Solar Energy
Funding Profile by Subprogram
(Non-Comparable, or as Appropriated, Structure)

(dollars in thousands)

	FY 2008 Current Appropriation[a]	FY 2009 Omnibus Appropriation	FY 2010 Request
Solar Energy			
Photovoltaic Energy Systems	136,744	145,000	149,470
Concentrating Solar Power	27,617	30,000	78,420
Systems Integration	–	–	29,660
Market Transformation	–	–	27,450
Solar Electricity Energy Innovation Hub	–	–	35,000
Solar Heating and Cooling Systems[b]	1,959	–	–
Total, Solar Energy	166,320	175,000	320,000

Funding Profile by Subprogram
(Comparable Structure to the FY 2010 Request)

(dollars in thousands)

	FY 2008 Current Appropriation [a]	FY 2009 Omnibus Appropriation	FY 2010 Request
Solar Energy			
Photovoltaic R&D	112,320	124,540	149,470
Concentrating Solar Power	24,420	24,310	78,420
Systems Integration	11,690	12,120	29,660
Market Transformation	15,931	14,030	27,450
Solar Electricity Energy Innovation Hub	–	–	35,000
Solar Heating and Cooling Systems [b]	1,959	–	–
Total, Solar Energy	166,320	175,000	320,000

Public Law Authorizations:

P.L. 93-409, "Solar Heating and Cooling Demonstration Act" (1974)

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008, which includes a reduction of $1,904,000 that was transferred to the SBIR program and $299,000 that was transferred to the STTR program.
[b] Transferred to EERE Buildings Technologies Program in FY 2009.

P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Conservation and Production Act" (ECPA) (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-590, "Solar Photovoltaic Energy Research, Development and Demonstration Act" (1984)
P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989" (1989)
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990" (1990)
P.L. 102-46, "Solar, Wind, Waste, and Geothermal Power Production Incentives Technical Amendments Act" (1991)
P.L. 102-486, "Energy Policy Act (EPAct)" (1992)
P.L. 109-58, "Energy Policy Act of 2005" (2005)
P.L. 110-140, "Energy Independence and Security Act of 2007" (2007)

Mission

The mission of the Solar Energy Program (Solar Program) is to conduct research, development, demonstration and deployment activities to accelerate widespread commercialization of clean solar energy technologies which will lower greenhouse gas emissions, provide a clean and secure domestic source of energy, and create high-paying green jobs.

Modifications were made to the budget structure to better reflect the Solar Energy Program's activities in FY 2010. The two tables above show a non-comparable and comparable funding profile at the subprogram level. The non-comparable table presents the FY 2010 funding in the new budget structure only with the FY 2008 and FY 2009 funding shown as appropriated. The comparable table shows the FY 2008 and FY 2009 funding in the new budget structure to assist in comparing year-to-year funding trends. A cross-walk of the new and old structure is provided in the detail section below that describes the modification to the budget structure and the rationale behind the proposed changes.

Benefits

The United States is the world's largest consumer of electricity, and at the same time has the largest solar resource of any industrialized country.[a] Developing technologies that can reliably and affordably harvest this resource will greatly enhance national energy security while reducing the threat of global warming and create high-paying U.S. jobs. To accomplish this mission, the Solar Program invests in two basic types of solar technologies – photovoltaics (PV) which convert the sun's energy directly into electricity, and concentrating solar power (CSP) technologies which concentrate the sun's rays and produce electricity from the resulting thermal energy.

The R&D effort focuses on technology pathways that have the greatest potential to lower costs and improve performance. Industry-led R&D partnerships, known as "Technology Pathway Partnerships (TPPs)," address the issues of cost, performance and reliability associated with each technology pathway, while other mostly university-led efforts focus on next generation PV devices and processes. Partners include industry, universities, laboratories, and other governmental entities broadening the base and increasing the likelihood of achieving the goals. Our modeling suggests that, in 2015, outcomes and benefits could include 5 to 10GW of cumulative new capacity.

Today, solar energy systems are well established. Demand for these systems is growing in many parts of the world. Possible near-, mid-, and long-term scenarios for solar technologies are:

[a] Based on radiation data collected by the National Renewable Energy Laboratory.

- Near-term – as system costs continue to decrease, the number of grid-connected solar systems could increase quite rapidly, meeting local energy needs such as decentralized and potentially uninterruptible power, community power, or peak shaving;
- Mid-term – reductions in cost could encourage penetration by solar technologies into large-scale markets, first in distributed markets such as commercial buildings and communities, and later in utility-scale systems; and
- Long-term – provide both distributed and centrally generated electricity and heat throughout the U.S., with an increasing share of residential and commercial buildings generating their own energy on-site with grid-connected systems.

DOE analysis of the potential benefits of its renewable energy programs suggest that by 2030, the Solar Program can directly contribute to private sector development of more than 70GW of electric power to the grid and reduce carbon emissions by roughly 500 million metric tons, and can essentially triple those contributions by mid-century.

The proposed FY 2010 Budget investments complement funds provided by the Recovery Act that accelerated the development of critical path technologies in support of the program's goals of making electricity generated from solar competitive with conventional grid electricity by 2015, and address market barriers and accelerating the development of advanced and next generation PV technology. To enable decision makers and the public to follow performance and plans, the program will post its progress in these planned activities at: http://www.energy.gov/recovery/index.htm.

In addition, the FY 2010 Budget proposes several structural changes within the Solar Energy Program. The PV and CSP Programs were brought together under a single Solar Program in FY 2003. Since that time, Solar has been managed as a single program, with corporate needs for crosscutting areas such as systems analysis, resource assessment, and technical outreach. Accordingly, Solar now consists of four subprograms - two technologies based, PV & CSP, and two crosscutting, Systems Integration and Market Transformation. In this way, the program preserves the technology distinction between two fundamentally different ways of producing solar power, while providing two distinct crosscutting areas that afford better efficiency in addressing needs common to the entire solar technology portfolio. The two technology paths focus on cost reduction, while the two crosscutting paths focus on enabling the high penetration of solar into the market. Together they form an effective strategy for making solar a significant contributor to U.S. alternative energy.

Climate Change

The Solar Program's research, development, demonstration and deployment activities all support the achievement of a national reduction in greenhouse gas (GHG) emissions. Solar technologies have the potential for significantly displacing fossil-based electricity generation, thus reducing the amount of carbon emitted into the atmosphere. For example, DOE analysis suggests that by 2030 the Solar Program's activities could directly contribute to a cumulative reduction of more than 400 million metric tons of CO_2. By mid-century these benefits could increase tenfold.

Energy Security

While solar does not directly displace petroleum imports for transportation, it does displace natural gas used in the electricity sector. Thus, increasing the use of solar for electricity generation will have a significant impact on reducing the need for imported liquefied natural gas (LNG). In addition, if plug-in hybrid electric vehicles (PHEVs) are successful at penetrating the market for transportation, then solar power, by providing electricity to charge PHEVs, could also help to displace the demand for petroleum and/or fossil-based electricity generation for transportation purposes. The combination of solar and PHEVs could help the U.S. move to a much more secure and sustainable transportation system.

Economic Impact

Due to continued improvements in the cost and performance of solar technologies the program's activities could result in considerable savings to consumers. For example, by 2030 the program's activities could directly contribute to a cumulative savings to consumers of at least $15 billion (primarily in the form of savings on consumer electricity bills). Consumer savings could grow rapidly to more than $200 billion.

The benefit tables below shows the estimated benefits from 2015 through 2050 that would result from realization of the program's goals. These benefits are achieved by targeted Federal investments in technology research and development in partnership with industry members, universities, National Laboratories, States other governmental and/or other stakeholders. These partnerships facilitate the technical coordination of activities and attract cost sharing to provide leveraged benefits.

The benefits table also reflects the increasing market share of advanced solar technologies over time as projected installed system costs decline and system performance improves. The expected benefits reflect solely the achievement of the program's goals. Not included are any policies, regulatory mechanisms, or other incentives already in existence that might be expected to support or accelerate the achievement of the program goals.

The program goal case is modeled along with a "baseline" case in which no DOE R&D exists. The baseline case is intended to represent the future without the effect of the Solar Energy Program, and is identical for all DOE applied energy R&D programs, thereby ensuring that all program benefits are estimated using the same assumptions for external factors such as economic growth, energy prices, and levels of energy demand. The expected outcome benefits are calculated using the same fundamental methodology across EERE and across all of DOE's applied energy R&D programs, and the metrics by which expected outcome benefits are measured are identical. This standardization of method and metrics has been undertaken as part of DOE's efforts to make all program stated benefits comparable.

Prospective benefits are calculated as the arithmetic difference between the baseline case and the program goal case, and the resulting economic, environmental and security benefits attributed to the program's activities. This approach of calculating the benefits as an incremental improvement to the

baseline helps ensure that improvements in solar energy technologies that would occur in the absence of the program are not counted as part of the program's benefits. In addition to technology and process advances due to the program's activities, energy market policies, such as solar tax policy and state and Federal tax policies, facilitate the development and deployment of clean energy technologies. The expected impacts of current legislated policies in the baseline case are included so that the expected benefits calculated reflect as much as possible the effects of activities funded by the program. In 2007, Congress passed the Energy Independence and Security Act (EISA 2007). This act included several important authorizations to advance solar power which included training workforce and research and development to improve solar technologies. These new EISA authorizations are considered current policies in the baseline case.

The benefits are generated by modeling both the program goal and baseline cases within two energy-economy models: NEMS-GPRA10 for benefits through 2030, and MARKAL-GPRA10 for benefits through 2050. The full list of modeled benefits appears below.

Primary Metrics for FY 2010 Budget Request

(Incorporates Approximate Impacts of EISA 2007)

	Metric[1]	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, cumulative[2] (Bil bbl)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
	Natural Gas Imports Reduction, cumulative (Tcf)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	13.1
	Reduction in Share of Highway Fuel Demand Derived from Crude Oil[3] (%)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Environmental Impacts	CO_2 Emissions Reduction, cumulative (Mil $mtCO_2$)	NEMS	ns	ns	426	N/A
		MARKAL	5	16	523	4795
	SO_2 Allowance Price Reduction[4] ($/ton)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
	NO_x Allowance Price Reduction ($/ton)	NEMS	ns	ns	626	N/A
		MARKAL	N/A	N/A	N/A	N/A
	Hg Allowance Price Reduction (thousand $/lb)	NEMS	ns	ns	ns	N/A
		MARKAL	N/A	N/A	N/A	N/A
Economic Impacts	Consumer Savings, cumulative[5] (Bil $)	NEMS	ns	ns	15	N/A
		MARKAL	3	10	46	235
	Electric Power Industry Savings, cumulative (Bil $)	NEMS	2	6	34	N/A
		MARKAL	5	10	14	111
	Household Energy Expenditures Reduction ($/household/yr)	NEMS	ns	ns	30	N/A
		MARKAL	8	13	11	61

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. All cumulative metrics are based on results beginning in 2010.
3. Metric includes oil-derived fuel use by light-duty vehicles, commercial light trucks and freight trucks; the metric excludes buses. Reported oil use is adjusted to exclude ethanol, biodiesel and CTL.
4. All monetary metrics are in 2006$.
5. Cumulative monetary metrics are in 2006$ that are discounted to 2010 using a 3% discount rate.

ns - Not significant
NA - Not yet available
N/A - Not applicable

Secondary Metrics for FY 2010 Budget Request

(Incorporates Approximate Impacts of EISA 2007)

	Metric[1]	Model	Year			
			2015	2020	2030	2050
Energy Security	Oil Imports Reduction, annual (Mbpd)	NEMS	ns	0.0	0.0	N/A
		MARKAL	0.0	0.0	0.0	ns
	Natural Gas Imports Reduction, annual (Tcf)	NEMS	0.0	0.0	0.1	N/A
		MARKAL	0.0	0.0	0.0	1.1
	MPG Improvement[2] (%)	NEMS	0%	0%	0%	N/A
		MARKAL	ns	0%	0%	ns
Environmental Impacts	CO_2 Intensity Reduction of US Economy (Kg CO2/$GDP)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	0.00	0.01	0.01
	CO_2 Intensity Reduction of US Power Sector[3] (Kg CO2/kWh)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	0.00	0.02	0.06
	CO_2 Intensity Reduction of US Transportation Sector[4] (Kg CO2/mile)	NEMS	ns	ns	ns	N/A
		MARKAL	ns	ns	ns	ns
Economic Impacts	Consumer Savings, annual[5] (Bil $)	NEMS	ns	ns	7	N/A
		MARKAL	1	3	12	69
	Electric Power Industry Savings, annual (Bil $)	NEMS	1	1	8	N/A
		MARKAL	ns	ns	6	32
	Energy Intensity of US Economy (energy/$GDP)	NEMS	ns	ns	0.02	N/A
		MARKAL	ns	ns	0.03	0.07
	Net Energy System Cost Reduction, cumulative (Bil $)	NEMS	N/A	N/A	N/A	N/A
		MARKAL	ns	2	15	80

1. "Reductions" and "savings" are calculated as the difference between results from the baseline case (i.e. no DOE technology) and the technology case (i.e. all DOE technology R&D programs are successful).
2. Change in light duty vehicles miles traveled per gallon of oil, where oil is only that derived from petroleum.
3. Emissions include all power sector emissions. Generation calculated as total net generation adjusted for estimated T&D losses.
4. Emissions calculated using highway fuel use and related carbon emission factor. Miles calculated as highway miles traveled, excluding buses.
5. All monetary metrics are in 2006$.

ns - Not significant
NA - Not yet available
N/A - Not applicable

The following external factors could affect the Solar Program's ability to achieve its strategic goal:

- Material costs and availability (e.g., silicon supply, etc.);
- Labor costs;
- Currency exchange rates;
- The price and availability of alternative technologies and conventional fuels;
- International R&D and deployment efforts;
- Financial incentives and other policies;
- Interest rates and inflation;

- State and local regulation;
- Market participant withdrawal or entry;
- Building community infrastructure; and
- Utility barriers and pricing strategies.

Contribution to the Secretary's Priorities

The Solar Program activities contribute to several of the Secretary's priorities as enumerated below. The principal focus area(s) are Clean Energy and Economic Prosperity.

Priority 1: Science and Discovery – Invest in science to achieve transformational discoveries.

The Solar Energy Program re-energizes the National Laboratories as centers of great science and innovation through lab facility improvements and increased hiring of post-doctoral students. It also creates an effective mechanism to integrate National Laboratory, university, and industry activities through joint solicitations, on topics such as thermal storage that require inputs from all sectors. The Solar Program also participates in the IPCC and contributes to IEA solar related tasks. The Solar Program connects basic and applied sciences through collaborations with DOE's Office of Science, the National Institute of Standards and Technology (NIST), and National Science Foundation (NSF).

Priority 2: Clean Energy – Change the landscape of energy demand and supply.

The Solar Program demonstrates and facilitates the deployment of a range of solar energy technologies with commercial partners, while also aggressively advancing a wide-range of solar energy technologies through cutting edge R&D, working with the National Laboratories, universities, private sector partnerships, and other non-profit research organizations.

Priority 3: Economic Prosperity – Create millions of green jobs and increase competitiveness.

The Solar Program works to develop low-cost solar technologies for residential, commercial and utility-scale applications. These technologies will contribute to fostering economic prosperity through creating green jobs, reducing consumers' energy bills, and improving the reliability of the electricity system.

Priority 5: Lower GHG Emissions – Position U.S. to lead on climate change policy, technology, and science.

The Solar Energy Program works through the International Energy Agency (IEA) in PV and CSP technologies to define joint areas of collaborative research and develop standards that would facilitate the manufacturing scale-up improvements and uniform testing protocols.

Contribution to GPRA Unit Program Goal 1.1.03.00 (Solar Energy)

Solar Energy Program contribute to Strategic Goal 1.1.03.00 by developing next generation technologies with improved performance and by reducing system, manufacturing, and installation costs of solar energy technologies to levels competitive with fossil and nuclear energy sources.

Means and Strategies

The Solar Program will use various means and strategies to achieve its GPRA Unit Program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's

goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

The Solar Program will implement the program using the following means:

- Perform research, development, demonstration and deployment activities in partnership with coalitions of industry members, universities, National Laboratories and/or States to reduce costs;
- Increase PV module efficiency, system reliability, and manufacturing capability; develop lower cost production processes for cells and modules;
- Select technology pathways for accelerated development of improved manufacturing methods, materials use, defect control and throughput;
- Increase the efficiency and reliability of CSP systems;
- Develop low-cost thermal storage for CSP systems;
- Conduct systems integration activities such as technology modeling and analysis to help identify research priorities;
- Identify the barriers and benefits of grid integration;
- Work with Solar America Cities to build sustainable solar infrastructures, while assisting a second round of cities in defining and launching their activities;
- Conduct other market transformation activities to identify and address market barriers to solar technology usage, and promote market expansion opportunities; and
- Coordinate with the Buildings Technologies Program through the Solar Buildings Initiative to accelerate deployment of higher-efficiency buildings incorporating PV technologies.

The Solar Program uses the following strategies:

- Work with cost-shared partnerships consisting of industry members, universities, National Laboratories, States and/or other governmental entities to solve scientific and technical barriers necessary to improve performance and reliability, while reducing cost in PV technology pathways;
- Work with States, industry, and other entities to leverage Federal taxpayer resources, communicate technology advances and opportunities effectively, reduce barriers, and accelerate market penetration of technology applications; and
- Work with the Office of Science, the Building Technologies Program and the Federal Energy Management Program on solar R&D and deployment opportunities. This includes work with other agencies such as the Defense Advanced Research Projects Agency (DARPA), the BLM, and others.

These strategies will significantly reduce the cost of solar technologies, which will improve energy security by increasing the amount, availability and diversity of the domestic energy supply.

The Solar Program will work with solar energy and other industry experts outside of DOE to:

- Ensure that the Solar Program's research directions and priorities address the needs of manufacturers, utilities, state agencies, consumers, and other stakeholders;
- Ensure that program activities are within the realm of technical feasibility and properly aligned with market forces;

- Develop technology roadmaps and peer reviews, versions of which have been completed within the last two years for each of the primary solar subprograms;
- Ensure that adequate Federal land is made available for solar power plants; and
- Ensure that adequate transmission is allocated for solar projects.

Validation and Verification

To validate and verify program performance, the Solar Program will conduct internal and external reviews and audits. The table below summarizes validation and verification activities.

Data Sources:	National Solar Technology Roadmaps (2007); Annual Energy Outlook (2007); Solar Program Peer Review (2005); Sargent and Lundy, Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts (2003); National Research Council, Critique of the Sargent and Lundy Draft Assessment of Cost and Performance Forecasts for Concentrating Solar Power (2002); National Research Council, Renewable Power Pathways: A Review of DOE's Renewable Energy Programs (2000).
Baselines:	The Solar Program's 2003 baselines for system production cost reduction goals are: $0.19 to $0.24/kWh for PV electric energy (see the Solar Program Multi-Year Technical Plan) and; $0.12 to $0.14/kWh for electricity from CSP technologies (See the CSP Technology Transition Plan 2004). Sargent and Lundy are working on updating the baseline based on 2008 costs.
Frequency:	Annual.
Evaluation:	In carrying out the program's mission, the Solar Program uses several forms of evaluation to assess progress and to promote program improvement: ▪ Technology validation and operational field measurement; ▪ Implementation of a consistent methodology across the program for analyzing levelized cost of energy (LCOE); ▪ Critical peer review of both the program and subprogram portfolios and activities by independent outside experts; ▪ Annual internal Technical Program Review of the Solar Program; ▪ A Technical Review Team specific to the SAI; ▪ Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate; ▪ Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets); ▪ Annual review of methods, and re-computation of potential benefits for the Government Performance and Results Act (GPRA).

Data Storage:	EIA and other organizations, such as National Laboratories (including the National Renewable Energy Laboratory, Sandia National Laboratories (Sandia), store data on computer servers.
Verification:	Peer reviews; National Laboratory system and component test data; trade association reviews; National Laboratory survey of PV manufacturing cost/capacity data from U.S. industry; EIA survey of solar manufacturers; literature reviews.

Annual Performance Results and Targets

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Results	FY 2009 Targets	FY 2010 Targets
GPRA Unit Program Goal 1.1.03.00 (Solar Energy)					
Photovoltaic R&D					
Verify, using standard laboratory measurements, a conversion efficiency of 13.5 percent of U.S.-made, commercial crystalline silicon PV modules. Production cost of such modules is expected to be $1.95 per Watt. [MET]	Verify, using standard laboratory measurements, a conversion efficiency of 13.8 percent of U.S.-made, commercial crystalline silicon PV modules. Production cost of such modules is expected to be $1.90 per Watt. [MET]	Verify, using standard laboratory measurements, a conversion efficiency of 14.5 percent of U.S.-made, commercial crystalline silicon PV modules. Production cost of such modules is expected to be $1.80 per Watt. [MET]	Reduce producer manufacturing cost of silicon PV modules to $1.70 per Watt, roughly equivalent to a modeled levelized cost of energy of $0.14-$0.23/kWh. [MET]	Modeled levelized cost of $0.17-$0.20/kWh for residential PV applications.	Modeled levelized cost of $0.15-$0.18/kWh for residential PV applications.
Develop thin-film PV modules with an 11.0 percent conversion efficiency that are capable of commercial production in the U.S. [MET]	Develop thin-film PV modules with an 11.2 percent conversion efficiency that are capable of commercial production in the U.S. [MET]	Develop thin-film PV modules with an 11.8 percent conversion efficiency that are capable of commercial production in the U.S. [MET]	Complete R&D that will reduce the direct manufacturing cost of thin film PV modules to $1.60 per Watt, roughly equivalent to a modeled levelized cost of energy of $0.14-$0.23/kWh. [MET]	Modeled levelized cost of $0.12-$0.16/kWh for commercial PV applications.	Modeled levelized cost of $0.10-$0.14/kWh for commercial PV applications.
Concentrating Solar Power					
	Conduct advanced research on trough collectors and receivers that will lead to a reduction in the modeled cost of energy from CSP troughs to $0.12-$0.14/kWh. [MET]	Develop CSP trough collector and receiver technologies that enable a system conversion efficiency of 13.1 percent. The levelized cost of energy from such a system is expected to be in the range of $0.11-$0.13/kWh. [MET]	Modeled levelized cost of power from large-scale concentrating solar power (CSP) plants in the range of $0.11-$0.13/kWh from completed R&D. [MET]	Modeled levelized cost of $0.10-$0.12/kWh for utility - scale CSP applications.	Modeled levelized cost of $0.10-$0.12/kWh for utility-scale CSP applications.
Systems Integration					
					Identify at least 5 SEGIS awards to move into prototype development in Phase II.
Market Transformation					
					Complete technical assistance to 20 Solar America Cities to address issues such as financing, permitting, city planning, and outreach.

FY 2005 Results	FY 2006 Results	FY 2007 Results	FY 2008 Results	FY 2009 Targets	FY 2010 Targets
Solar Heating and Cooling Systems Achieve 5.0 cents per kilowatt-hour modeled cost of energy from solar water heater capable of operating in non-freezing climates. [MET]					
General Program Goals					
Contributed proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the program FY 2004 end of year adjusted uncosted baseline ($19,342K) until the target range is met. [MET]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent. [MET]	Maintain administrative costs as a percent of total program costs less than 12 percent. [MET]	Maintain administrative costs as a percent of total program costs less than 12 percent.	Maintain administrative costs as a percent of total program costs less than 12 percent[a].

[a] Administrative costs are comprised of Program Direction and elements of Program Support (Technology Advancement and Outreach; and Planning, Analysis and Evaluation), baseline and targets under development.

Photovoltaic R&D
Funding Schedule by Activity
(Comparable, or as Appropriated, Structure)

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Photovoltaic Energy Systems			
Applied Research	36,861	41,439	48,539
Systems Development	64,210	67,725	87,550
Technology Evaluation & Integration	21,503	21,209	10,870[a]
Technology Acceptance	14,170	12,420	0[b]
SBIR/STTR	–[c]	2,207	2,511
Total, Photovoltaic Energy Systems	136,744	145,000	149,470

Photovoltaic R&D
Funding Schedule by Activity
(Non-Comparable Structure to the FY 2010 Request)

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Photovoltaic R&D	0	0	146,959
Applied Research	*36,861*	*41,439*	–
Systems Development	*64,210*	*67,725*	–
Technology Evaluation & Integration	*21,503*	*21,209*	–
Technology Acceptance	*14,170*	*12,420*	–
SBIR/STTR	–[d]	2,207	2,511
Total, Photovoltaic Energy Systems	136,744	145,000	149,470

Description

Modifications were made to the budget structure to better reflect Photovoltaic R&D activities in FY 2010. The two tables above show a non-comparable and comparable funding profile at the subprogram level. The non-comparable table presents the FY 2010 funding in the new budget structure only and FY 2008 and FY 2009 funding is shown as appropriated. The comparable table shows the FY 2008 and FY 2009 funding in the new budget structure to assist in comparing year-to-year funding trends.

[a] This amount represents the tech evaluation funding for PV only. The rest is now included in the new Systems Integration subprogram.
[b] This funding is now covered in the new Market Transformation subprogram.
[c] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.
[d] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

Photovoltaic (PV) technologies utilize semi-conducting materials that directly convert sunlight into electricity. Modular by nature with no moving parts, they can be sized to almost every need and placed almost anywhere sunlight is available. This characteristic differentiates PV from almost all other renewable energy technologies and allows electricity to be created where consumed thereby reducing the need for addition transmission lines.

The basic building block of a PV system is the solar cell that converts sunlight into electricity. Solar cells are connected together to form modules. Modules can be further connected together to form arrays. Modules and/or arrays are primarily used to feed electricity directly into the grid via inverters and can be used to power electrical appliances, such as security lighting or highway signs. R&D efforts focus on improving performance and reliability of systems, and reducing manufacturing and installation costs.

Module size is typically one square meter with a power output ranging from roughly 80 to 200 Watts (W), roughly 2 to 4 times the energy needed for the typical incandescent light bulb (but 8 to 16 times a typical compact fluorescent light bulb). The module comprises 50 to 60 percent of the levelized cost of energy yielded from a PV system and presents a significant opportunity for cost savings. Crystalline silicon is the most mature technology and comprises greater than 85 percent of the market. New technologies with the potential for lower costs include thin films and high performance multi-junction cells for use in concentrating collectors.

To accelerate cost reductions the PV subprogram is accelerating R&D to focus on full system solutions with the highest potential to reach cost competitiveness by 2015. New industry-led partnerships, known as "Technology Pathway Partnerships" (TPPs) are being funded to address the technical issues associated with each pathway. Milestones and metrics are used in a stage-gate process to monitor progress and down select poorly performing projects to ensure that only those technology pathways that have the most potential move forward. This strategy is aimed to maximize public funding benefits while increasing the chance of achieving program goals.

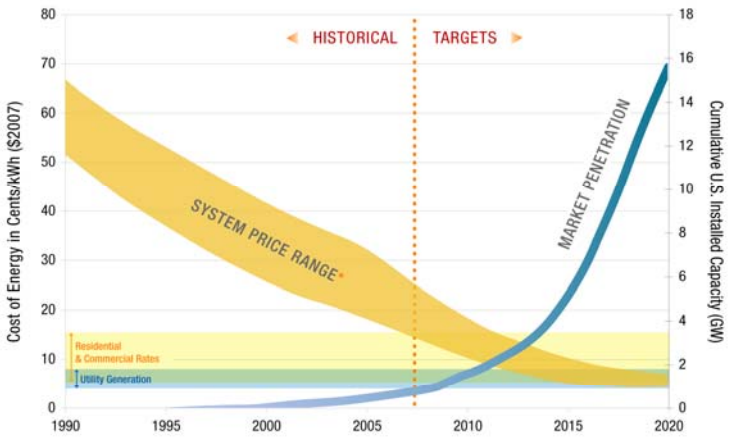
For FY 2010, the PV subprogram's priorities are:

- Align R&D activities to concentrate on the most promising technology pathways and market acceptance activities;
- Produce R&D results and meet all technical milestones commensurate with the second full year of industry-led multi-year 50/50 cost-shared contracts under competitive solicitations to reduce costs. The TPPs and Technology Acceptance activities will include teams with industrial, university, National Laboratory, and/or state agency partners;
- Advance module and system manufacturing technologies to achieve higher performance and lower-cost products with faster throughput; and
- Continue systems reliability research to increase the lifetime of modules and the mean time to failure of DC-to-AC current inverters for low-cost, grid-tied distributed PV systems.

Benefits

The Solar Program goal of achieving cost-competitive solar electricity translates to a range of costs based on specific markets. For PV, the estimated cost ranges for market-specific cost-competitive electricity generation in 2015 are:

- 5-7¢/kWh for centralized power markets;
- 6-8¢/kWh for commercial markets; and
- 8-10¢/kWh for residential markets.
- By 2010, reduce the 30-year user cost for PV electric energy to 10-18¢/kWh from 18-23¢/kWh in 2005.[a,b]



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

Because the Solar Program is designed to affect the levelized cost of energy, the program changed the primary metrics from $/W to $/kWh. In addition, the metric was split into commercial/utility and residential, which more accurately reflect the divides of the solar market. The cost of power is expressed in ranges due to the diversity of PV module applications. The low-end reflects commercial applications under good conditions, such as advantageous financing terms and sunny locations, while the higher end is more common in residential applications. Costs could be impacted by changing key factors such as: interest rates; labor costs; raw material costs; Federal, state and local incentives; global deployment efforts; and geography of installation. A sample of data across U.S. installations was used to calibrate the cost analysis tool, which resulted in higher cost estimates for residential PV installations.

Projected Solar Energy Costs Targets and Actuals

	Historic					
	2003	2004	2005	2006	2007	2008
Levelized Electricity Cost from PV Modules ($/kWh)[c]						
Target	0.19-0.24	0.18-0.23	0.18-0.23	0.17-0.23	0.16-0.27	0.14-0.23
Actual	0.19-0.24	0.18-0.23	0.18-0.23	0.17-0.23	0.16-0.27	0.14-0.23

[a] Key technology pathways to the goals include detailed annual performance progress indicators are presented in their respective benefits sections.
[b] The additional American Recovery Reinvestment Act funds would increase the probability of achieving the goals.
[c] The Levelized Cost of Electricity (LCOE) is the principle metric by which electricity generation technologies are compared. This established basis for evaluating the cost of a generation method takes into account those aspects of a technologies performance that directly impact power generation efficiency, system cost, and reliability. LCOE is a measure of the total lifecycle costs associated with a PV system divided by the expected lifetime-energy output, while accounting for the appropriate adjustments such as time value of money, etc. The National Renewable Energy Laboratory (NREL) has developed a robust model that considers the climatic variables which impact solar energy generation for hundreds of US locations called: the Solar Advisor Model (SAM). The SAM was used by EERE's Solar Program to calculate the LCOE estimates if its technical goals were met, under a range of assumptions about factors outside the Program's direct control, such as Operations & Maintenance costs.

	Planned			
	2009	2010	2011	2015
Levelized Electricity Cost from Residential PV Modules ($/kWh)				
Target	0.17-0.20	0.15-0.18	0.13-0.16	0.08-0.10
Levelized Electricity Cost from Commercial Utility PV Modules (E/kWh)				
Target	0.12-0.16	0.10-0.14	0.09-0.13	0.05-0.08

Detailed Justification

(dollars in thousands)

FY 2008	FY 2009	FY 2010
Photovoltaic R&D	**0**	**0**	**146,959**

The Photovoltaic R&D subprogram has five components: Exploratory Research, Conversion Devices, Measurements and Characterization, Systems Development, and Technology Evaluation.

Exploratory Research consists of work on cutting-edge next generation R&D, which currently includes technologies such as plasmonics, organic cells, and multiple exciton generation (MEG). The core activity is the Next Generation PV R&D work, begun in FY 2008 through a competitive solicitation that resulted in awards to universities and industry members. These three year projects will reach go/no-go decision points in FY 2010. R&D on non-traditional PV technologies is essential to ensure innovation and support the development and expansion of advanced PV options. Seed funding for refreshing the National Laboratory PV research portfolio with the earliest stage technology is also a focus of Exploratory Research. This work helps bridge the gap between basic science and technology development. (Approximate funding $13,300,000)

Conversion Devices covers research to improve PV cells in all the major currently commercially available technologies: Wafer Silicon, Film Silicon, Copper Indium Gallium Selenide (CIGS), Cadmium Telluride (Cd Te), Concentrating PV, Organic PV, and Sensitized Cells. The focus of this R&D is semiconductor materials, device properties, and fabrication processes to improve the efficiency, stability, and cost of PV solar energy conversion. Researchers work closely with industry to help solve current problems, and conduct further research to prepare improvements that industry can adopt in the future. (Approximate funding $19,100,000)

The Measurement and Characterization activity supports cross-cutting research including the device-level analysis of NREL's Measurements and Characterization (M&C) group and the new manufacturing-development focused Process Development Integration Laboratory (PDIL), housed in the Science and Technology Facility at NREL. M&C provides test, measurement, and analysis support and research for all PV material technologies, and collaborates with internal research groups, external research partners in university and industry laboratories, and PV manufacturers. This effort assists stakeholders through the test and analysis of thousands of materials and device samples annually, helping them to understand and direct work on their research and commercial product development. The PDIL gives stakeholders an extra level of insight into product development of all

(dollars in thousands)

FY 2008	FY 2009	FY 2010

PV material technologies with specialized equipment that simultaneously allows the creation and analysis of PV devices. With the capability to study their processes in more depth as the cells are made, the improvement in manufacturing will be accelerated. (Approximate funding $13,400,000)

The Systems Development activity works primarily through cost-shared contracts with industry to advance the development of PV systems and components. This activity has three primary projects: the TPPs; the PV Incubator Project; and the University Process and Product Development.

The industry-led TPPs are executing projects segmented into three manageable three-year phases, with new funding opportunities released at the completion of each phase ─ for both continuing industry-led teams and new applicants. These phases will progressively reduce the cost of commercially-available PV systems and components, and will ultimately yield commercial products and production processes that achieve the cost and capacity targets for 2015.

In FY 2010, the third year of the first phase, the partnerships will focus on development, testing, demonstration, validation, and interconnection of new PV components, systems, and manufacturing equipment. Results from these projects will help inform the issuance of a funding opportunity announcement for a second round of projects.

In phase one, TPPs are developing new PV solutions for the residential, commercial, and utility market sectors of grid-tied electric power:

- Residential Rooftop Market ─ Typically mounted on rooftops and range in size from under 1kW to 10kW, most commonly in the 3 to 4 kW range. These systems are connected to the grid on the retail (customer) side of the utility meter. These systems can be retrofitted onto existing homes or integrated into new construction through building-integrated PV (BIPV) designs.
- Commercial Rooftop Market ─ Typically mounted on the large flat roofs of commercial, institutional, and industrial buildings, ranging in size from less than 10kW to 500kW and connected on the retail side of the utility meter. Retrofits and BIPV are also possible applications in this market.
- Utility Market ─ Large-scale (multi-megawatt) systems that displace conventional utility generated intermediate load (e.g. natural gas continuous cooling transformation (CCT) plants) on a wholesale basis. Typical utility PV systems are ground-mounted and range in size from 1MW to10MW, although much larger systems are also possible. Designs include both fixed and tracking configurations.

The TPPs are developing systems which have the greatest potential for cost-competitiveness by 2015. Examples of promising PV technologies include crystalline silicon, thin film, and concentrating PV. The partnerships are also developing and testing balance-of-system component designs that address emerging requirements for modularity, interface standardization, reliability, and decreased installation cost.

(dollars in thousands)

FY 2008	FY 2009	FY 2010

The PV Incubator project, launched in FY 2008, enables start-up PV companies to work with the National Laboratories to scale up laboratory processes into pilot manufacturing processes. Additional awards are issued each year, with the third round planned for FY 2010. All performers will continue to work closely with the laboratories in order to deliver new module prototypes and demonstrate ≥ 3MW of pilot production within 18 months of the start of the projects. This will reduce risk in capital investments for manufacturing capacity expansion, and allow private capital markets to fund the build-out of manufacturing capacity based on these projects.

The University Process and Product Development Project, entering its third year, leverages the essential expertise that universities hold through competitively awarded university-led process and product development projects. Universities possess a fundamental understanding of materials and device physics, as well as experience with laboratory-scale processes and prototype production. This experience uniquely positions universities to leverage their knowledge in assisting the transition of PV technology from laboratory to marketplace, as well as offer guidance to industry on how to move forward efficiently. Additionally, market-oriented research offers students exposure to the growing PV-related commercialization efforts and supplies industry with a stream of qualified scientists

A new effort in FY 2010 is the PV Manufacturing Initiative. This initiative intends to accelerate the commercialization and cost reduction of PV technologies. The initiative would involve individual consortiums of industry and university participants centered around specific processes or device architectures in order to identify and solve critical manufacturing problems. (Approximate funding $90,100,000for Systems Development Activities)

Technology Evaluation activities will focus on the critical need to test and evaluate all deliverables developed under the TPPs. The information will be used to determine if the TPPs are meeting milestones and goals on time. This independent testing activity will provide the data necessary to conduct stage-gate reviews and periodic down selects through its series of competitive phases. The Reliability R&D activity also includes laboratory R&D to help reduce the cost of installed systems and improve their reliability. The laboratory R&D emphasizes four technical objectives: 1) reducing life-cycle costs; 2) improving reliability of systems; 3) increasing and assuring the performance of fielded systems; and 4) removing barriers to the use of the technology.

Performance evaluation of thin-film systems will continue to be conducted in the field by the Regional Experiment Stations (RESs) to compare against benchmark data in both hot, humid climates representative of the Southeastern U.S. and hot, dry climates representative of the Southwestern U.S. Accelerated lifetime testing in the laboratory will be conducted in parallel with the field testing Any failures found in the field or in the laboratory will be analyzed to determine the degradation mechanisms. Work at the RESs will also continue to improve the reliability of distributed grid-tied systems, especially in the buildings sector.

The Community Project solicitation was issued in FY 2009 using industry input from the Accelerated Aging and Reliability Workshop. Awardees will test new PV systems in various climates and configurations, and then correlate test results with failure modes. In FY 2010 accelerated testing will be conducted in the lab to guide the design, material, and process changes for further product improvements in performance and cost reduction.

(dollars in thousands)

FY 2008	FY 2009	FY 2010

In addition, researchers will work in partnership with universities, industry and the National Laboratories to improve the efficiency of cell materials and devices by investigating fundamental properties and operating mechanisms. This team research approach identifies efficiency-limiting defects in cell materials and analyzes their electrical and optical properties. Researchers will also work with the TPPs to improve the understanding of materials, impurities and defects and their impact on device performance and reliability. (Approximate funding $11,000,000 for Technology Evaluation Activities)

Applied Research **36,861** **41,439** **−**

Applied Research has been a separate key activity under the Photovoltaic subprogram that included next generation concepts and cross-cutting research on semiconductor materials and devices. Beginning in FY 2010, these activities will be consolidated with the former Systems Development key activity and the technology evaluation component of the former Technology Evaluation & Integration key activity into a unified Photovoltaic R&D subprogram which captures only PV-related efforts. The main purpose in this change is to move the Systems Integration and Market Transformation activities that cut across both PV and CSP out from under the PV subprogram into their own crosscutting subprograms. This allows the Solar Program to be managed and operated more efficiently, improving both the speed and effectiveness of program implementation.

Systems Development **64,210** **67,725** **−**

Systems Development has been a separate key activity under the Photovoltaic subprogram that included cost-shared contracts with industry to advance the development of PV systems and components. Beginning in FY 2010, these activities will be consolidated with the Applied Research and technology evaluation activities specific to PV as noted in the above paragraph.

Technology Evaluation & Integration (TEI) **21,503** **21,209** **−**

TEI has been a separate key activity under the Photovoltaic subprogram that focused on the evaluation of technical advances throughout the Solar Program using independent testing and analysis. Beginning in FY 2010, all of the non PV-specific elements of testing and evaluation are being combined with similar activities that had been funded under the CSP subprogram and moved to a separate cross-cutting subprogram called Systems Integration. This will allow these activities to be managed much more effectively with a single point of contact.

Technology Acceptance **14,170** **12,420** **−**

Technology Acceptance has been a separate key activity under the Photovoltaic subprogram that focused on achieving solar energy technology cost competitiveness by minimizing market barriers to solar commercialization and promoting opportunities for solar technology market penetration. Beginning in FY 2010, these activities are being combined with similar activities formerly funded under the CSP subprogram and moved into a separate cross-cutting subprogram called Market Transformation. This will heighten their visibility and improve management as noted above.

SBIR/STTR **0** **2,207** **2,511**

In FY 2008, no funding was transferred to the SBIR and STTR programs. The FY 2009 and FY 2010

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
amounts shown are estimated requirements of the continuation of the SBIR and STTR program.			
Total, Photovoltaic Energy Systems	**136,744**	**145,000**	**149,470**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Photovoltaic R&D	
The increase in the PV subprogram funding is a result of combining projects formerly funded under Applied Research, Systems Development, and the projects formerly under Technology Evaluation that solely focused on PV into a single key activity. The increase is also related to the new Solar Electricity Energy Innovation Hub and PV Manufacturing initiatives.	+ 146,959
Applied Research	
These activities will be consolidated under Photovoltaics R&D.	-41,439
Systems Development	
These activities will be consolidated under Photovoltaics R&D.	- 67,725
Technology Evaluation	
These activities will be consolidated under Systems Integration.	- 21,209
Technology Acceptance	
These activities will be consolidated under Market Transformation.	- 12,420

SBIR/STTR

Changes in the SBIR/STTR funding are a result of shifting the above program activities to new areas with the Solar Program request.	+ 304
Total Funding Change, Photovoltaic R&D	**+ 4,470**

Concentrating Solar Power

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Concentrating Solar Power	27,617	29,621	77,250
SBIR/STTR	0[a]	379	1,170
Total, Concentrating Solar Power	27,617	30,000	78,420

Description

Concentrating solar power (CSP) has over 350 MW operating in the Mojave Desert for the past 20 years. Various factors such as deregulation and the large capital investment for utility-scale plants kept additional plants from coming on line for many years. However, with rising fuel prices, favorable government incentives, and recent R&D advances, CSP is experiencing a rebirth with new plants coming on line both domestically and overseas. With a renewed sense of urgency to commercialize renewable energy sources, and the prospect of developing a prolific domestic source of renewable energy that can provide power on demand, the Solar Program is ramping up its CSP research, development, and deployment efforts. These efforts, which leverage both industry partners and the National Laboratories, are directed toward the development of parabolic trough, dish/engine, and power tower CSP systems.

The Solar Program's goals include increasing the use of CSP in the U.S., making CSP competitive in the intermediate power market by 2015, and developing advanced technologies that will reduce systems and storage costs, enabling CSP to be competitive in the baseload power market by 2020. DOE plans to achieve these goals through cost-shared contracts with industry, advanced research at National Laboratories, and working with other government agencies to remove barriers to the deployment of the technology.

Concentrated sunlight from CSP systems produces thermal energy to run heat engines or steam turbines for generating power. These plants can also store the sun's energy so it can be used when the sun is not shining, enabling it to displace significant quantities of carbon dioxide. Although CSP plants can be configured in all sizes, they are most cost effective when they generate greater than 100MW.[b] Their size and economical energy storage make CSP systems strong candidates for centralized power applications by utilities. The major focus of the CSP subprogram in FY 2010 will be twofold: the development of low cost systems that include thermal storage and establishment of a pilot solar zone that will facilitate the construction of several utility-scale solar projects.

Benefits

Today, in areas with favorable conditions, CSP technology can generate electricity at costs as low as $0.13/kWh. The goal for CSP is being cost-competitive (7-9 ¢/kWh) in the intermediate power market by 2015 with a modest amount of storage. The long-term goal for CSP systems is cost competitive (5-7¢/kWh) baseload power including 12 to 17 hours of thermal storage by 2020. Key technology pathways to the goals include (detailed annual performance progress indicators are presented in their respective benefits sections):

[a] SBIR/STTR funding was transferred to the Science Appropriation in FY 2008.

[b] Based on reports by Sandia National Laboratory and Sargent and Lundy Draft Assessment Cost and Performance (see Validation and Verification).

By 2010, reduce the cost of large-scale CSP power plants in the Southwest U.S. to 10 to 12¢/kWh from 12 to 14¢/kWh in 2004. The Solar Program uses the following historical cost data and projections as indicators of progress toward achieving program benefits.

U.S.-Produced Parabolic Trough System Efficiency Targets and Actuals

	Historic						Planned			
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2015
Annual Solar-to-Electric Conversion Efficiency (%)										
Target	n/a	n/a	n/a	11.9	13.1	14.0	14.8	15.4	16.0	16.6
Actual	11.1	11.9	11.9	11.9	14.0	14.3	—	—	—	—

CSP Solar Energy Cost Targets and Actuals[a]

	Historic						Planned			
	2003	2004	2005	2006	2007	2008	2009[b]	2010	2011	2015
Levelized Electricity Cost from Utility-scale CSP										
Target	0.12-0.14	0.12-0.14	0.12-0.14	0.12-0.14	0.11-0.13	0.11-0.13	0.10-0.12	0.10-0.12	0.10-0.12	0.07-0.09
Actual	0.12-0.14	0.12-0.14	0.12-0.14	0.12-0.14	0.11-0.13-	0.11-0.13	—	—	—	—

Detailed Justification

(dollars in thousands)

FY 2008	FY 2009	FY 2010
Concentrating Solar Power (CSP)	**27,617**	**29,621**	**77,250**

The primary focus of the CSP subprogram is to achieve cost competiveness of CSP in the intermediate power market by 2015. A solicitation issued in FY 2007 resulted in 12 industry contract awards focused on establishing a U.S. manufacturing capability of low cost trough components and the technical feasibility of lower cost thermal storage and innovative new concepts such as linear Fresnel. In FY 2008, the Solar Program funded Phase I of these contracts. In FY 2009, the more promising contracts moved into Phase II and will undergo a rigorous evaluation at the end of that Phase (some in FY 2009 and some in FY 2010). Those that continue on will be completed in FY 2010 or FY 2011. (Approximate funding $18,000,000)

[a] In this table, years indicate the years in which field verification of modeled cost occurs.
[b] These cost projections are based on 2004 dollars. The program is currently working on updating the numbers to reflect 2009 dollars as well as the impact of rising commodity costs. The cost of steel, for example, has risen 43 percent in two years. The cost of nitrate salts (the baseline for thermal storage) has risen 69 percent over that time frame.

The development of low cost thermal storage is another major focus of the CSP subprogram. The addition of energy storage helps alleviate the intermittent nature of the solar resource and enables CSP plants to operate whenever homes and businesses require power regardless of weather or time of day. Although the addition of storage increases the cost of building a CSP power plant, it will actually reduce the cost of power generated by the plant. It also has the advantage of increasing the value of the power produced because the power can be put into the grid when it is most needed; for example in the early evening when the weather is still warm. This provides a double benefit to consumers: lower cost and power on demand. Low cost thermal storage systems, however, have to be developed. To this end, a solicitation issued in FY 2008 focused on establishing the technical feasibility of several storage concepts and identifying the potential for near-term thermal storage demonstrations. Phase I of many of these contracts will be completed in FY 2009. Phase II of these contracts, prototype development and evaluation will begin in FY 2010. (Approximate funding $12,000,000)

The additional funds provided in FY 2010 will be used to establish two new activities; both of which are designed to lower the cost of the technology:

- A solicitation will be released challenging industry to develop CSP systems capable of operating competitively in the baseload power market by 2020. This is a stretch goal for CSP because baseload power is fueled primarily by coal, which is the least expensive fossil fuel. In addition, to provide baseload power would require CSP plants to have between 12 and 17 hours of storage, whereas the optimum (lowest cost) amount of storage for CSP is about 6 hours. In order to meet this goal, CSP systems that operate at higher temperatures will be required. Higher temperature operation results in higher system efficiency and enables thermal storage systems to be less costly. (Approximate funding $17,000,000)
- A pilot solar zone will be established whose goal is to develop a piece of land in a manner that facilitates the construction of utility-scale solar projects. It will serve as a model for the western States that are exploring the use of zones as a method of planning for the development of renewable energy. The use of zones will potentially speed the deployment of solar power plants. These plants will lead to cost reduction as a result of industry learning from those plants how to incorporate cost savings into their manufacturing, installation, and operation. DOE has been working with the Bureau of Land Management (BLM) on their current land proposal evaluations with plans to expand this working relationship into addressing infrastructure (e.g. roads, water, transmission tie-in), and conducting environmental studies. DOE will work with BLM to develop a process by which developers of solar projects would gain access to a piece of the zone and with state regulators to get access to transmission. (Approximate funding $22,000,000)

The CSP subprogram will also expand laboratory R&D efforts in the areas of dish/engine and parabolic trough technologies, and new R&D efforts in the areas of linear Fresnel technology and distributed power towers. There will be an increased National Laboratories effort in thermal storage, including R&D by lab staff, as well as new and refurbished facilities. The labs will provide technical assistance to the solar industry with emphasis given to those companies that have won

(dollars in thousands)

FY 2008	FY 2009	FY 2010

competitive CSP awards and those preparing for upcoming projects. Research will also focus on materials research related to reflector coatings (e.g. glass, aluminum, polymers), thermal receivers, and high temperature heat transfer fluids and thermal storage media. It is expected that a good portion of this work will be at universities. (Approximate funding $8,000,000)

SBIR/STTR	**0**	**379**	**1,170**

In FY 2008, $1,883,000 and $227,000 were transferred to the SBIR and STTR programs respectively. The FY 2009 and 2010 amounts shown are estimated requirements of the continuation of the SBIR and STTR program.

Total, Concentrating Solar Power	**27,617**	**30,000**	**78,420**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Concentrating Solar Power	
This increase in funding reflects additional commitments for the trough and advanced components solicitation moves into Phase III ($14M), the thermal storage solicitation moves into Phase II ($9M), and the baseload CSP solicitation is fully funded in Phase I ($15M), and establishment of a pilot solar zone ($20M). In addition, the market transformation and systems integration efforts related to CSP have been moved to those new subprograms to be combined with similar efforts in PV. This allows these activities to be managed more effectively and reflects their crosscutting nature.	+ 47,629
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+ 791
Total Funding Change, Concentrating Solar Power	**+ 48,420**

Systems Integration

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Systems Integration	–	–	29,270
SBIR/STTR	–	–	390
Total, Systems Integration	–	–	29,660

Description

The Systems Integration subprogram is a new subprogram proposed for FY 2010. This modification was made to better reflect Photovoltaic R&D program activities in FY 2010.

The Systems Integration subprogram focuses on the integration of high-penetration solar energy systems into end-use locations and the electricity grid. This subprogram emphasizes on engineering development and integration of technical advances throughout the Solar Program into end-use applications, including those advances made through ongoing system-level progress of the TPPs. Systems Integration also features development of integration devices, i.e., inverters, controllers, and interfaces to energy management systems, which are required to integrate solar systems into end-use locations and the electricity grid. A key application area is in the residential/commercial/industrial buildings, where Systems Integration activities are coordinating with the Building Technologies Program to provide the thermal energy and electricity, generated from solar energy technology, needed for a zero-energy building (or home). Similar coordination is being carried out with DOE's Office of Electricity Delivery and Energy Reliability (OE) to achieve high-penetration levels of solar energy technologies into both transmission and distribution grid. System Analysis activities will continue enhancing Solar Advisor Model (SAM) development, validating component/system models, and integrating varying modeling platforms for collaborative development and use.

Benefits

Systems Integration activities provide enabling technologies with technology evaluation tools, and methodologies to support meeting the target goals of high-penetration levels of grid-tied solar electric generation. In addition, these activities drive energy independence through a systems engineering approach by incorporating advances in technologies along with innovative policy, regulation, and financing practices.

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Systems Integration	–	–	**29,270**

Systems Integration contains three primary activities: Systems Modeling & Analysis, Grid Integration, and Resource & Safety R&D.

System Modeling & Analysis activities will continue benchmarking, modeling and analysis for the systems-driven approach. Validation of models for annual energy production using data collected from the four "technology showcase" arrays and one additional system atop the DOE Forrestal building will be completed in FY 2010. The datasets from the Forrestal systems allow validation of models performance of PV systems operating in a diffuse irradiation environment under partly cloudy weather conditions like those in Washington, D.C. In FY 2010, System Modeling & Analysis will also support continuing development and enhancements for Solar Advisory Model (SAM), guided by the needs of the SAM user forum, and continuing market, value, and policy analyses.

Grid Integration activities focus on high-penetration integration of a solar energy systems into end-use locations and the electricity grid. Within Grid Integration, there is critical need to improve the reliability of the inverter and other balance of system (BOS) components. Emphasis is placed on reducing life-cycle costs by increasing mean-time-between-failure (MTBF) of inverters and battery charge controllers, by developing higher performance technologies through advanced solutions to thermal management and surge protection, and by optimizing designs to achieve "plug and play" ability. FY 2010 will be the third and last year of funding for the Solar Energy Grid Integration Systems (SEGIS) contracts with industry to advance into pilot production of advanced inverters and energy management systems with improved reliability, enhanced value and reduced cost. In addition, new awards are planned for FY 2010 to support development of energy storage systems for integration with PV operations through the SEGIS-Energy Storage (ES) FOA. The SEGIS-ES efforts will accomplish the planned SEGIS progression to address integration of PV and storage technologies at distribution levels to meet the challenges of high penetration. Additionally, the program will continue to support projects awarded through the FY 2009 Funding Opportunity Announcement on field demonstration projects to analyze the effects of high penetration of distributed PV systems on electricity grid performance.

The Solar Program will also work with DOE's Office of Electricity to address the lack of access to electrical transmission which will be a major inhibitor to the increased use of CSP. The program will provide resource information and analyses that recommend optimum routes for new transmission lines that will enable CSP to be moved from arid areas of the Southwest U.S. to major population centers throughout the western U.S.

Resource & Safety R&D will look at improving resource maps for both PV and CSP technologies with an emphasis on providing "bankable data" to assist industry in site selection. Main activities will include: development, validation, and dissemination of reliable, accurate solar resource information; continued benchmarking of U.S. data with international data sets; improvements of the quality and completeness of the National Solar Radiation Data Base; benchmarking U.S. solar databases against international data sets following internationally established protocols; and provision of solar products and tools to stakeholders through accessible web-based mechanisms and staff outreach activities. The program will also develop a better method of accurately predicting the solar resource from satellite data, establishing a standard system of collecting data at specific sites, and disseminating resource information

to project developers.

SBIR/STTR	–	–	**390**

In FY 2008, no funding was transferred to the SBIR and STTR programs. The FY 2010 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Systems Integration	–	–	**29,660**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Systems Integration	
The increase in Systems Integration subprogram funding is the result of combining elements formerly included under the Technology Evaluation key activity under the Photovoltaics subprogram and several activities formerly funded under Concentrating Solar Power. Creation of this separate subprogram was done in order to highlight the crosscutting nature of this subprogram across both PV and CSP technologies and to more effectively manage these efforts together rather than as separate projects in different key activities. Funding for FY 2010 includes a significantly increased effort in addressing grid integration issues specific to the high penetration of solar technologies.	+ 29,270
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities.	+ 390
Total Funding Change, Systems Integration	**+29,660**

Market Transformation

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Market Transformation	–	–	27,450
Total, Market Transformation	–	–	27,450

Description

The Market Transformation subprogram is a new subprogram proposed for FY 2010. This modification was made to better reflect Photovoltaic R&D program activities in FY 2010.

The Solar Program recognizes it is of critical importance to engage adopters and decision makers in identifying existing market barriers and ways to address those barriers. Market transformation efforts focus on facilitating the commercialization of solar technologies by identifying and breaking down market barriers and promoting deployment through stakeholder outreach at all levels. Market transformation efforts look to ensure that technologies do not wind up "on the shelf" instead of "on the roof" because of barriers in areas such as interconnection standards, net metering, utility policies, solar access laws, policymaker understanding of solar technologies, and international safety issues. Activities also seek to capture opportunities to promote market-pull through the facilitation of large-scale solar deployment opportunities.

Benefits

Market Transformation creates significant benefits for the Solar Program across a wide variety of technical, financial and policy activities. The subprogram enables DOE to provide significant assistance to the goal of lowering the cost of solar power by identifying and reducing the market barriers to solar technology commercialization. Efforts under this subprogram complement the R&D work of the PV and CSP subprograms, as well as the Systems Integration work, by focusing on addressing these critical, post-development obstacles.

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Market Transformation	–	–	**27,450**

The Solar America Board of Codes and Standards ("Solar ABCs" formerly called Solar Codes and Standards Working Group) is now in the third year of activity. Areas of work include improving national and international standards coordination, providing inputs into National Electrical Code revisions, maintaining current product safety standards, developing and promoting national module performance rating test procedures, and streamlining interconnection and net metering regulations. DOE will work closely with many stakeholders, including state and local governments, the solar

manufacturing community, non-profits, and others.

A professional development program to support the training and certification of solar installers and code officials will continue in order to create a sufficiently large and qualified workforce that can install PV systems in sufficient quantities to meet Solar Program goals. FY 2010 efforts will focus on the second year of a series of multi-year development awards.

With Solar America Cities and Solar America Showcases, the Solar Program is supporting direct technical partnerships that work to overcome key barriers to significant solar penetration. Both activities involve partnerships between DOE and stakeholders to leverage the advanced efforts occurring throughout the U.S. on a local level. The Solar America Cities activity features assistance to 25 U.S. cities that have committed to using solar power, and helps to address implementation issues such as financing, permitting, city planning, stakeholder engagement, and grid integration. The Solar America Showcases activity provides technical assistance (not hardware purchases) to large-scale, high-visibility installations, such as new building communities, big box retailer installations, and utility-scale solar. FY 2010 funds will be used to support previously selected Solar America Cities under multi-year awards some selected during the FY 2007 for whom work commenced in FY 2008, and the others selected during FY 2008 for whom work commenced in FY 2009. Cities will be encouraged to share best practices through the use of interactive tools and discussion opportunities provided by DOE. In addition, in response to EPAct Section 931, funding will support a Government Solar Installation Program that will employ third-party financing to capitalize large installations on Federal sites. Through these funds, the Solar Program will work with Federal Energy Management Program to provide administrative services to Federal agencies that will enter into power purchase agreements with private third-party project developers, facilitating rapid adoption of solar technologies

Market Transformation features technical outreach and communications activities to engage other key decision makers in the wide scale adoption of solar. Target audiences include States, local governments, and utilities. These activities will provide technical information and peer sharing opportunities on solar technologies and related policy topics for the purpose of accelerating innovative approaches to solar implementation. This outreach now includes working with these same entities to help CSP gain market penetration such as: state governments to provide information on the impact of state incentives on+ cost of power, the job impacts of CSP projects, resource assessment; utilities to assist in technical evaluation of proposals; and the Western Governors' Association to assist in their Clean and Diversified Energy Initiative and Renewable Energy Zone project, as well as other regional renewable activities (e.g. transmission, renewable energy credits).

The Solar Policy and Analysis Network (SPAN) is a new market transformation activity being launched in FY 2010. SPAN will help fulfill the continuing critical need for accurate and timely research and analysis on local, state, regional, national, and international policies that promote solar market transformation by tapping into the expertise of the Nation's universities. Competitively-selected institutions of higher education located in geographically diverse areas will conduct analysis on regional policies and markets and provide technical outreach to stakeholders. This regional approach will complement the Solar Program's traditional top-down, Federal approach to advancing the U.S. solar marketplace. SPAN will engage engineering, business, law, policy, urban planning and other related schools within universities that can develop novel solutions to reducing barriers to wide scale solar commercialization. In addition, SPAN will further solar professional development by attracting and educating a new generation of university students who can join the solar industry in various capacities, as well as by expanding the expertise of faculty members across disciplines to include solar energy issues. SPAN universities will also assist in conducting technical assistance for DOE-selected projects in their regions. In FY 2010, DOE anticipates selecting approximately six SPAN universities, with the potential to add more in later fiscal years.

Total, Market Transformation	–	–	**27,450**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Market Transformation	
The increase in Market Transformation subprogram funding is the result of combining elements formerly included under the Technology Evaluation key activity under the PV subprogram and several activities formerly funded under CSP, as well as increased efforts in professional development and technical outreach. Creation of this separate subprogram was done in order to highlight the crosscutting nature of this subprogram across both PV and CSP technologies and to more effectively manage these efforts together rather than as separate projects in different key activities.	+ 27,450
Total Funding Change, Market Transformation	**+ 27,450**

Solar Electricity Energy Innovation Hub

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Solar Electricity Energy Innovation Hub	–	–	34,294
SBIR/STTR	–	–	706
Total, Solar Electricity Energy Innovation Hub	–	–	35,000

Description

DOE proposes to establish multi-disciplinary Energy Innovation Hubs (Hubs) to address the basic science, technology, economic, and policy issues hindering the ability to become energy secure and economically strong while being good stewards of the planet by reducing greenhouse gas (GHG) emissions. The main focus of the hub is to push the current state-of-the-art energy science and technology toward fundamental limits and support high-risk, high-reward research projects that produce revolutionary changes in how the U.S. produces and uses energy.

The hubs are inspired by the Bell Labs research model, which produced the transistor, the building block of modern computers. Their objective is to focus a high-quality team of researchers on a specific question and to encourage risk taking that can produce real breakthroughs, as opposed to the typical, more cautious approach that can result in meaningful, but often only incremental, improvements to existing technology. DOE will encourage risk-taking by making the initial grant period five years, renewed thereafter for up to 10 years. Any funding after 10 years would be predicated on "raising the bar" above that needed for simple renewal. The grants will not provide "bricks and mortar," but up to $10 million of the $35 million award may be used for retrofits and capital equipment.

Benefits

The hubs will create significant benefits for the Nation's energy security, growing economy and reducing green house gas emissions. The Solar Electricity Energy Innovation Hub will be devoted to the discovery and design of wholly new concepts and materials needed by solar to electricity conversion.

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Solar Electricity Energy Innovation Hub	–	–	**34,294**

The Solar Electricity Hub will incorporate cutting edge research that may include both PV and CSP technology areas. PV research will be the primary focus of the hub with emphasis on the synthesis and modeling of disruptive PV device structures and processes to enable conceptual and cost breakthroughs. More specifically, projects will incorporate optical, electrical, and thermal phenomena, previously demonstrated only at the material level, into a PV device structure in order to demonstrate the technical viability and economic promise of the approach. Additionally, radical processes which promise disruptive 5 to 10x reductions in feedstock, processing costs or capital expenditure will be explored at the laboratory scale. The CSP portion would likely focus on materials research related to reflector coatings (e.g. glass, aluminum, polymers), thermal receivers, and high temperature heat transfer fluids and thermal storage media. The grants will not provide "bricks and mortar," but up to $10 million of the $35 million award may be used for retrofits and capital equipment.

SBIR/STTR	–	–	**706**

This is an estimated amount based on the continuation of the SBIR and STTR program.

Total, Solar Electricity Energy Innovation Hub	–	–	**35,000**

Explanation of Funding Changes

	FY 2010 vs. FY 2009 ($000)
Solar Electricity Energy Innovation Hub	
This is a new activity for FY 2010.	+ 35,000
Total Funding Change, Solar Electricity Energy Innovation Hub	**+ 35,000**

Solar Heating and Cooling Systems

Funding Schedule by Activity

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Solar Heating and Cooling Systems	1,959	–	–
Total, Solar Heating and Cooling Systems	1,959	–	–

Description

Solar hot water and space heating/cooling technologies were previously managed by the Solar Program. Following increased collaboration with the Buildings Technologies Program (BT), the Solar Program transferred the Solar Heating and Cooling Systems activity to BT in FY 2009. BT continues to focus on developing a zero energy home with a cost within the means of most Americans. To accomplish this in the most efficient manner possible, all aspects of a home (e.g. walls, windows, insulation, HVAC, PV, solar water heating, solar space heating/cooling) have to be designed and analyzed as a whole system. The transfer of the Solar Heating and Cooling Systems activity provides a more complete and efficient use of these technologies to help advance zero energy home R&D. The Solar Program continues to promote the Solar Heating and Cooling technologies along with the growing suite of market-ready solar technologies as part of its market transformation efforts. In addition, the Solar Program will continue to provide technical assistance to BT as needed. PV R&D related to buildings remains the responsibility of the Solar Program.

Detailed Justification

(dollars in thousands)

	FY 2008	FY 2009	FY 2010
Solar Heating and Cooling Systems	**1,959**	–	–

The Solar Heating and Cooling Systems subprogram completed the development of hybrid solar lighting and solar water heating for nonfreezing locations in FY 2008. These technologies were sufficiently developed to enable their transfer to industry for commercialization. The conclusion of these activities facilitated the transition to the Building Technologies Program in FY 2009.

Total, Solar Heating and Cooling Systems	**1,959**	–	–