



To: CESA Colleagues  
From: Mark Sinclair  
Date: August 31, 2007  
Re: California State Solar Program Recommendations

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The California Energy Commission (CEC) recently released a report, *Eligibility Criteria and Conditions for Incentives for Solar Energy Systems* (August 2007), which summarizes major principles and recommendations for developing a successful statewide photovoltaic program to guide California's Million Solar Roofs Initiative. The report may provide useful guidance for the design of other state-based solar programs. The following is a summary of the major recommendations.

CEC has established several guiding principles that relate directly to the successful development of solar PV program eligibility criteria, conditions for incentives and component rating standards. These principles include:

- Leveraging energy efficiency improvements should be a primary consideration in deploying photovoltaics. To participate in the state PV program, new buildings should be required to exceed current building energy efficiency standards, while existing buildings should be required to improve their efficiency. Combining energy efficiency measures with PV will ensure proper sizing of PV systems, contribute to the state's efficiency goals, and provide maximum benefits to PV purchasers and electricity consumers.
- Rational targeting of PV deployment to achieve the greatest cost benefit should be a central feature of a large-scale solar program. Therefore, solar installations should be targeted to climate zones with high peak demands for air conditioning and where solar systems can provide the most benefit.
- Transitioning away from capacity-based incentives to performance-based incentives by integrating energy efficiency and time of use energy considerations should be a priority.

The report then makes the following specific recommendations to achieve these program principles:

### ***1. Solar Energy Component Standards***

- Modules – The test requirements developed under CEC's New Solar Homes Partnership program<sup>1</sup> for PV modules should be used for all modules. Specifically, PV modules

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<sup>1</sup> The California New Solar Homes Partnership is aimed at new residential construction with the goal of creating a self-sustaining market for solar homes where builders incorporate high levels of energy efficiency and high performing solar systems.

should be certified to the UL 1703 safety testing standard to ensure safety and reliability. Module performance characteristics should be measured using the International Electrotechnical Commission (IEC) 61215 or 61646 standards by independent accredited laboratories. The reliability of this detailed performance data is critical to determine the expected performance of systems.

- Inverters – Inverters should be certified to UL 1741 standards. Inverter performance data should be tested in accordance with the “Performance Test Protocol for Evaluating Inverters Used in Grid-Connected Photovoltaic Systems”, prepared by Sandia National Lab (2004 version), enabling the use of detailed performance curves for determining expected system performance rather than just the single weighted inverter efficiency numbers. (This testing requirement is already in use in California).
- Meters – Performance meter requirements should be used to ensure the accuracy and quality of meters. The requirements include display and monitoring of the long term and instantaneous production from systems to assist in diagnosing and mitigating any faults which affect performance. Performance meters, whether stand alone or integrated with the inverters, should be required to meet the following:
  - $\pm 2$  percent accuracy for all “performance-based” incentive applicants
  - 5 percent accuracy meters (these are primarily inverter integrated) are allowed for “expected performance” incentive applicants
  - All meters must measure and display, both instantaneous (kw or W) and cumulative energy produced (kwh or Wh)
  - All meters must retain production data during power outages
  - All meters must be easy to read for the customer’s benefit
  - All meters must have a communication port capable of enabling connection to remote performance monitoring and reporting service

## ***2. Solar Energy System Installation Standards***

- Performance Based Incentives – **the payment of incentives based on capacity should be discontinued.** Incentives should be paid either through an actual or an expected performance based incentive mechanism.
- For new residential construction, CEC provides incentives based on “expected performance” as determined through detailed hourly calculations accounting for the interaction of components at the range of operating conditions associated with specific installation characteristics, based on the performance characteristics determined by independent testing of the components. Specifically, the expected performance calculation is based on a capacity incentive (\$/W), which is adjusted by a “design factor”

that takes into account aspects of the variation in performance of specific systems. The capacity is calculated using the PTC nameplate rating of the modules and the weighted efficiency of the inverter. The design factor calculations account for the impact of geographic and design-related differences between the proposed and reference locations and installation characteristics such as tilt, azimuth, and shading.

- For systems larger than 100 kW (AC), California requires use of a performance-based incentives. The payments are made over 5 years on a monthly basis in terms of \$/kWh. All other systems use the estimated performance approach (although are encouraged to opt for the performance-based approach).
- PV Calculator – Expected performance based incentives (EPBI) are based on the use of an hourly calculation engine to determine expected system performance (in Time-of-Use weighted kwh), using detailed tested and certified module and inverter performance characteristics to estimate performance in each hour. The Calculator accounts for the unique hourly output of the specific module/inverter combination as a function of power, current and voltage conditions and matching; cell temperatures as a function of module engineering, ambient temperature and wind at the project location; and the consequences of installation characteristics, including azimuth, tilt, and shading obstructions in each hour.
- The Expected Performance Based Incentive (EPBB) calculation methodology used by the CEC is as follows:

EPBB Incentive = Incentive Rate x System Capacity Rating x Design Factor.

The calculator used by CEC for EPBB is a web-based application and uses NREL's PV Watts v2 engine. The calculation accounts for the following:

- Location (latitude and longitude)
- Hourly weather data
  - Solar radiation (solar resource available)
  - Ambient temperature
  - Wind speed
- Installation characteristics
  - Azimuth
  - Tilt
  - Mounting type and offset (rack mounted vs. BIPV)
  - Height above ground (for scaling wind impact)
  - Number of modules per string and number of strings in parallel
  - Shading impact
- Detailed Tested and Certified Equipment Performance Characteristics

- PV Modules
  - Full Current-Voltage (I-V) curve at Standard Test Conditions
  - Normal Operating Cell Temperature
  - Temperature coefficients
- Inverter
  - Full Performance efficiency curves for the range of voltage and power conditions applicable
  - Night time tare loss
  - Maximum Power Point Tracking
- System degradation/derating
  - Dirt and dust build up
  - Wiring mismatch
- Shading – Installation standards should encourage a purposeful avoidance of shading based on the EPBB calculation methodology. This approach should be reflected in EPBB incentive calculations, and existing and future shading obstructions should be accounted for in the hourly determination of expected system output, as determined by the PV Calculator.
- Peak Load – Time Dependent Valuation (TDV) multipliers established by the CA Energy Commission are used to weight the hourly kwh system performance to account for time-of-use production and provide incentives for component engineering, system design and installation that reduce peak demand.
- Field Verification – A sample of systems should be required to have third party field verification for visually checking components, installation characteristics and shading, and to verify performance.
- Installation – Installers must have a valid license. NABCEP certification should be encouraged (although it is not required). Installers must carryout a field verification protocol for each of their jobs to avoid installation problems.

### ***3. Energy Efficiency Requirements for Receiving Solar Incentives***

- A two-tiered energy efficiency criterion is applied to eligibility for PV incentives for new residential construction. Tier 1 is the minimum level of energy efficiency necessary to qualify for PV incentives in the CEC program. Tier 1 requires a 15% reduction in the building's combined space heating, cooling, and water heating energy, compared to current state building energy efficiency standards (Title 24 in California). Tier II is the preferred efficiency level that encourages buildings to achieve a 35% reduction in the building's combined space heating, cooling and water heating energy and 40% in the

building's cooling energy compared to state building energy efficiency standards. Additionally, under both tiers, appliances must be ENERGY STAR if applicable.

- Newly Constructed Residential Buildings – Tier I and Tier II criteria should apply to all newly-constructed residential buildings. Utility-funded energy efficiency incentives should be made available for each Tier.
- Newly Constructed Commercial Buildings – A similar Tier structure should be applied to newly-constructed commercial buildings. Tier I should be the minimum requirement for qualifying for solar incentives and be set at 15% beyond the Title 24 Standards requirements, in line with the energy efficiency requirements of LEED New Construction and Savings By Design. Tier II should be the preferred level and be set at 30% beyond the Title 24 Standards, in line with ASHRAE Standard 189, and the federal tax credit. Utility-funded energy efficiency incentives should be made available for each Tier.
- Existing Commercial Buildings – Existing commercial buildings should be benchmarked, using Energy Star's Portfolio Manager. If the rating is at 75 or above and the building is equal to or smaller than 50,000 square feet, no further action should be required. If the rating is less than 75 or the building is larger than 50,000 square feet, commissioning of the building should be required, and the project should implement equipment repairs and adjustments and install all cost effective measures or achieve a minimum benchmarking rating level of 75. Utilities should provide incentives for using a building commissioning agent and for installing cost effective measures identified through building commissioning.
- Existing Residential Buildings should be required to undertake an online energy audit. Utilities should establish a targeting system (benchmarking) that compares the home's energy use per square foot to the range of energy use of the utility's residential customers, to identify which quartile of energy use per square foot the home falls into. The quartile for the individual home would determine what level of investigation would be appropriate to determine energy efficiency measures that would be cost effective for the home. Homes that fall into the best quartile of energy use per square foot, 75 percent to 100 percent, would use an online energy audit and should be encouraged to implement those measures which are determined to be cost effective for which the utility offers measure-specific incentives. Homes in the lower quartiles are prime candidates for further onsite investigation (onsite energy audit, HERS rating, or building performance contractor assessment) to determine cost effective measures. Homes that are in the bottom three quartiles should install cost effective measures or improve their energy use per square foot to the point that the home falls into the 75 percent quartile. Utilities should provide incentives for using an energy auditor, home energy rater or building performance contractor and for installing cost effective measures identified in the audit, HERS rating or building performance contractor assessment.

#### ***4. Other Eligibility Requirements***

- A warranty of the installed system must cover at least the first 10 years of operation and include the PV modules, inverters, and meters. The warranty must include protection against defective workmanship, system or component breakdown or degradation in electrical output of more than 15% from the originally rated electrical output during the first ten-years. The warranty must provide for a no-cost repair or replacement of the system or components, including associated labor during the warranty period.
- All systems should be new and unused. All equipment must be listed on the CEC's eligible equipment list.