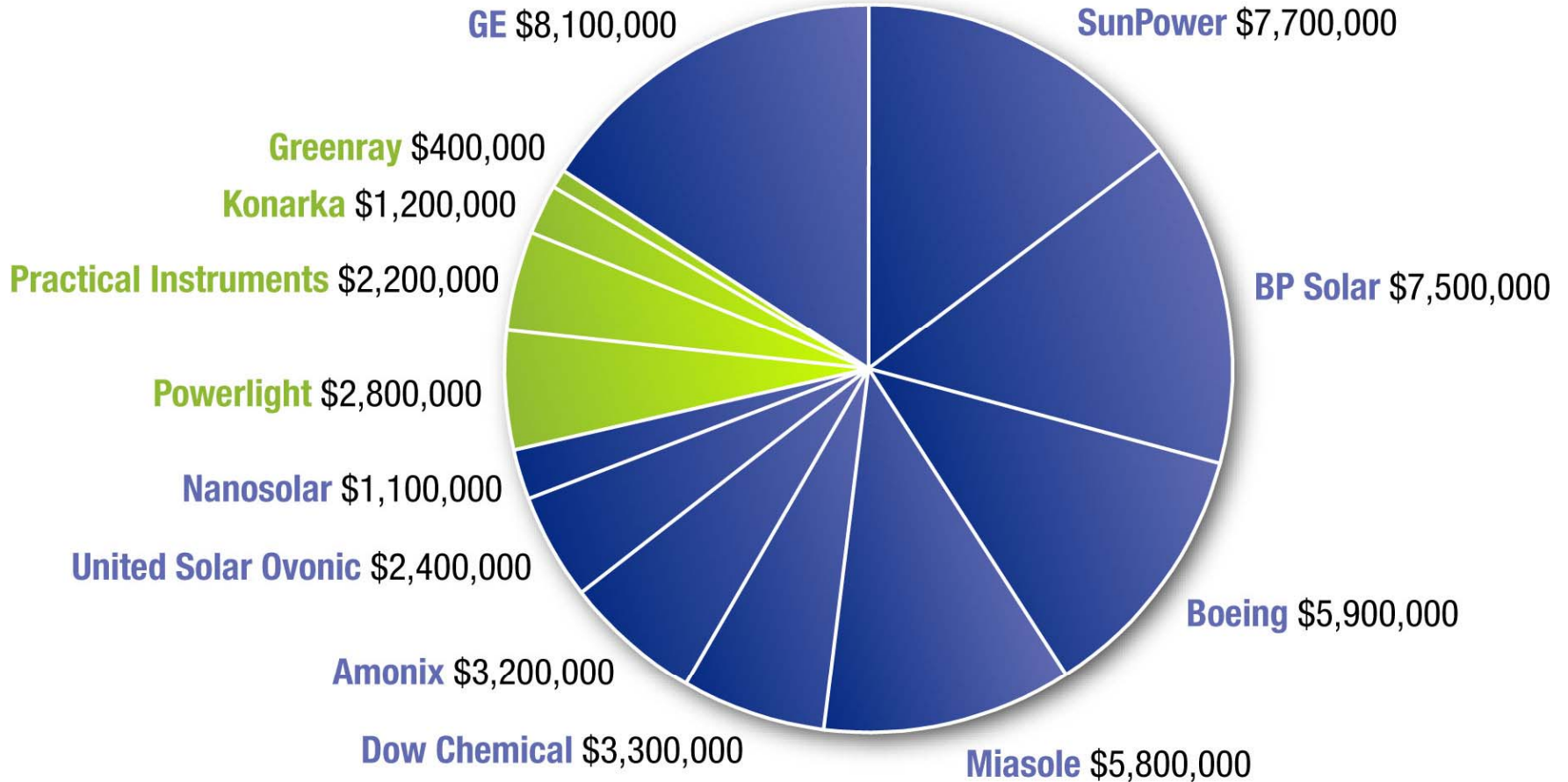
Projects will include a broad cross-section of U.S. industry:

- 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

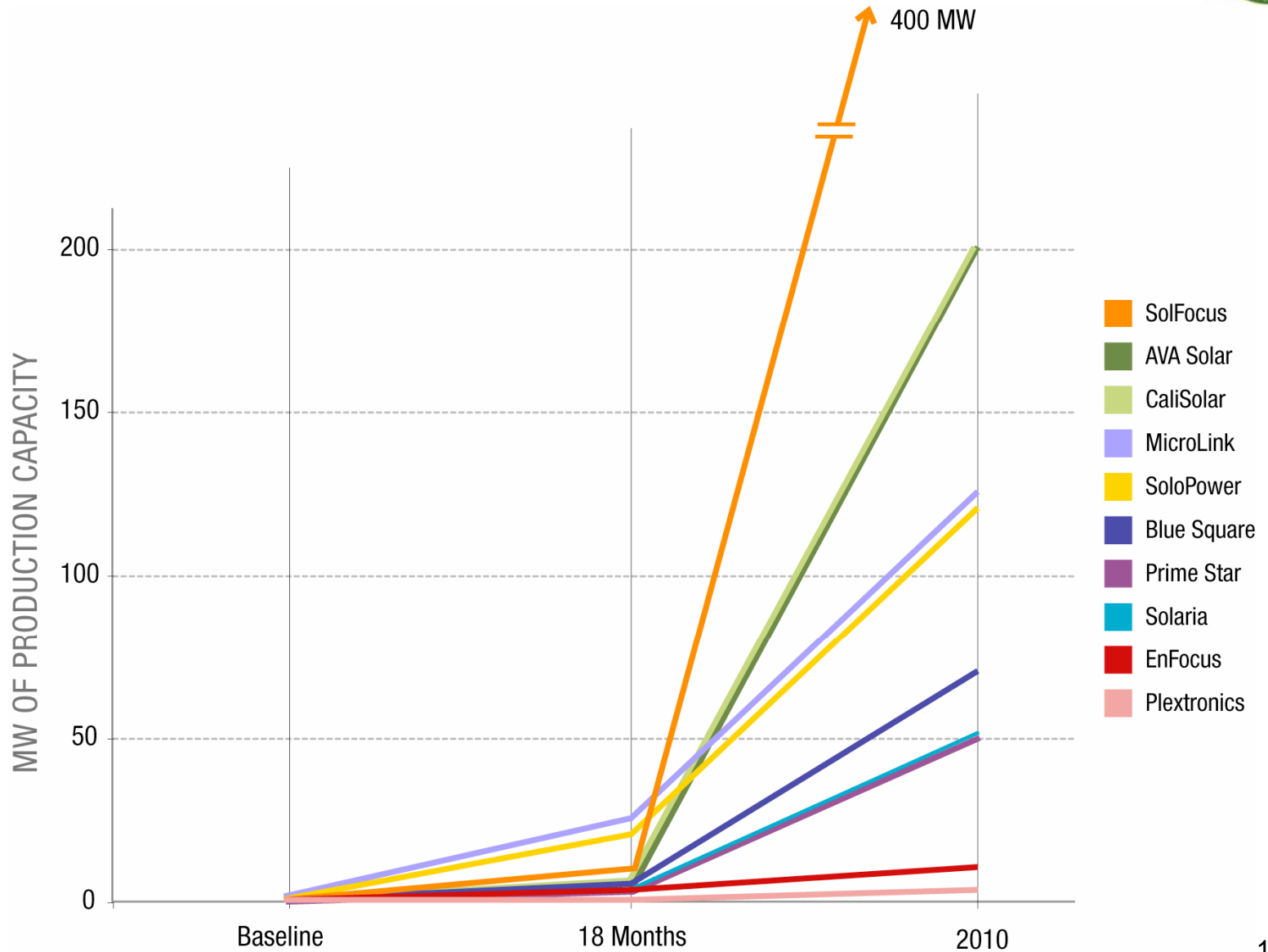


Subsystems Total:
\$6,600,000

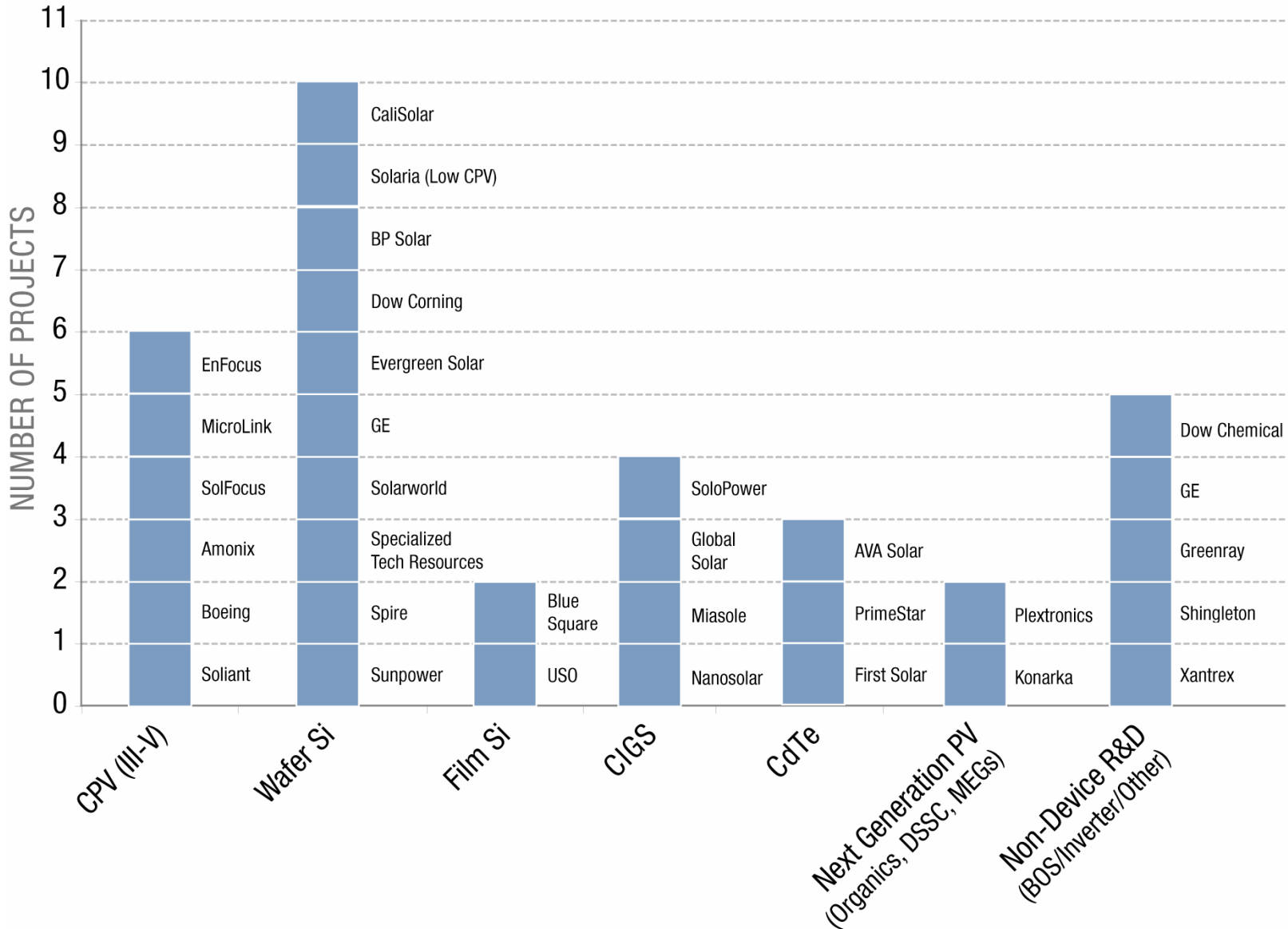
Total Funding:
\$51,600,000

Systems Total:
\$45,000,000

Incubator Projects Quickly Ramp Production Capacity to Pilot and Commercial Levels



DOE's Portfolio Balances Technology, Maturity & Risk, with new early-stage companies adding diversity



Specific DOE Initiatives

Commercialization (under development)



- Commercialization and deployment fund
 - \$7.2M in inaugural year for NREL, Oak Ridge, and Sandia
 - Cross “valley of death” between research and commercialization
- EIR program
 - Venture capital EIRs at National Laboratories
- CEBUS
 - Finance domestic clean energy development
 - Mitigate risks facing investors in large-scale production and distribution
 - Increase amount of private capital being deployed

Specific DOE Initiatives

National Labs R&D and Tech Transfer



- Technology roadmaps
- PDIL
- Grid integration
- Workforce development
- Technology transfer

Technology Roadmaps define need



Solar Energy Technologies Program

National Solar Technology Roadmap:

Wafer-Silicon PV

Facilitator: *Bhushan Sopori*

Participants included:
*National Renewable Energy Laboratory
Sandia National Laboratories
U.S. Department of Energy
University and private-industry experts*

DRAFT

Management Report
NREL/MP-520-41733
June 2007

- Metrics
 - Quantitative indicators
 - Track progress
 - Set goals for future
- Needs
 - What must happen to achieve goals?
 - Which organizations should address needs?
- Consensus driven
 - Reflect wisdom of community

Technology Roadmaps help R&D community respond to changing industry

Technology Roadmaps for each technology



Solar Energy Technologies Program

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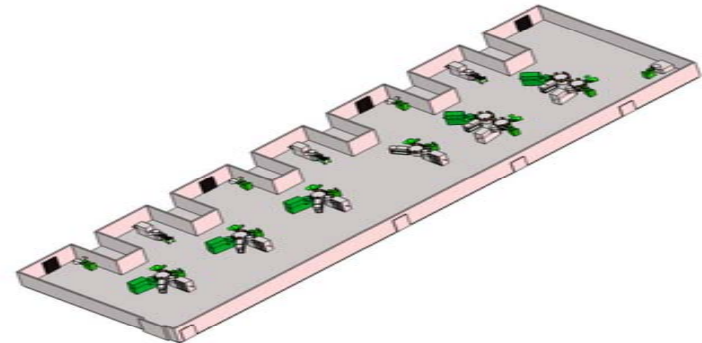
- Wafer Si
 - Film Si
 - CdTe
 - CIGS
 - Concentrating PV
 - Organic PV
 - Sensitized cells
-
- Revised by community next spring
 - Current versions on web:

http://www1.eere.energy.gov/solar/solar_america/planning.html

NREL Science and Technology Facility Process Development and Integration Laboratory



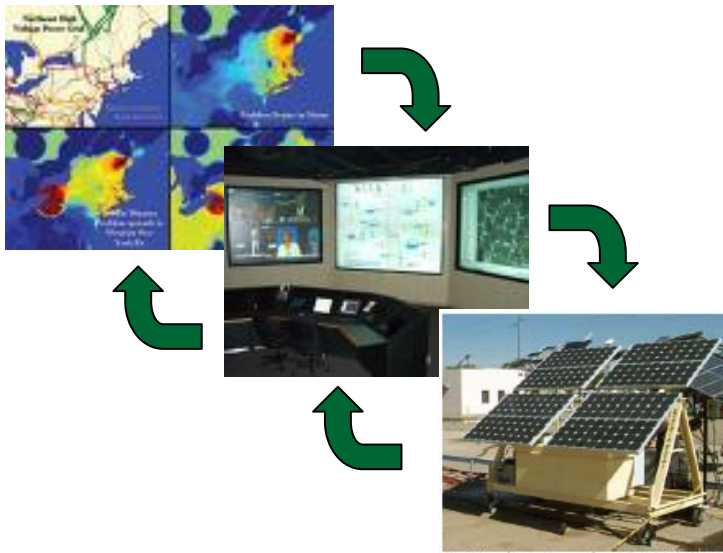
- *Complete PV cell process flow*
- *NREL and user-contributed equipment*
- *User facility for companies, NREL, others*
- *Capabilities*
 - *Si, CdTe, CIGS, and others*
 - *Vacuum and AP processing*
 - *Complete characterization suite*
- *Enables the study of*
 - *Cell performance, uniformity, and yield*
 - *Manufacturing process changes*



Solar-Grid Integration: Meeting New Needs



Problem: To facilitate broad deployment of PV while mitigating grid reliability impacts of transient loads and grid frequency/voltage fluctuation, we must:



Develop Solutions for Utilities:

- Conduct detailed analysis of grid effects and requirements through T&D simulation
- Establish grid infrastructure for localized wide-area energy networks, including utility load/production control methodologies
- Utilize prototype testbeds to evaluate characteristics of new PV systems for grid

Make PV Easier for Utilities to Manage:

- Improve stand-alone capabilities of PV systems with marginal storage
- Develop utility-interactive controls for distributed PV installations

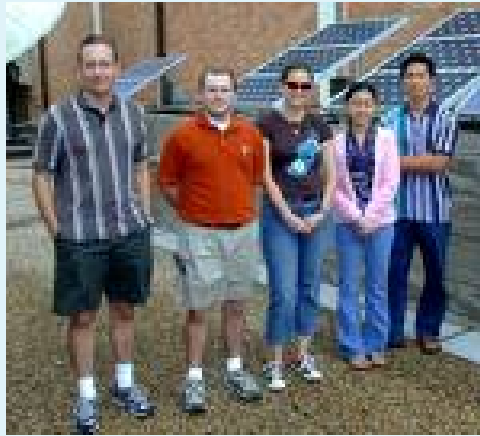


Workforce development program



GOAL

A skilled workforce for the solar industry



PRESENT STATUS

Solar companies find it difficult to find applicants with appropriate training

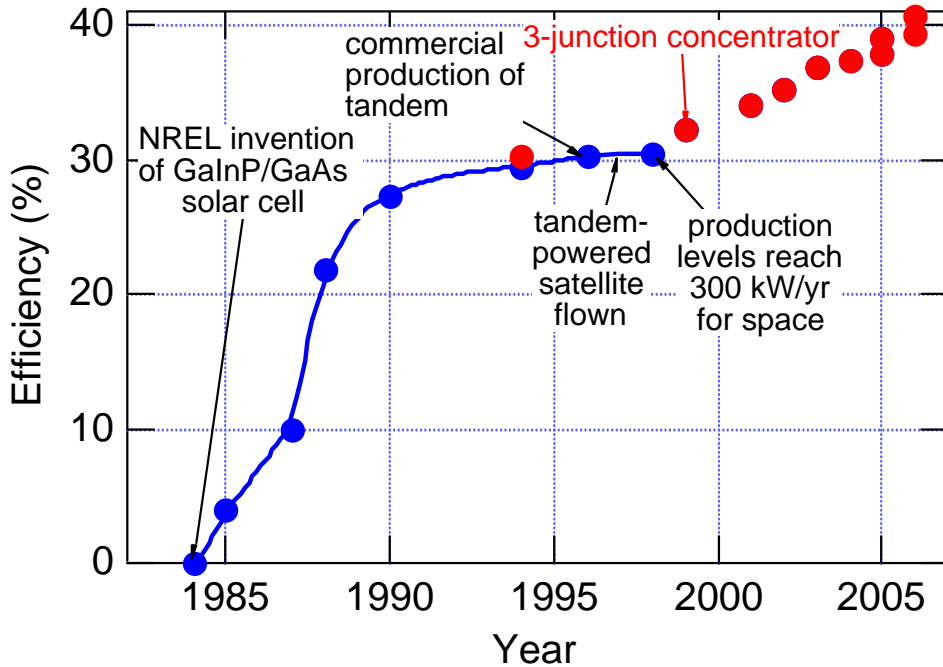
RECOMMENDATION

A program for undergraduates, PhD candidates, post docs, and visiting scientists to do research with scientists at NREL and other National Labs; sabbaticals

BENEFIT

A premier solar labor pool with training and ideas at the cutting edge of research, development, and industrial deployment

Successful Tech Transfer of GaInP/GaAs/Ge cell from NREL to Spectrolab and Tecstar



40.7%!



Mars Rover powered by multijunction cells

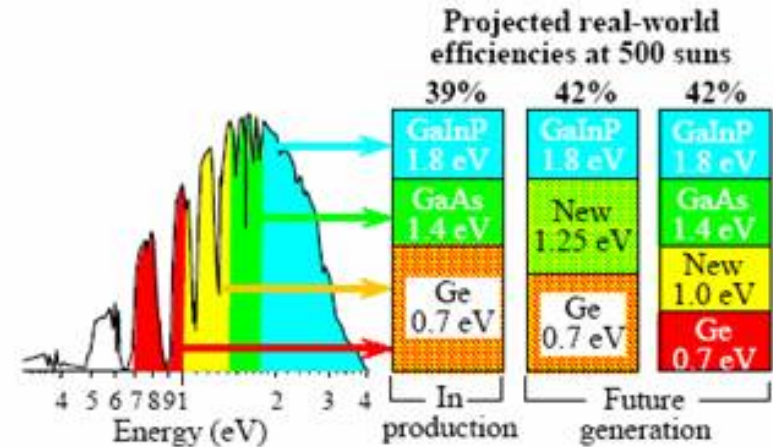
This very successful space cell is currently being engineered into systems for terrestrial use



Sandia and Emcore Have a Long and Successful History of Technology Transfer and Commercialization (Current: Commercial Development of CPV Technology)



**First Company in Science Park
Sandia Developed Technology/Staff
Photovoltaics and Fiber Optics**



Sandia's Current Contributions (WFO):

- 1) Tracking System Design & Hardware
(CSP Staff)
- 2) Packaging and Thermal Modeling
(Microelectronics Staff)
- 3) Performance Characterization and Reliability Assessments
(PV Staff)
- 4) Historical Perspectives (Do's & Don'ts)
(multiple staff)



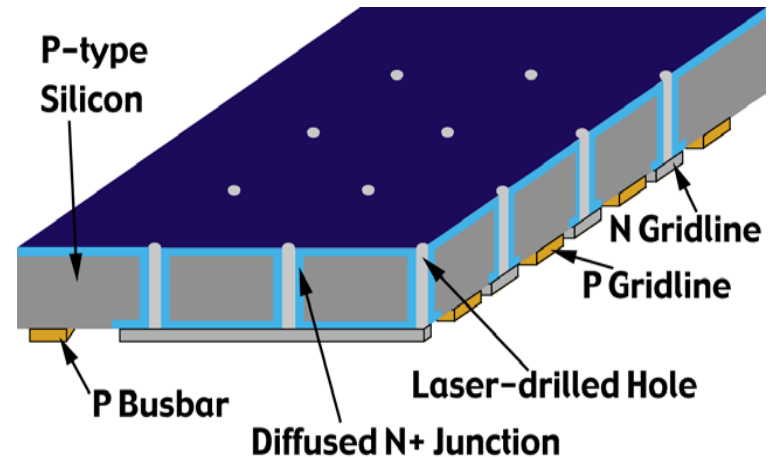
Space PV

~1-2 Year



Terrestrial CPV

Role of Sandia in the development of Advent Solar technologies



- Sandia patented and demonstrated the Emitter Wrap Through (EWT) solar cell in its Photovoltaic Device Fabrication Laboratory in CY2000.
- The patent was licensed to Advent Solar, which has gone on to acquire significant venture capital and open a manufacturing plant based on this concept in 2007. Recently shipping first commercial products.
- Co-Founder and CTO of Advent Solar was Former Sandia Solar Staff Member



- DOE and National Labs focused on supporting solar industry
 - Funding R&D
 - Technology Roadmaps
 - Tech Transfer
- DOE developing close ties to private sector
 - Venture capital industry
 - Large companies, startups, universities
- Mode of operation is open, transparent, enabling