U.S. Department of Energy
Solar Energy Technologies Program:

Systems Integration Activities

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Solar Energy Technologies Program
United States Department of Energy (DOE)

Renewable Energy Grid Integration Systems Workshop
January 13, 2009 - Hawaii

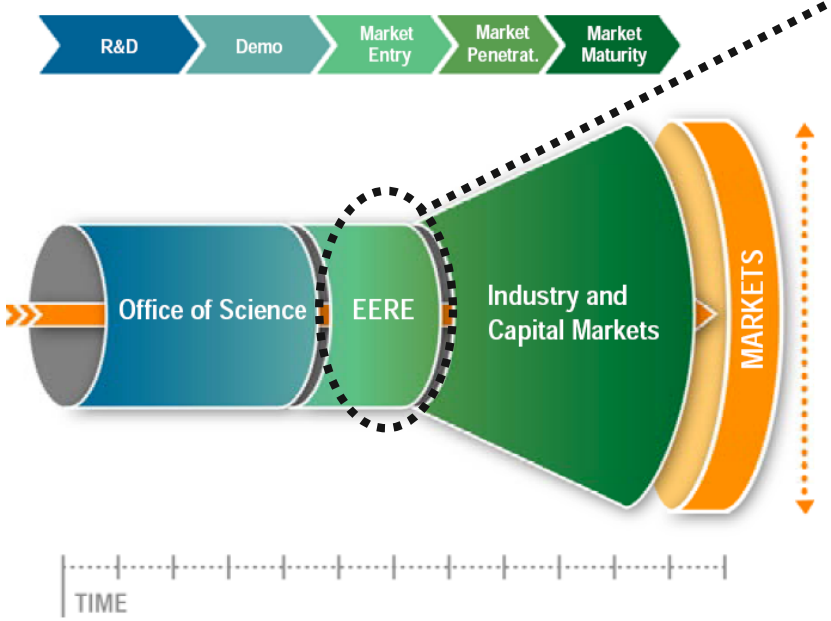
Agenda

- **Overview: U.S. Department of Energy Solar Energy Technologies Program**
- **Overview: Systems Integration Subprogram**
- **Systems Integration Activities**
- **Workshop and Peer Review Meeting**
- **Systems Integration Opportunities**

Organizational Structure

U.S. Department of Energy

Annual Budget: $23.9 Billion (FY08)



Energy Efficiency, Renewable Energy (EERE)

Annual Budget: $1.7 Billion (FY08)

10 Programs

Energy Efficiency

- Building Technologies
- Weatherization & Intergovernmental Program
- Industrial Technologies
- Federal Energy Management
- Vehicles

Renewable Energy

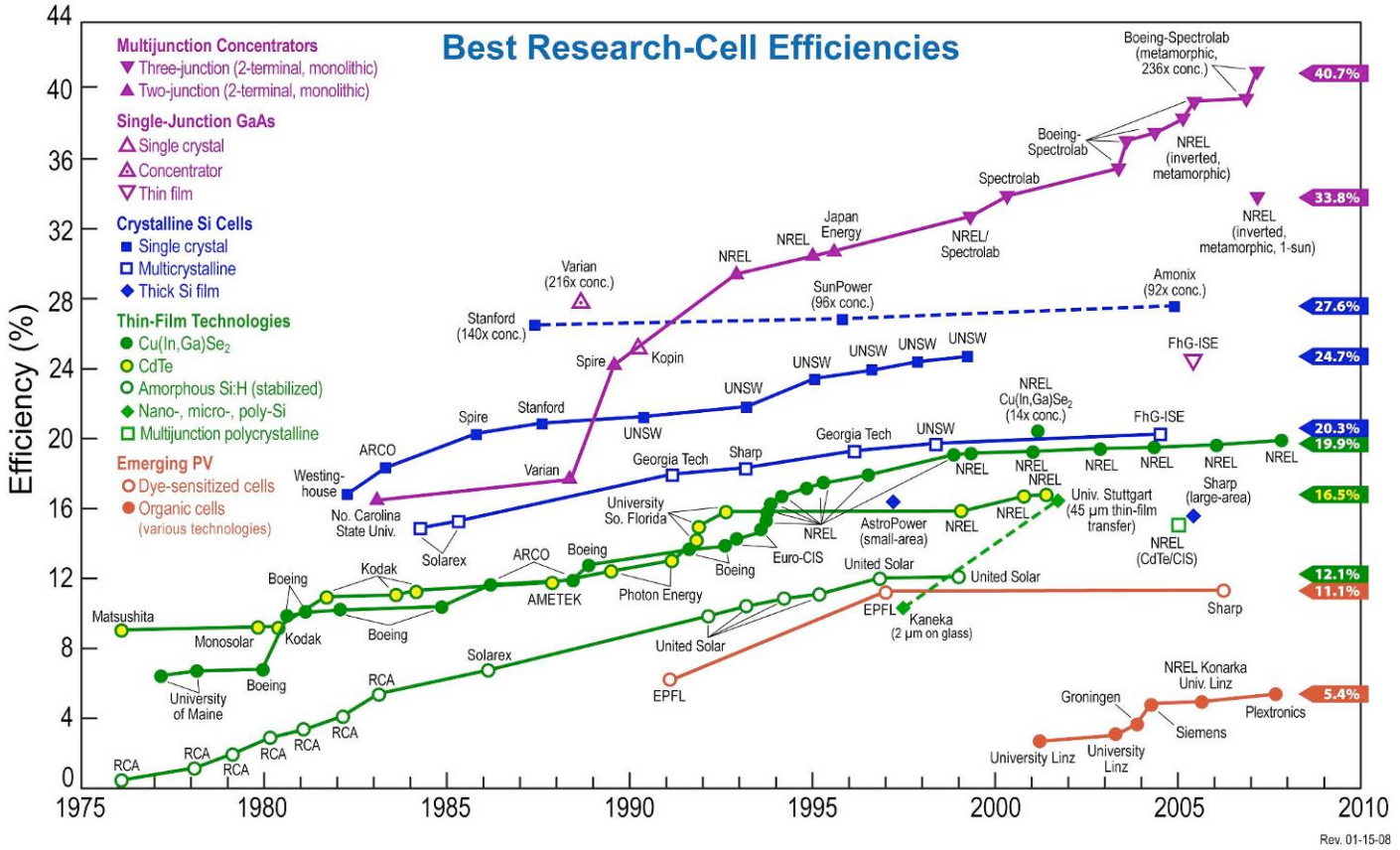
- Wind & Hydropower
- Biomass
- Geothermal
- Hydrogen, Fuel Cells & Infrastructure
- and ….

Solar Energy Technologies Program (SETP)

Annual Budget: $168 Million (FY08)

~20 Staff (incl. contractors)

DOE R&D Focus for Advancing Solar Energy

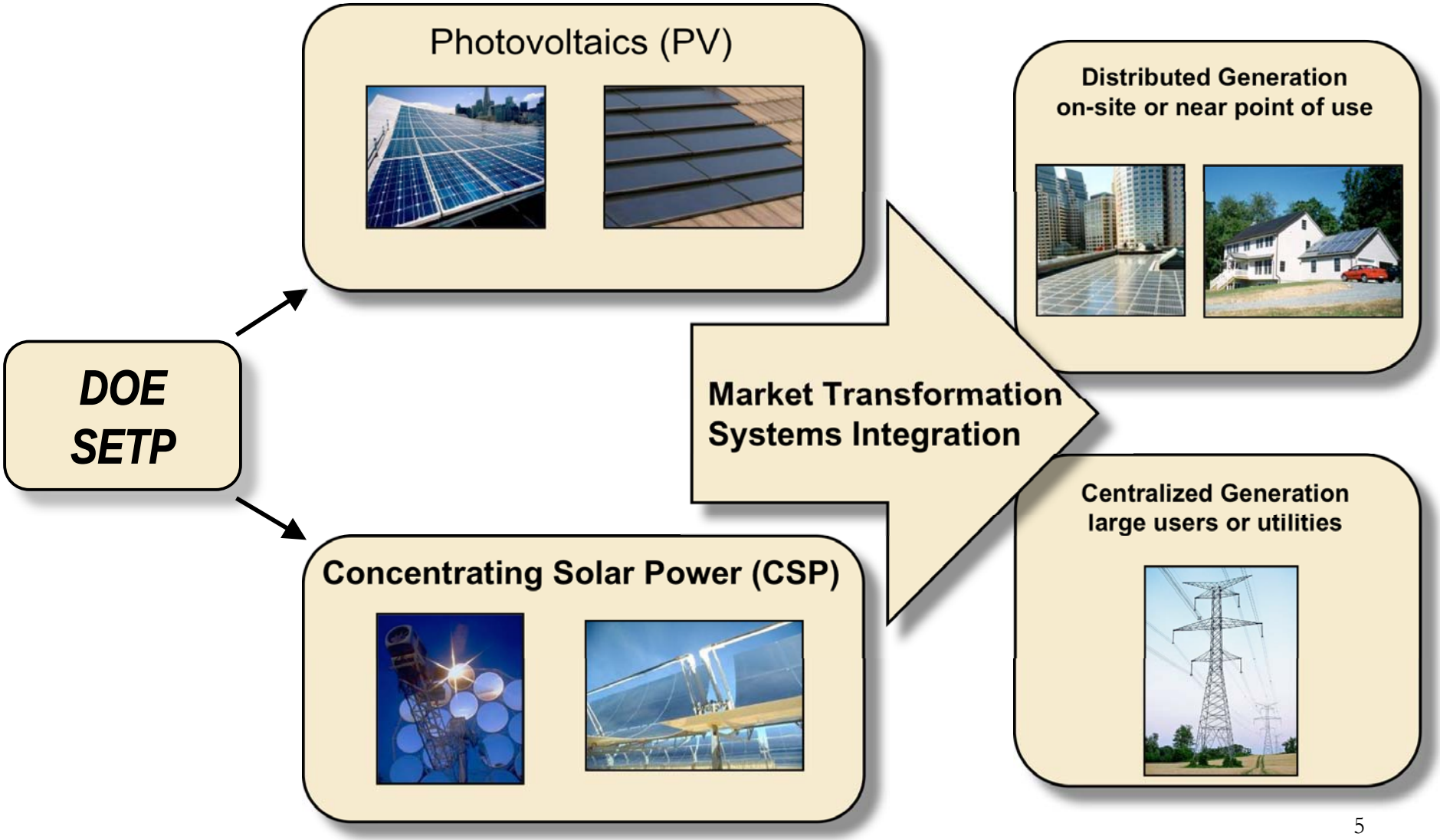


Historical Role of DOE

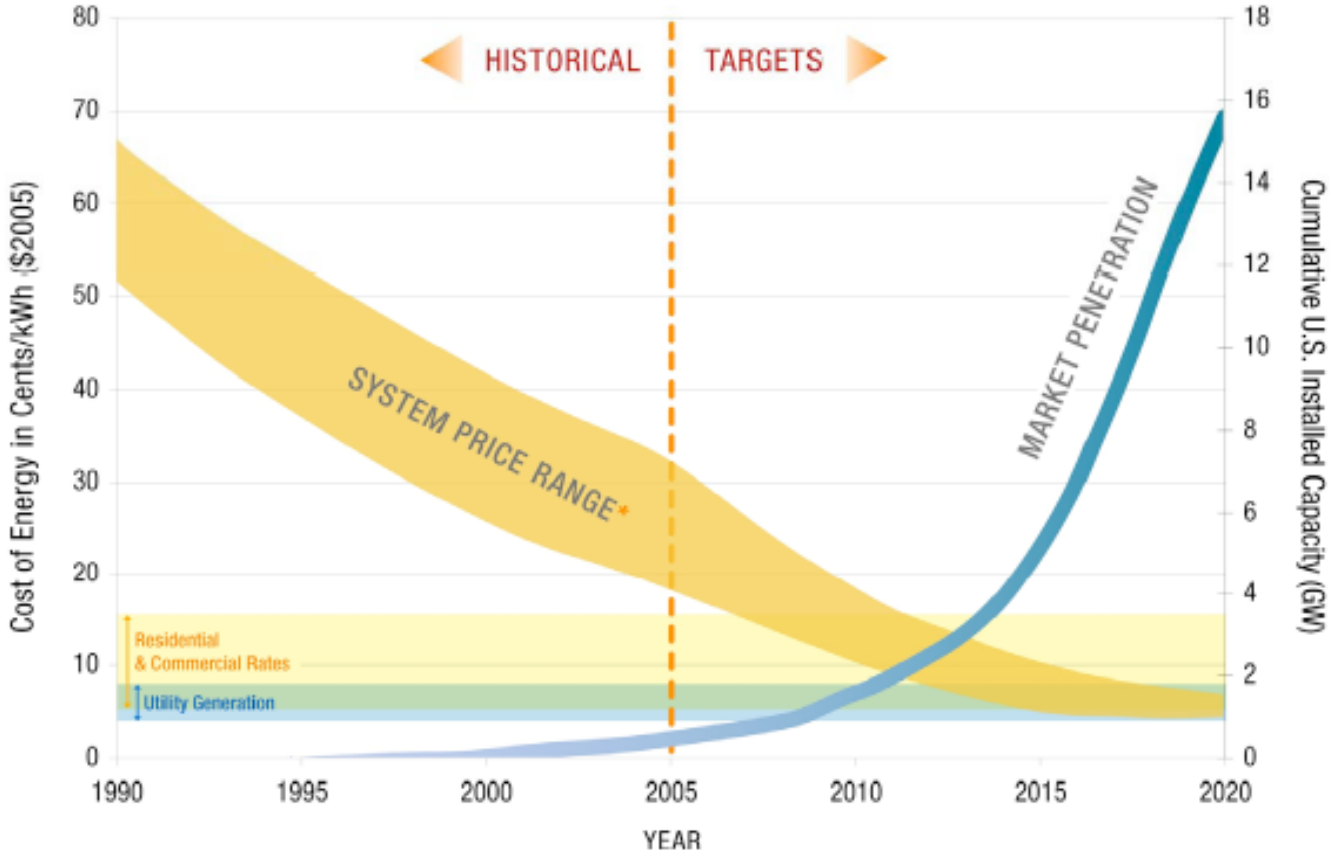
- Focus on narrow and quantifiable metrics: $/W, cell efficiency, g/W, etc.
- Fund risky technologies: advanced materials, designs, processes, products
- Provide support for new and emerging industries

The mission of DOE's Solar Program is to

Accelerate the wide-spread adoption of solar electric technologies across the United States



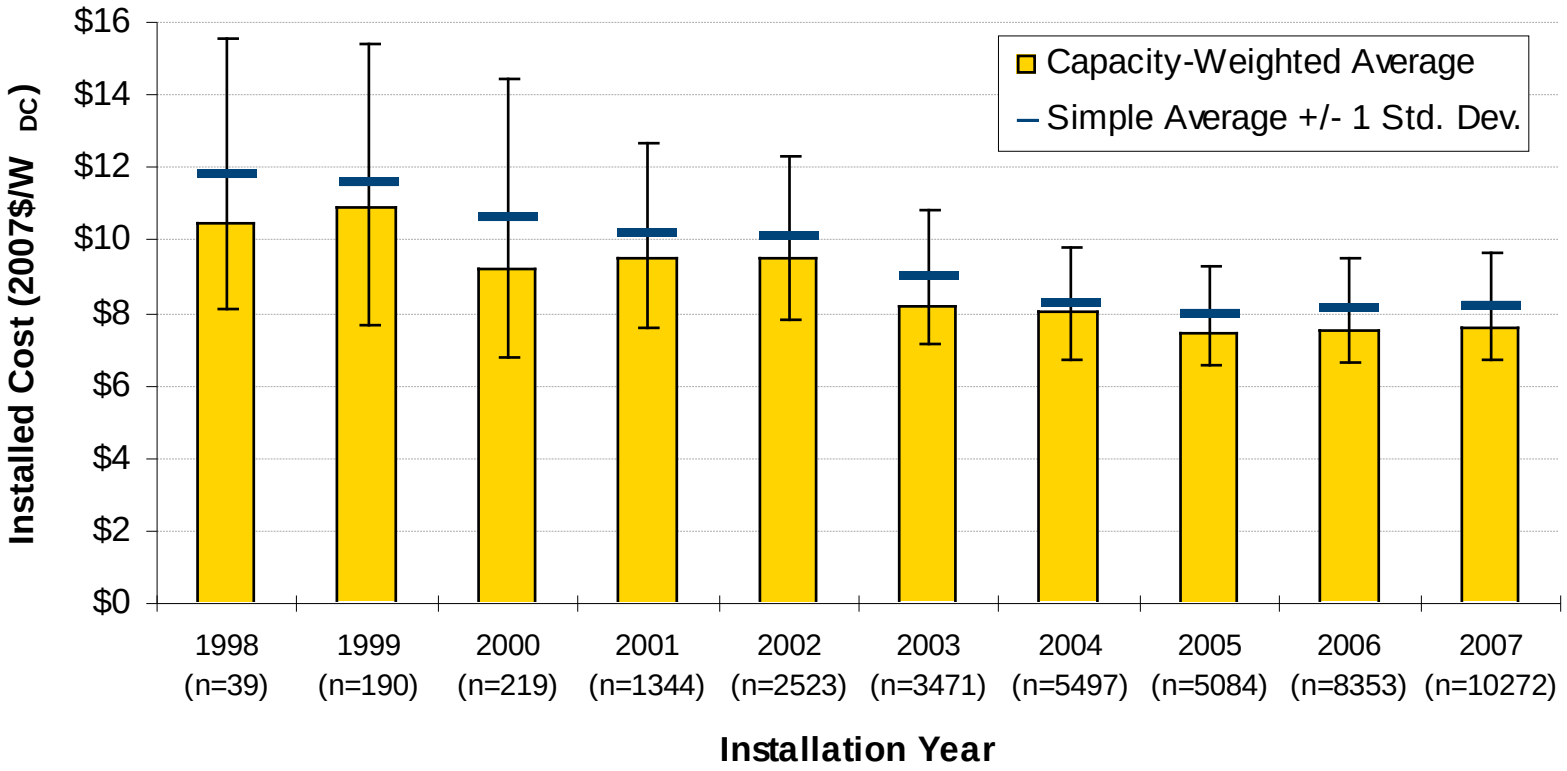
Program Goal on Achieving Grid Parity



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

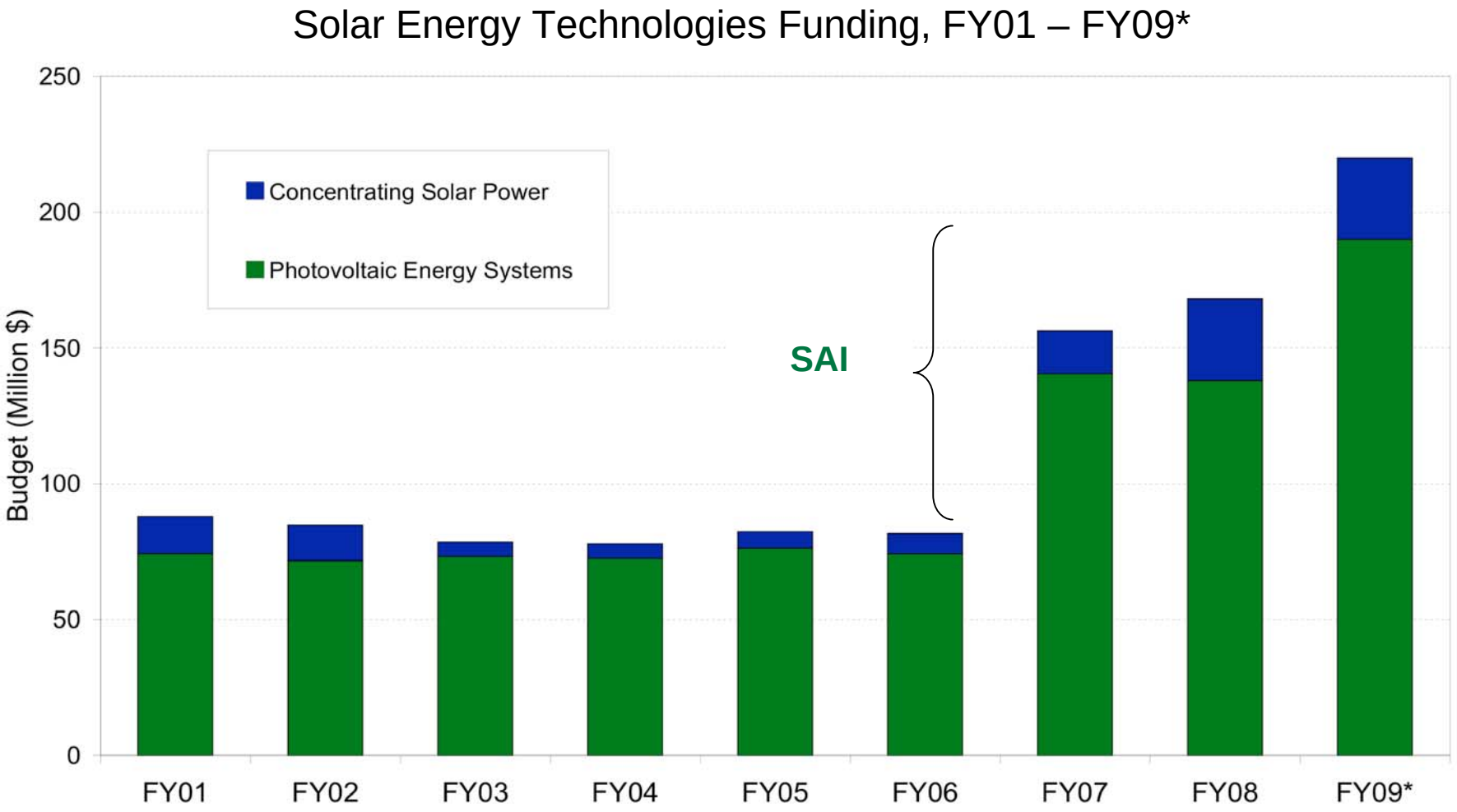
While significant progress has been made, PV system costs must be reduced by >2X to reach wide-spread grid parity

Average annual reduction of $0.32/$W_{DC}$ in real 2007$ (3.1%/yr real, 4.8%/yr nominal) from 1998-2007, but no apparent reduction in costs since 2005



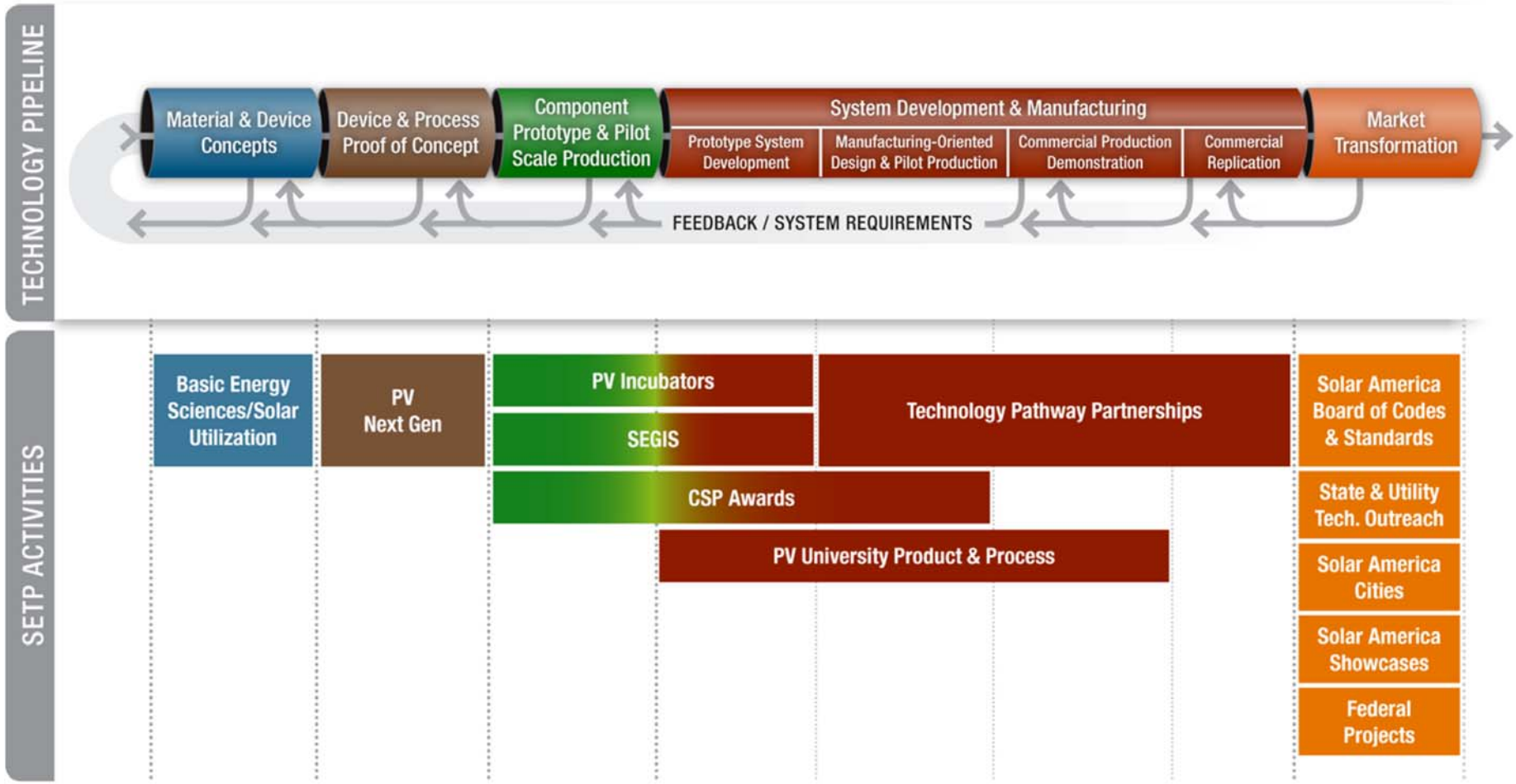
Source: Wiser, Barbose, Peterman (LBNL)

Funding for Solar Energy Technologies Program Increased in Response to Solar America Initiative



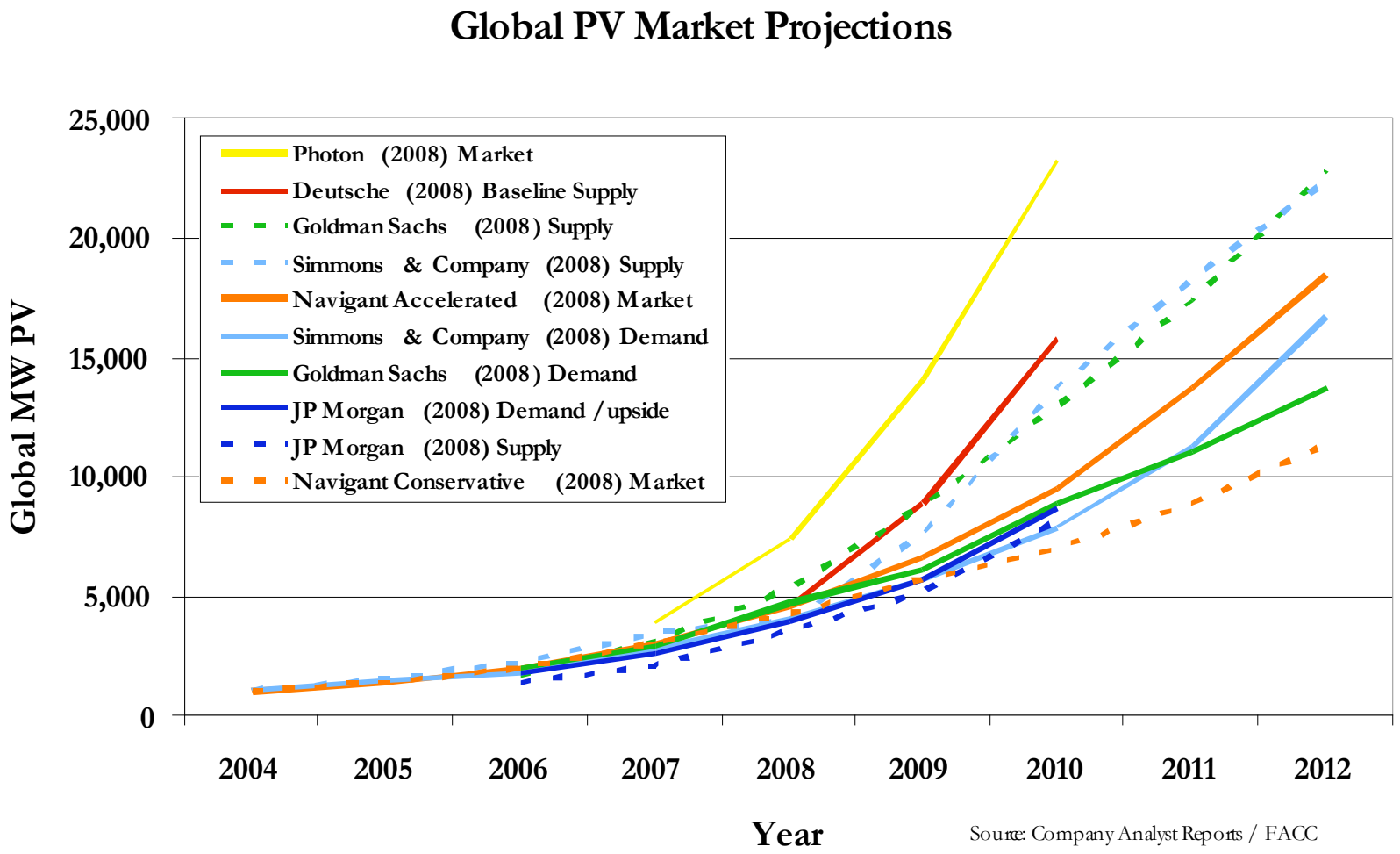
*President's request for FY09 was $150M, current House mark is $220M, current Senate mark is $229M.

Solar Energy Technologies Program Works Along the Whole RDD&D Pipeline



Global PV Market Projections

Although there are large differences in industry analysts' projections for the global PV market, even the most conservative forecast shows over 25% compound annual growth from 2008 to 2012



Source: Company Analyst Reports / FACC

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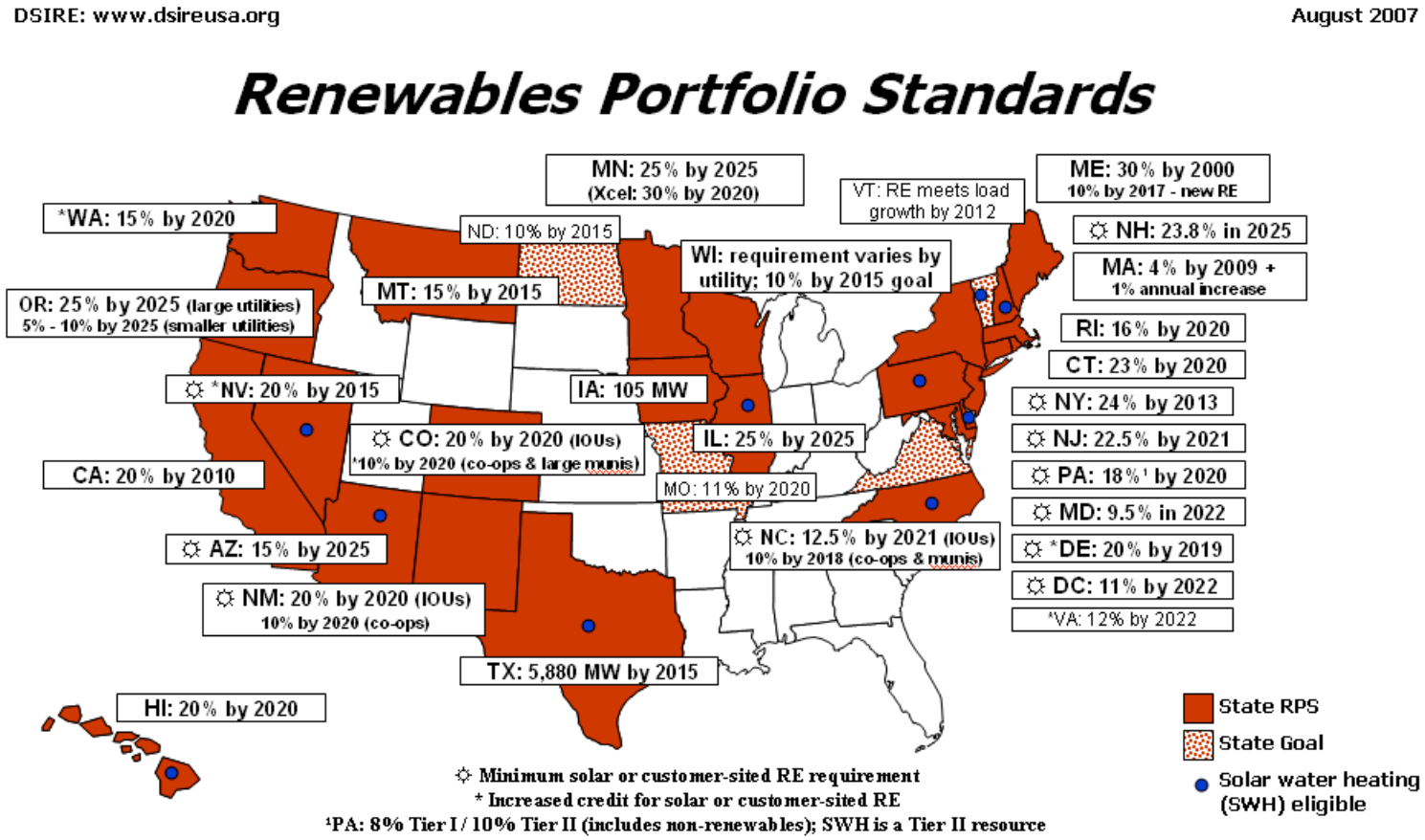
Drivers for Systems Integration of Renewables

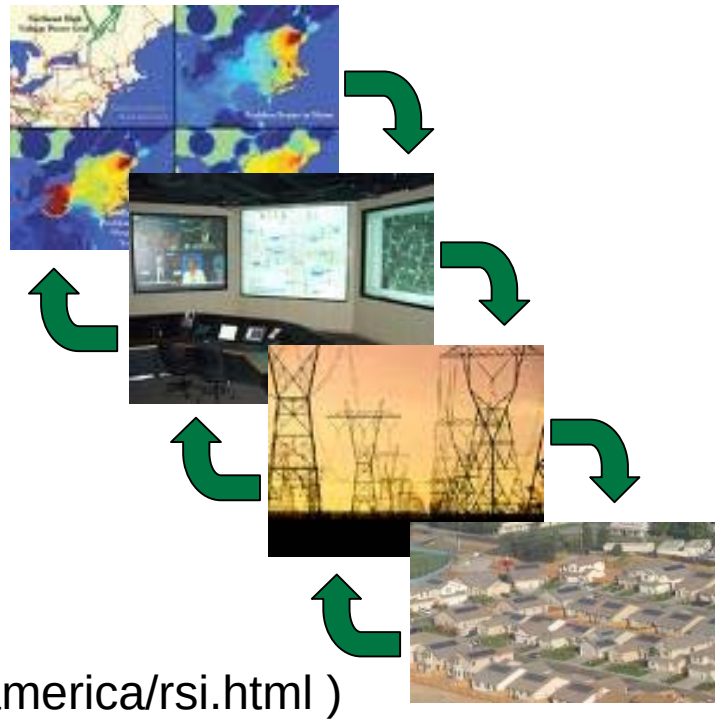
Climate change concerns, renewable portfolio standards, energy security, and green job growth are driving renewable systems integration with the grid (e.g., 28 States & DC with RPS mandates).



Systems Integration Addressing High-Penetration Solar Electricity Challenges

- **Issues Associated with High Penetration**
  - Affected by utilities' existing generation mix, regulating capabilities, load characteristics, resource availability, and market structure
  - Additional systems costs may go up with increasing penetration due to variability and uncertainty

- **Solution Pathways**
  - Spatial diversity of the resource
  - Flexible conventional generation
  - Grid operations and control
  - Load management
  - Energy storage



- **Technical Challenges**
  - Documented in Renewable Systems Interconnection (RSI) Reports

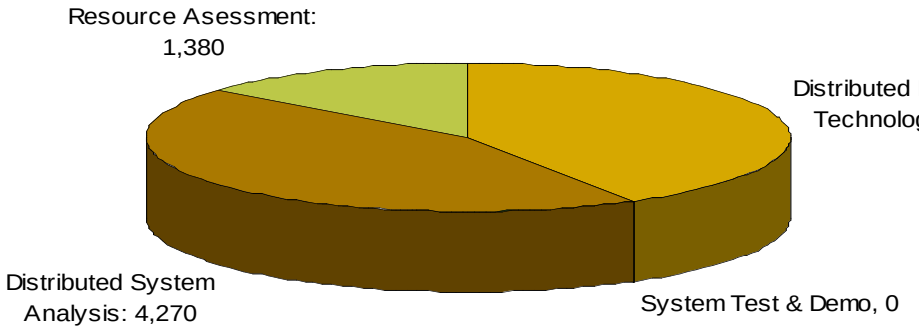
    (http://www1.eere.energy.gov/solar/solar_america/rsi.html)

Systems Integration Focus Areas

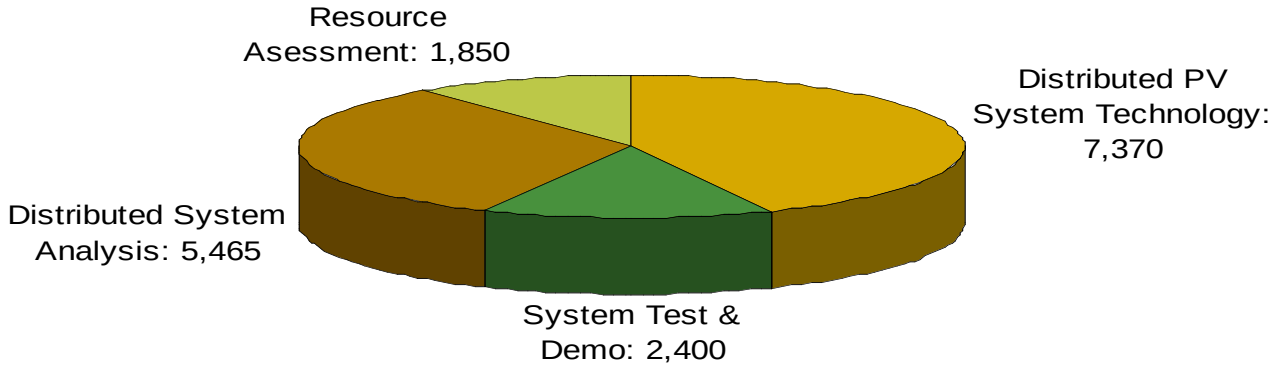
Multi-year Research Plan guided by the 14 RSI reports and structured into six areas

- **Distributed PV System Technology Development**
  - **Solar Energy Grid Integration Systems (SEGIS)**
  - **SEGIS-Energy Storage**
- **Advanced Distribution Systems**
- **System Level Test and Demonstration**
  - **High penetration PV at distribution grid**
- **Distributed Renewable Energy System Analysis**
  - **Modeling & analysis**
- **Solar Resource Assessment**
- **Codes, Standards, and Regulatory Implementation**

Funding Allocations by Focus Area



FY08
$9,654 K



FY09
$17,085* K

*** Enhanced budget level, pending appropriations**

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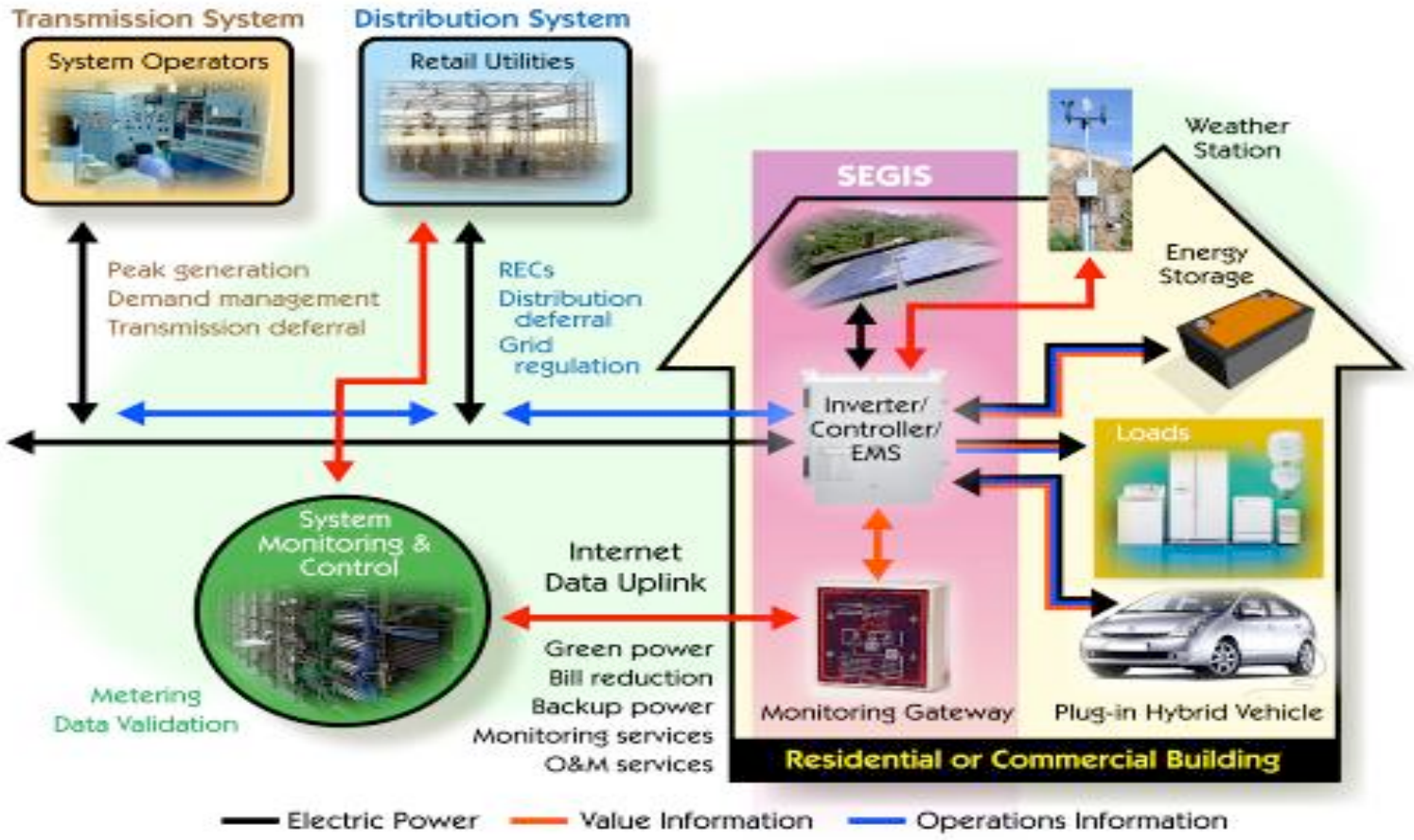
Current Activities: Distributed PV System Technology Solar Energy Grid Integration Systems (SEGIS)

- SEGIS is a “System” development program focused on new requirements for interconnecting PV to the electrical grid.
- SEGIS is the intelligent hardware that strengthens the ties of Smart Grids, Microgrids, PV, and other Distributed Generation.

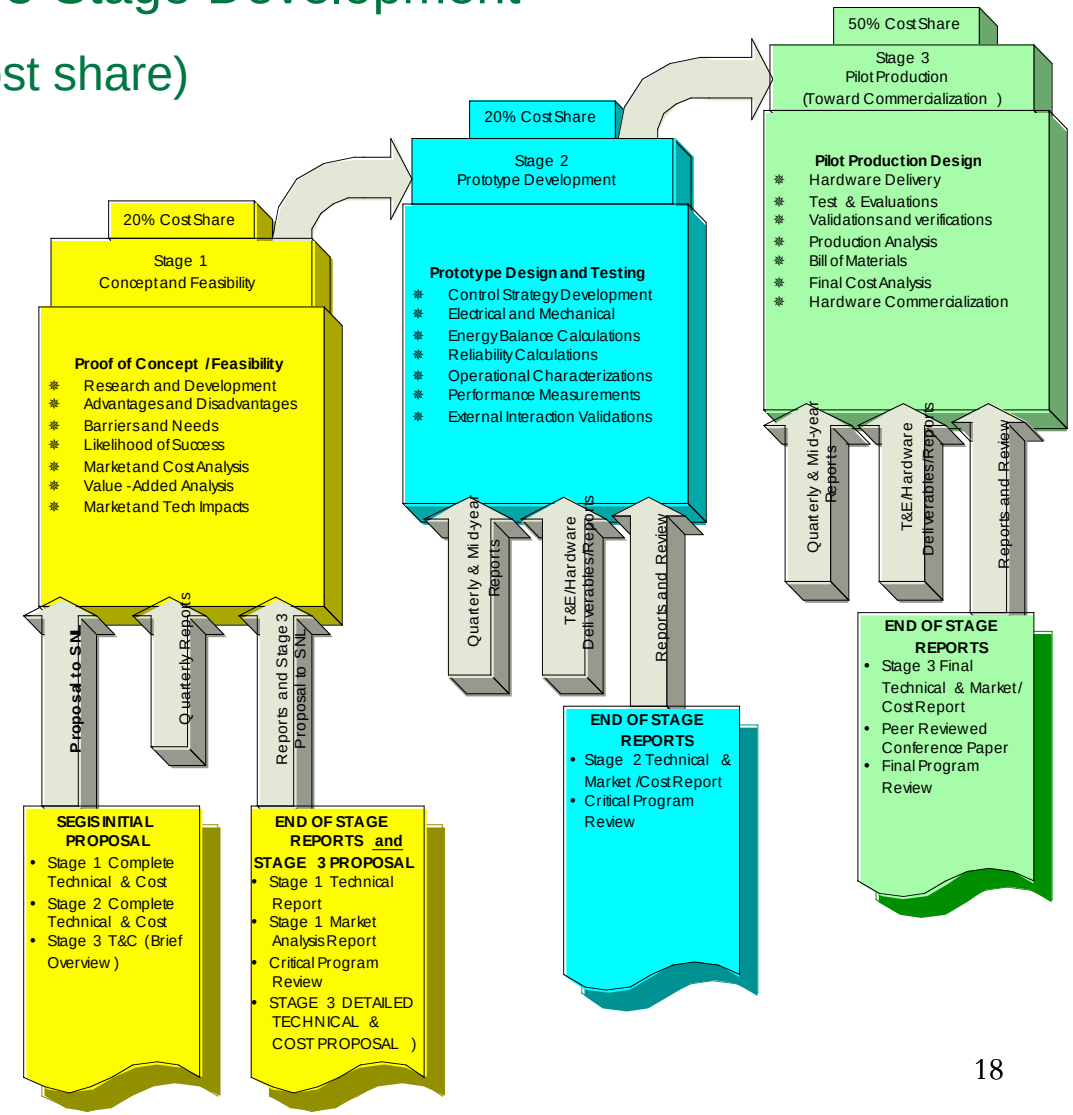


SEGIS Industry Solicitation & Awards

Up to $24M DOE Investment over 3 Years (FY08-10); 27 Proposals Responded for 3-Stage Development

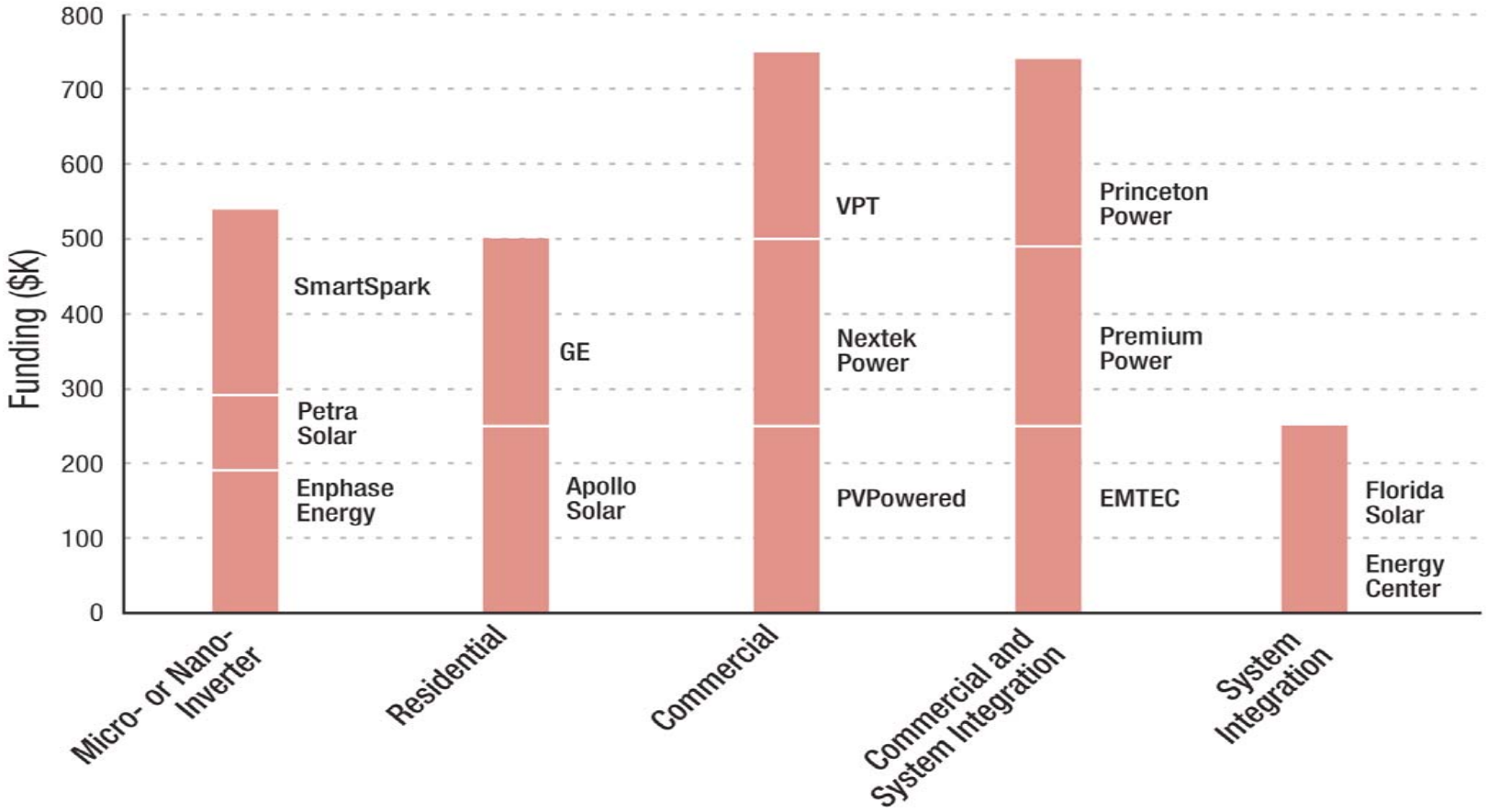
($40M total including industry cost share)

- Stage 1 (9-mo. feasibility): 12 awards in June 2008; avg. $238K DOE funding per award
- Stage 2 (1-yr engineering development/prototyping): avg. $2.67M DOE funding requested per award
- Stage 3 (1-yr toward commercialization): avg. $2.56M DOE funding requested per award



SEGIS Phase-I Awards

Purpose: Address solar energy integration application needs for smart grid, microgrid, demand response, zero-energy homes/buildings, communication portals, PHEV integration

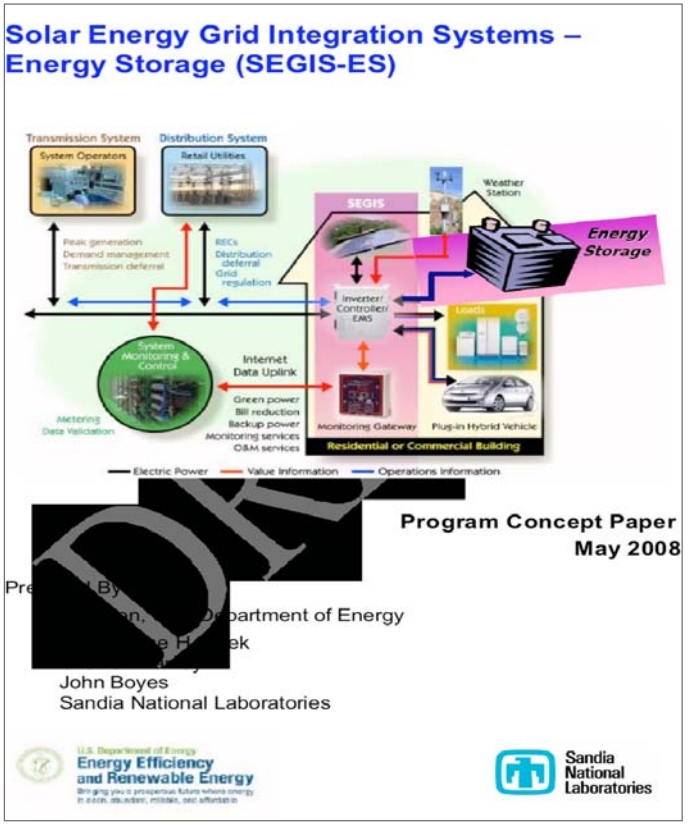


Current Activities: SEGIS-Energy Storage

Address integration of energy storage with high-penetration PV systems for residential/ small commercial/commercial applications

Program concept paper developed, with key R&D needs identified

- Existing battery systems enhanced for PV integration
- Control electronics
- System-level modeling tools
- Non-battery storage systems



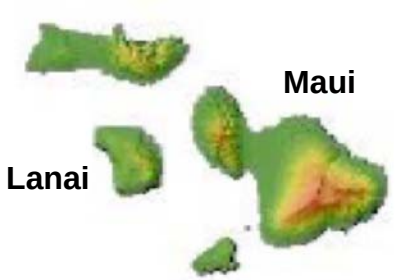
Program concept paper, May 2008

Current Activities: Distributed System Analysis

Kauai

Oahu

Support of Hawaii Clean Energy Initiative with data collection planned for large arrays and high rooftop penetrations



Maui

Lanai

Kauai

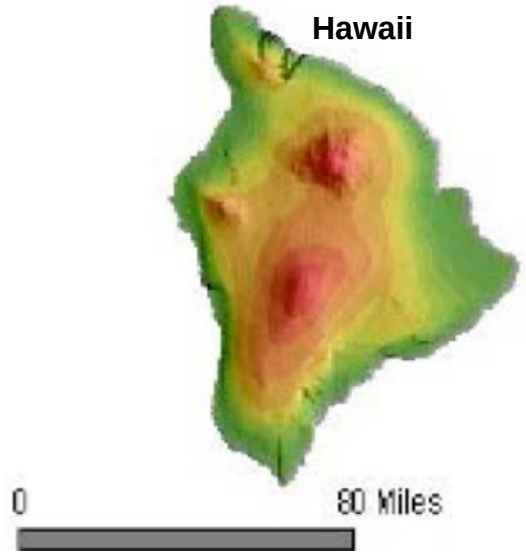
Characterize benefits and costs of variable renewable integration solutions, ownership options, and implementation for KIUC

Oahu

Assist Forest City with renewable options for military housing

Lanai

Assist Castle & Cooke and MECO with analysis and implementation for 1.5MW PV array (Total 5MW load)



Current Activities: Distributed System Analysis, Cont'd

Provide analysis of distribution system data to understand the effects of high penetration of PV on the electric power system (SMUD, Alamosa, Nellis AFB)

- SMUD: Installing DAS and monitoring on distribution feeder in Rancho Cordova, CA; over 600 homes will have 2kW of PV

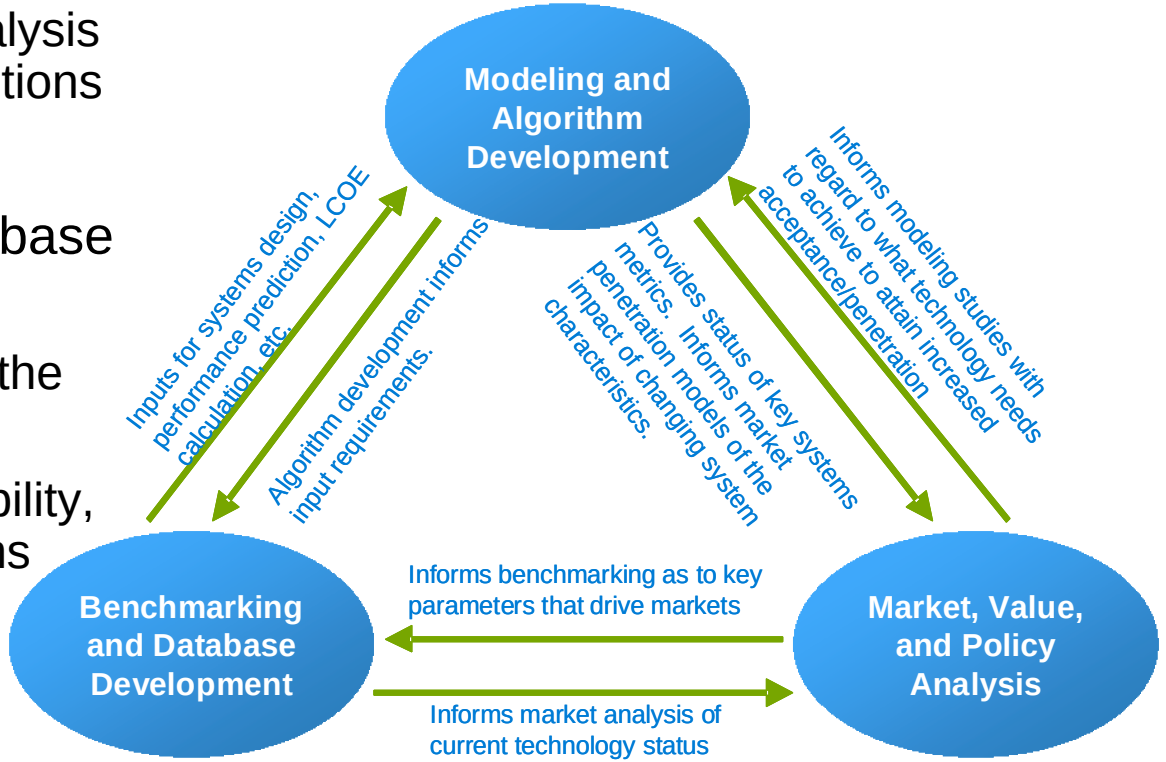
Monitoring on Distribution Transformer

- Alamosa, CO: Working with Xcel Energy and SunEdison on monitoring effects of 8MW PV system on distribution feeder

- Nellis AFB: Leveraging data already being collected on 14MW PV system
  - System operation, impact & benefit analysis, PV performance

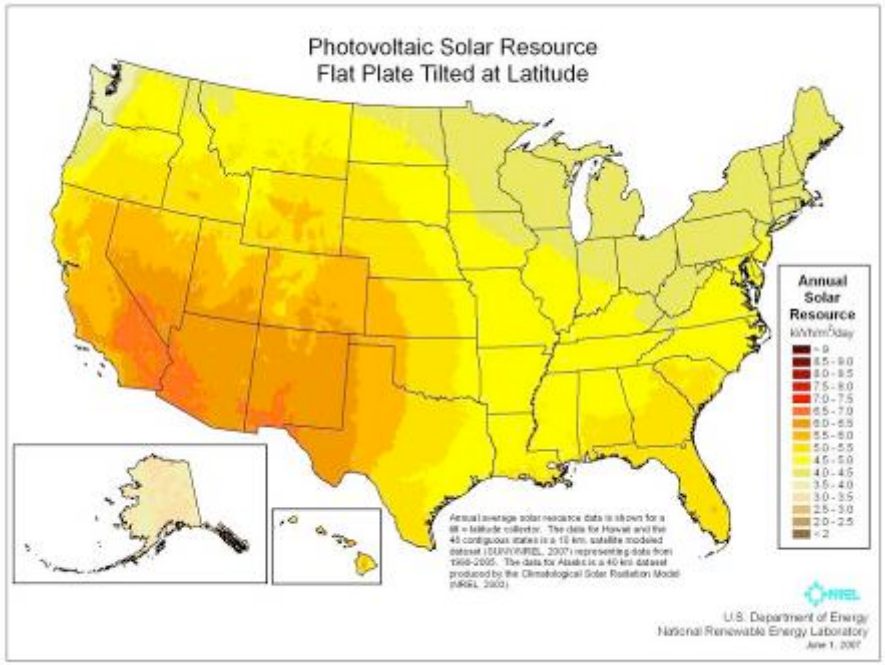
Current Activities: Distributed System Analysis, Cont'd
Modeling & Analysis

- System Performance Modeling & Algorithm Development
  - Predict system performance and costs
  - Conduct parametric analysis of research & design options
- Benchmarking and Database Development
  - Assess current state of the technology
  - Characterize cost, reliability, and efficiency of systems and components
- Market, Value, and Policy Analysis
  - Provide the basis for setting Program targets
  - Monitor and model technology and market trends



Current Activities: Solar Resource Assessment

- Resource forecasting over various time steps: (1-3 hour), day ahead, seasonal, inter-annual
- Progress toward reliable, sub-hourly data sets
- Improve the spatial resolution of data sets
- Develop a user-interactive data archive.



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Planned Workshop: PV/Distribution Grid Integration

1.5-day Workshop on February 24-25, 2009, at Hilton Ontario Airport in Ontario, CA

- Workshop organized by SETP partnering with Southern California Edison (Workshop host) and SEPA (sponsorship support)
- Purposes:
  - Identify key technical issues and barriers associated with high PV-penetration levels
  - Determine high-priority RD&D activities for near-term, mid-term, and long-term to address issues and barriers identified
  - Define performance requirements for high-priority RD&D activities
- Planning committee assembled to develop the workshop sessions
- Target attendance: subject-matter experts and practitioners from electric utilities, solar energy system integrators, manufacturers, end-use groups, and research institutions (national labs, universities)
- Workshop info: http://www.e2rg.com/pvworkshop

Planned FY 2009 Solar Energy Technologies Program
Peer Review Meeting

- March 9-11 at the Downtown Denver Marriott
- Currently 117 Projects on the Peer Review List
- Format:
  - March 9-10: Project-Level Peer Review; 30 minutes per project
  - March 11: Program-Level Peer Review and Discussion (Invitation only)
- Seven Technical Tracks Proposed:
  - Concentrating Solar Power
  - Thin Films, III-V, Concentrators and Related
  - Systems Integration
  - Market Transformation
  - Exploratory Research
  - Crystalline Silicon and Related
  - Nano Technology/Materials and Quantum Dots

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FY09 Funding Opportunity 1*: System Level Demo

Objective: Analyze and demonstrate effects of high-penetration PV systems on varying designs and operations of distribution circuits

- Solicitation topic areas to be derived from high-penetration workshop findings on high-priority RD&D activities and performance requirements for the defined high-penetration PV scenarios
- Integrated team approaches (industry lead, with national lab partner) to be solicited
- Solicitation targeted for release in May 2009, with awards made by September 2009
  - DOE funding*: $2.6 M in FY09; $2M or more each in FY10 and FY11
  - Number of Awards: TBD

*** Pending FY09 budget appropriations**

FY09 Funding Opportunity 2*: SEGIS-ES

Objectives: Energy storage R&D for SEGIS-ES applications in residential, small commercial, and commercial sectors

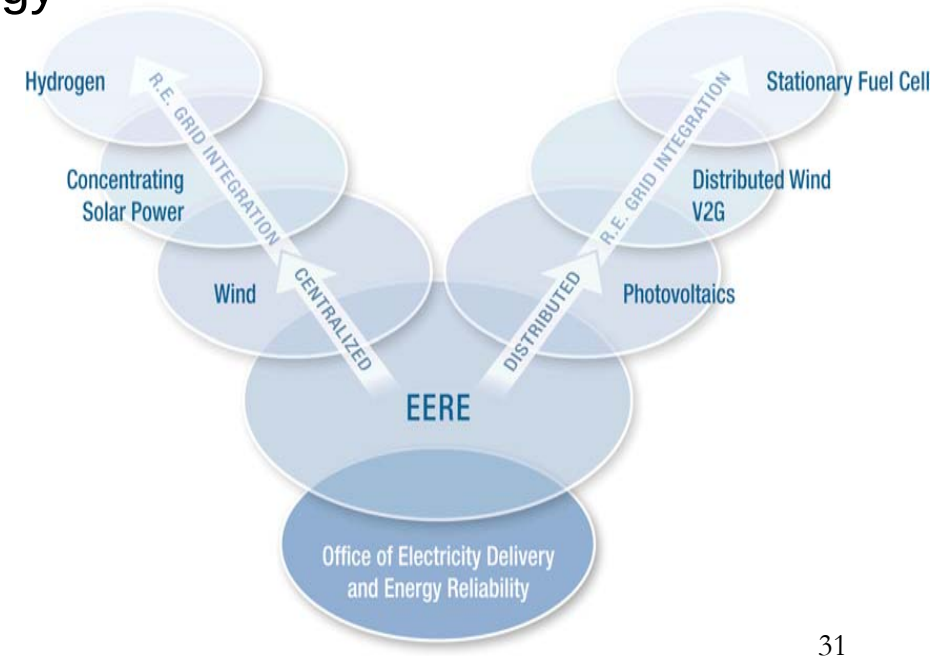
- R&D plan to be developed in May 2009 to define:
  - Energy storage R&D gap areas and their performance requirements for distributed PV integration applications
    - Energy, power, size, cost, efficiency, lifetime, cycle life, charge and discharge rates, maintenance, reliability, etc. and their tradeoffs
  - Codes and standards governing SEGIS-ES applications
- Solicitation to address select high-priority R&D areas, targeted for release in June 2009, with awards made by September 2009
  - DOE funding: $550-750K in FY09; outyear funding TBD
  - Number of Awards: TBD

*** Pending FY09 budget appropriations**

Renewable Systems Integration Strategic Opportunity Areas

A DOE Strategy Document is being developed to realize a significantly larger share of the nation's energy consumption from renewable energy (wind, solar, geothermal, tidal wave) and renewable fuels (biomass, biofuels)

- High-resolution renewable energy resource characterization
- Advanced operational strategies with integrated renewables, energy storage, and load management
- Comprehensive regional infrastructure planning and coordination
- Advanced communications and controls for interconnection and interoperability
- Education and workforce development



Questions and Resources:

Questions & Follow-up:
Dan Ton – dan.ton@ee.doe.gov – 202-586-4618

Resources:

DOE Solar Energy Technologies Program: www1.eere.energy.gov/solar/

System Integration: www1.eere.energy.gov/solar/systems_integration_program.html

Sign up for our Newsletter and Market Analysis: Send email to solar@ee.doe.gov