

CALIFORNIA  
ENERGY  
COMMISSION

**GUIDELINES FOR CALIFORNIA'S SOLAR  
ELECTRIC INCENTIVE PROGRAMS  
PURSUANT TO SENATE BILL 1**

**GUIDELINES**

DECEMBER 2007  
CEC-300-2007-012-CMF



Arnold Schwarzenegger, *Governor*

# CALIFORNIA ENERGY COMMISSION

John L. Geesman  
*Presiding Commissioner,  
Renewables Committee*

Jackalyne Pfannenstiel  
*Chairman and Associate  
Member, Renewables Committee*

Melissa Jones  
*Executive Director*

Bill Blackburn  
Claudia Orlando  
*Supervisors*

Mark Hutchison  
*Manager*  
**RENEWABLE ENERGY  
PROGRAM**

Bill Pennington  
*Manager*  
**BUILDINGS AND APPLIANCES**

Valerie Hall  
*Deputy Director*  
**EFFICIENCY AND RENEWABLE  
ENERGY**

# TABLE OF CONTENTS

Abstract .....	v
CHAPTER 1: Introduction .....	1
Background .....	2
Schedule.....	4
CHAPTER 2: Minimum Program Requirements.....	5
Solar Energy System Definition .....	5
Declining Incentives.....	5
Incentive Level for Publicly Owned Utilities .....	6
System Location and Grid Interconnection .....	6
Solar Energy System Components.....	6
Performance Meter .....	7
System Sized to Offset On-Site Electricity Load.....	7
System Warranty .....	7
Installation .....	7
Energy Efficiency.....	8
CHAPTER 3: Solar Energy System Component Standards.....	9
Photovoltaic Modules.....	9
Inverters.....	10
Meters.....	11
CHAPTER 4. Solar Energy System Design and Installation Standards and Incentives	12
Performance-Based Incentives.....	12
Expected Performance-Based Incentives .....	13
Hourly Photovoltaic Production Calculation .....	14
Reference System and Location .....	15
Incentive calculation.....	16
Shading .....	16
Peak Load .....	17
Field Verification .....	17
Installation .....	17
Performance Monitoring and Maintenance .....	18
CHAPTER 5: Energy Efficiency .....	19
Newly Constructed Buildings .....	19
Residential Buildings.....	19
Commercial Buildings .....	20
Existing Buildings.....	22
Energy Audit, Information and Disclosure .....	22
Information to be provided to the building owner/manager/ratepayer: .....	22
Disclosures to be provided by the building owner/manager/ratepayer:.....	23

Existing Commercial Buildings – Benchmarking, Retro-Commissioning and Efficiency Improvements .....	23
Benchmarking .....	23
Retro-Commissioning .....	24
Commitment Agreement .....	24
Energy Efficiency Exceptions for Existing Commercial Buildings .....	25
Existing Residential Buildings .....	25
Energy Audit Exception for Existing Residential Buildings .....	25
Alternative Portfolio Energy Savings .....	26
CHAPTER 6: Reporting Requirements .....	27
Reporting Requirements for 2008 .....	27
Reporting Requirements Beginning in 2009 .....	28
APPENDIX 1: Criteria for Testing, Certification and Listing of Eligible Components .....	30
Photovoltaic Modules .....	30
Inverters .....	33
Meters .....	35
APPENDIX 2: Field Verification and Diagnostic Testing of Photovoltaic Systems .....	36
Background .....	36
Responsibilities .....	37
Field Verification and Diagnostic Testing Process .....	37
Relationship to Other Codes, Standards and Verification .....	38
Field Verification Visual Inspection .....	39
Photovoltaic Modules .....	39
Inverters .....	39
System Performance Meters .....	39
Tilt and Azimuth .....	39
Shading Verification .....	43
Minimal Shading Criterion .....	43
Accounting for Actual Shading .....	44
Measuring Heights and Distances or Altitude Angles .....	46
Mature Tree Height .....	48
Verification of System Performance .....	50
Measuring Solar Irradiance .....	52
Measuring Ambient Air Temperature .....	52
Observing Output AC Power at the Inverter .....	52
Multiple Orientation Arrays .....	52
APPENDIX 3: Senate Bill 1 (Murray, Statutes of 2006) .....	54

## **Abstract**

Pursuant to Senate Bill 1, this document presents Guidelines for solar energy system incentive programs in California.

Senate Bill 1 is the culmination of the Governor's Million Solar Roofs Initiative, expanding upon the California Solar Initiative and the New Solar Homes Partnership. This legislation requires the California Energy Commission to establish eligibility criteria, conditions for incentives and rating standards to qualify for ratepayer-funded incentives provided by the Energy Commission, the California Public Utilities Commission and local publicly owned electric utilities.

Senate Bill 1 establishes three specific expectations to be met to qualify for ratepayer-funded incentives:

1. High quality solar energy systems with maximum system performance to promote the highest energy production per ratepayer dollar,
2. Optimal system performance during periods of peak demand, and
3. Appropriate energy efficiency improvements in new and existing homes and commercial structures where solar energy systems are installed.

## **Keywords**

Senate Bill 1, SB 1, Million Solar Roofs Initiative, California Solar Initiative, CSI, New Solar Homes Partnership, NSHP, California Energy Commission, CEC, publicly owned utilities, investor-owned utilities, California Public Utilities Commission, CPUC, solar, solar energy systems, solar energy system incentive programs, electricity generation, photovoltaic, PV, PV Calculator, energy efficiency, guidelines, eligibility criteria, conditions for incentives, rating standards, benchmarking, retro-commissioning, HERS rating, field verification, energy audit, PMRS

# CHAPTER 1: Introduction

Senate Bill 1 (SB 1)<sup>1</sup> directs the California Energy Commission (Energy Commission) to establish eligibility criteria, conditions for incentives, and rating standards for projects applying for ratepayer-funded incentives for solar energy systems.<sup>2</sup> Pursuant to SB 1, this document establishes minimum guidelines to implement solar energy system incentive programs in California overseen by the Energy Commission, the California Public Utilities Commission (CPUC) and local publicly owned electric utilities (POUs). These Guidelines are not intended to serve as the sole requirements for solar energy system incentive programs.<sup>3</sup> Other requirements specific to the Energy Commission, CPUC and POU programs are expected to be addressed and delineated in their respective program guidebooks or handbooks.

The entities charged with implementing solar energy system incentive programs pursuant to SB 1, the Energy Commission, the CPUC, and the POUs, are referred to in this document, as “program administrators.”<sup>4</sup> The solar energy system incentive program administrators shall incorporate the requirements in this document as part of their respective program guidebooks or handbooks.

This document covers the following topics:

- Program and legislative background, and basis for guidelines
- Schedule for implementing these guidelines
- Solar equipment component requirements
- System design and installation requirements
- Energy efficiency requirements
- Reporting requirements for California publicly owned electric utilities

---

<sup>1</sup> SB 1 (Murray), Chapter 132, Statutes of 2006, § 4, as codified in Public Resources Code sections 25780 – 25784. Senate Bill 1 is an extensive, multi-faceted legislation that covers many other matters besides the eligibility criteria, conditions for incentives and rating standards addressed in these Guidelines. These Guidelines do not address those other matters.

<sup>2</sup> Public Resources Code Section 25781(e) defines solar energy systems subject to these Guidelines as follows: “Solar energy system” means a solar energy device that has the primary purpose of providing for the collection and distribution of solar energy for the generation of electricity, that produces at least one kW, and not more than five MW, alternating current rated peak electricity, and that meets or exceeds the eligibility criteria established pursuant to Section 25782.

<sup>3</sup> These Guidelines do not apply to incentives for solar thermal and solar water heating devices covered by Public Utilities Code Section 2851(b).

<sup>4</sup> Note that the term “program administrator” is used by many to refer to the entity (generally a utility or third-party) that is responsible for day-to-day processing of applications, payment requests, and related tasks.

SB 1 directs the Energy Commission, in consultation with the CPUC, POU's and interested members of the public, to establish eligibility criteria, conditions for incentives and rating standards for solar energy system incentive programs. **Solar energy system incentive programs funded by California electricity ratepayers must meet the requirements set forth in these Guidelines.** This includes solar energy system incentive programs established by the CPUC (California Solar Initiative), the Energy Commission (New Solar Homes Partnership) and programs administered by California's POU's.

## Background

SB 1 is the culmination of Governor Schwarzenegger's "Million Solar Roofs Initiative" and builds upon the CPUC's California Solar Initiative (CSI) program,<sup>5</sup> the Energy Commission's New Solar Homes Partnership (NSHP), and existing publicly owned utility solar energy system incentive programs. SB 1 directs total expenditures of up to \$3,350,800,000 by 2017 with goals to install solar energy systems with a generation capacity equivalent of 3,000 megawatts, to establish a self-sufficient solar industry in which solar energy systems are a viable mainstream option for both homes and commercial buildings in ten years, and to place solar energy systems on 50 percent of new homes in 13 years. The overall goal is to help build a self-sustaining solar electricity market in conjunction with improved energy efficiency in the state's growing number of solar-powered residential and non-residential buildings.

SB 1 establishes three specific expectations to be met for ratepayer funded incentives made available through the bill:

1. High quality solar energy systems with maximum system performance to promote the highest energy production per ratepayer dollar,
2. Optimal system performance during periods of peak demand, and
3. Appropriate energy efficiency improvements in the new and existing home or commercial structure where the solar energy system is installed.

To guide the state in developing a successful solar photovoltaic (PV) program that is consistent with the Governor's Million Solar Roofs Initiative, the Energy Commission delineated several principles in the *2005 Integrated Energy Policy Report* (IEPR). These principles include:

- Leveraging energy efficiency improvements should be a primary consideration in deploying PV systems. To participate in the PV program, new buildings should be required to exceed the current building standards, while existing buildings should be required to improve their efficiency. Combining energy efficiency measures with PV will ensure proper sizing of PV

---

<sup>5</sup> 'California Solar Initiative' often refers to all of the various solar incentive programs in the state and that are addressed in SB 1, including programs administered by the CPUC, the Energy Commission and the POU's. Here, it is used to refer specifically to the CPUC's program that includes solar energy system incentives for new and existing commercial and existing residential customers served by San Diego Gas & Electric Company, Southern California Edison Company and Pacific Gas & Electric Company.

systems, contribute to the state's efficiency goals, and provide the 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. 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 and integrating energy efficiency and time-of-use energy considerations should be a priority.

The IEPR also recognized the common policy vision of the loading order adopted by the state's principal energy agencies in the Energy Action Plan and the 2003 *IEPR*. The loading order establishes the following priority for the development of energy resources: 1) energy efficiency and demand response, 2) renewable energy resources and distributed generation, and 3) clean, fossil fuel, central-station generation. In the Governor's energy policy to the Legislature in response to the 2003 *IEPR*, he highlighted the importance of the Million Solar Roofs Initiative and the aggressive pursuit of all cost effective energy efficiency, consistent with the loading order.

There are also several other energy policy directives that are important to address as the Energy Commission responds to the SB 1 mandates:

- Assembly Bill 32 (AB 32, Nunez, Chapter 488, Statutes of 2006) and the Climate Action Initiative – Governor Schwarzenegger's Executive Order S-3-05 placed California in a global leadership position by establishing aggressive greenhouse gas emissions reduction targets. The Climate Action Team's 2006 Report to the Legislature highlighted the need for expansion of energy efficiency, coupled with increased penetration of photovoltaic systems. These policies were reinforced by AB 32.
- Energy Efficiency Goals and Resource Procurement – Senate Bill 1037 (SB 1037, Kehoe, Chapter 366, Statutes of 2005) and Assembly Bill 2021 (AB 2021, Levine, Chapter 734, Statutes of 2006) directed electricity corporations subject to the CPUC's authority and local publicly owned electric utilities, respectively, to first meet their unmet resource needs through all available energy efficiency and demand response resources that are cost effective, reliable and feasible.
- Green Building Initiative – Governor Schwarzenegger's Executive Order S-20-04 was his first concrete step to pursue the loading order. The Green Building Initiative (GBI) committed to aggressive action to reduce state building electricity use by 20 percent by 2015 by taking all cost-effective measures described in the Green Building Action Plan, and strongly encouraging commercial building owners to take aggressive action to reduce electricity usage in the same manner. The GBI urged the CPUC to apply its energy efficiency authority to improve commercial building energy efficiency by the 20 percent goal.
- The CPUC's October 18, 2007 Decision, 07-10-032, reaffirmed the Energy Action Plan vision of a loading order and states California's highest priority is to increase energy efficiency measures. Through this Decision, the CPUC adopted goals for new residential construction to be net zero energy by 2020 and new commercial construction to be net zero energy by 2030. The CPUC concluded that energy efficiency must become "business as usual" if we are going to meet growing energy demand and combat global warming.



To pursue all of the above policy directives, the goal of the SB 1 solar energy system incentive programs should be to create a self-sustaining market for solar buildings that incorporate high levels of energy efficiency and high performing solar energy systems. By combining high levels of energy efficiency and high solar energy system performance, California maximizes the major investment it is making through SB 1, the solar energy system market makes its maximum contribution to the accomplishment of California's required greenhouse gas emissions reductions, and the solar industry maximizes the value of its products and services to California ratepayers and consumers.

It is the intent of these Guidelines to establish eligibility criteria, conditions for incentives and rating standards that align solar energy system incentive programs throughout California to meet these goals.

## **Schedule**

Under SB 1, the Energy Commission must establish eligibility criteria, conditions for incentives, and rating standards, as described above, by January 1, 2008.

Separately, SB 1 also directs the CPUC and the POUs to implement solar energy system incentive programs for ratepayers subject to their respective jurisdiction by January 1, 2008. The solar energy system incentive programs established by the CPUC and POUs must be consistent with the directives of SB 1, as well as meet these Guidelines established by the Energy Commission.

As discussed in the Energy Commission's August 2007 staff report<sup>6</sup>, *Eligibility Criteria and Conditions for Incentives for Solar Energy Systems, Senate Bill 1*, a transition period is needed for the CPUC and POU solar energy system incentive programs to transition to conformance with all of the eligibility criteria, conditions, and rating standards established in these Guidelines.

These Guidelines establish minimum program requirements to be met by January 1, 2008 (Chapter 2), and allow for up to a 12-month transition period for full compliance with all the eligibility criteria, conditions, and rating standards described in Chapters 3 through 6. All program administrators shall conform their programs as necessary to these Guidelines no later than January 1, 2009 except as noted below. Program administrators may voluntarily conform to the Guidelines in advance of that date, and are encouraged to do so to the extent feasible. These requirements shall only apply to new incentive applications that are received on or after a program administrator has implemented these requirements. Applications submitted to solar energy system incentive programs for incentives prior to January 1, 2008 are not required to comply with these Guidelines.

POUs with peak demand of 200 MW or less as reported for calendar year 2006 are required to comply with Chapters 2, 3, and 6 only for 2008. These POUs may delay the implementation of the requirements in Chapters 4 and 5; however, they shall comply with the requirements as described in Chapters 4 and 5 no later than January 1, 2010.

---

<sup>6</sup> California Energy Commission, CEC 400-2007-014, August 2007

## **CHAPTER 2: Minimum Program Requirements**

This chapter describes the minimum solar program requirements established in SB 1 and by the Energy Commission to be met by solar energy system incentive program administrators no later than January 1, 2008.

Program administrators shall comply with the requirements covered in Chapters 3 through 5 regarding solar energy system component standards, system design and installation standards, and energy efficiency requirements no later than January 1, 2009. POUs with peak demand of 200 MW or less as reported for calendar year 2006 shall comply with the requirements in chapters 4 and 5 no later than January 1, 2010.

### **Solar Energy System Definition**

Solar energy systems eligible for financial incentives covered by these Guidelines must have the primary purpose of providing for the collection and distribution of solar energy for the generation of electricity. Solar energy systems must produce at least one kilowatt (kW), and not more than five megawatts, alternating current (AC) rated peak electricity, accounting for all system losses, and meet or exceed the eligibility criteria established in these Guidelines.<sup>7</sup>

Eligible solar technologies must primarily generate electricity. The statutory definition of “solar energy systems” includes solar photovoltaic technology and other solar technologies, such as solar thermal electric technologies. However, at this time, the Energy Commission’s Guidelines address only solar photovoltaic (PV) technology. These Guidelines will be revised in the future to include other covered solar energy system technologies when appropriate to do so. Manufacturers of covered, non-PV solar energy systems are directed to work with the Energy Commission staff to define comparably rigorous and appropriate requirements for such systems.

Solar technologies that do not primarily generate electricity are not eligible. These Guidelines do not apply to solar thermal and solar water heating devices that do not primarily generate electricity, but that qualify for the CPUC’s incentive program as specified in Public Utilities Code Section 2851(b).

### **Declining Incentives**

Solar energy system incentives must decline at a rate of no less than an average of 7 percent per year and must be reduced to zero by the end of 2016.<sup>8</sup>

---

<sup>7</sup> Public Resources Code, Section 25781 (e).

<sup>8</sup> Public Utilities Code, Section 387.5 (b), and Public Utilities Code Section 2851(a)(1).

## **Incentive Level for Publicly Owned Utilities**

Local publicly owned electric utilities must offer incentives for the installation of solar systems beginning at no less than \$2.80 per installed watt (AC), or the equivalent in terms of kilowatt-hours (kWh), on or before January 1, 2008.

## **System Location and Grid Interconnection**

The solar system must be located on the same premises where the consumer's own electricity demand is located. The system must be connected to the electrical distribution grid of the utility serving the customer's electrical load.<sup>9</sup>

## **Solar Energy System Components**

All components in the solar energy system must be new and unused and should not have previously been placed in service in any other location or for any other application.<sup>10</sup>

All major solar energy system components (PV and non-PV) eligible for ratepayer funding under SB 1<sup>11</sup> must be included on the Energy Commission's Eligible Equipment Lists. This includes PV modules, inverters and meters. PV modules currently listed with the Energy Commission on the website [[http://www.consumerenergycenter.org/cgi-bin/eligible\\_pvmodules.cgi](http://www.consumerenergycenter.org/cgi-bin/eligible_pvmodules.cgi)] may be considered eligible for incentives only between January 1, 2008 and December 31, 2008. Beginning January 1, 2009, these PV modules will need to complete the testing requirements of Chapter 3 to continue eligibility. Information on solar system components can be found at [<http://www.gosolarcalifornia.ca.gov>]. For non-PV solar electric technologies, manufacturers are directed to work with the Energy Commission staff to define comparably rigorous and appropriate component standards for such equipment, so they can be listed.

---

<sup>9</sup> Public Resources Code, Section 25782 (a)(5) and (6).

<sup>10</sup> Public Resources Code, Section 25782 (a)(3).

<sup>11</sup> Public Resources Code, Section 25782 (c).

## Performance Meter

All solar energy systems must be installed with a performance meter or an inverter with a built-in performance meter so that the customer can monitor and measure the system's performance and the quantity of electricity generated by the system.<sup>12</sup>

## System Sized to Offset On-Site Electricity Load

The solar energy system must be intended primarily to offset part or all of the consumer's own electricity demand.<sup>13</sup> The minimum size of an eligible system is 1 kW<sub>AC</sub>, accounting for all system losses.<sup>14</sup> Systems sized between 1 kW<sub>AC</sub> and 5 kW<sub>AC</sub>, inclusive, shall be assumed to primarily offset the customer's annual electricity needs.

## System Warranty

All solar energy systems must have a minimum ten-year warranty to protect against defects and undue degradation of electrical generation output.<sup>15</sup>

## Installation

The solar energy system must be installed in conformance with the manufacturer's specifications and in compliance with all applicable electrical and building code standards.<sup>16</sup> Chapter 4 of this report establishes installation standards which shall be complied with no later than January 1, 2009 except where noted. In the interim, the Energy Commission recommends that program administrators strongly encourage applicants for solar incentives to follow these installation Guidelines to the maximum extent feasible.

All eligible systems shall be installed by individuals with a current A, B, C-10 or C-46 contractor license. Roofing contractors with a current C-39 license may place PV panels in accordance with the limitations of their license; however, electrical connections must not be made by a roofing contractor. North American Board of Certified Energy Practitioners (NABCEP) certification of

---

<sup>12</sup> Public Resources Code, Section 25782 (a)(7).

<sup>13</sup> Public Resources Code, Section 25782 (a)(2).

<sup>14</sup> Public Resources Code, Section 25781 (e).

<sup>15</sup> Public Resources Code, Section 25782 (a)(4).

<sup>16</sup> Public Resources Code, Section 25782 (a)(8).

installers is encouraged, though not required. Systems may be self-installed by the purchaser (owner).

## **Energy Efficiency**

Chapter 5 of this report establishes energy efficiency requirements, which shall be complied with no later than January 1, 2009. In the interim, the Energy Commission recommends that program administrators strongly encourage applicants for solar incentives to follow these efficiency requirements measures to the maximum extent feasible.

## CHAPTER 3: Solar Energy System Component Standards

This chapter establishes rating standards for equipment, components, and systems to assure reasonable performance in accordance with SB 1.<sup>17</sup> Setting rating standards and guidelines to ensure the quality of systems and components is critical to a successful solar incentive program and to ensure high performing systems are incentivized. The three main components that are subject to standards and ratings specific to PV installations are the modules, inverters and meters.

A description of the testing criteria and the criteria for reporting performance of eligible equipment is detailed in Appendix 1 - Criteria for Testing, Certification and Listing of Eligible Components.

*These Guidelines focus on component standards for photovoltaic (PV) systems. Manufacturers of non-PV solar energy systems, which are covered by these Guidelines, are directed to work with the Energy Commission staff to define comparably rigorous and appropriate component standards for such systems.*

**The requirements in this chapter shall be implemented by solar energy system incentive program administrators no later than January 1, 2009.**

### Photovoltaic Modules

Eligible PV modules shall be required to provide testing data from independent laboratories to ensure safety and high quality data on module performance in the field. This data shall also be used to calculate the expected performance of the system. Eligible modules are listed with the Energy Commission.<sup>18</sup>

The PV module eligibility requirements are as follows:

- Modules shall be certified to UL 1703 by a Nationally Recognized Testing Laboratory (NRTL) to ensure safety and reliability.
- Detailed performance data shall be reported and certified using the subsections of International Electrotechnical Commission (IEC) Standard 61215 or 61646 (depending on the

---

<sup>17</sup> Public Resources Code, Section 25782(c).

<sup>18</sup> Modules currently eligible under these requirements are listed under the NSHP eligible modules list [[http://www.gosolarcalifornia.ca.gov/nshp/eligible\\_pv.html](http://www.gosolarcalifornia.ca.gov/nshp/eligible_pv.html)]. Modules previously listed as eligible with the Energy Commission on the following website [[http://www.consumerenergycenter.org/cgi-bin/eligible\\_pvm\\_modules.cgi](http://www.consumerenergycenter.org/cgi-bin/eligible_pvm_modules.cgi)] need to meet the testing requirements specified in Chapter 3 before January 1, 2009 to be eligible for programs implementing these Guidelines.

type of PV system) an International Laboratory Accreditation Corporation (ILAC) accredited laboratory.<sup>19</sup>

- The Normal Operating Cell Temperature (NOCT) for roof integrated building integrated photovoltaic (BIPV) products shall be determined using the specification described in Appendix 1, Criteria for Testing, Certification and Listing of Eligible Components.

*All modules shall fulfill the eligibility criteria testing requirements by January 1, 2009 to qualify as eligible equipment.*<sup>20</sup> *Between January 1, 2008 and December 31, 2008, performance data based on test procedures specified in UL 1703, Section 18.1 (in-house laboratory and flash test data) may be relied upon to list eligible modules.*

## Inverters

The inverter test protocol developed by the Energy Commission to determine inverter performance data shall be used along with the UL certification for safety and reliability. The inverter test protocol ensures that the reported performance data of efficiency at the full range of operating conditions (power and efficiency at the full range of possible voltages) along with the night time tare loss for each inverter provides full performance information and enables hourly estimating of the overall performance of the system.

Eligible inverters are listed with the Energy Commission.<sup>21</sup>

The following are inverter eligibility requirements:

- Inverters shall be certified to UL 1741 standards by a Nationally Recognized Testing Laboratory (NRTL).
- Performance data (Maximum Continuous Output Power, Conversion Efficiency, and Tare Losses) tested in accordance with "Performance Test Protocol for Evaluating Inverters Used in Grid-Connected Photovoltaic Systems<sup>22</sup>" by a NRTL shall be reported for each inverter.

---

<sup>19</sup> An ILAC laboratory inside or outside the United States may be used to conduct this testing and reporting.

<sup>20</sup> Modules that are of identical type can be grouped for testing purposes within a range of power ratings. Details for grouping modules are provided in Appendix 1.

<sup>21</sup> Inverters eligible under these requirements are listed with the Energy Commission at [[http://www.consumerenergycenter.org/cgi-bin/eligible\\_inverters.cgi](http://www.consumerenergycenter.org/cgi-bin/eligible_inverters.cgi)].

<sup>22</sup> This document can be found at [[http://www.energy.ca.gov/renewables/02-REN-1038/documents/2004-12-01\\_INVERTER\\_TEST.PDF](http://www.energy.ca.gov/renewables/02-REN-1038/documents/2004-12-01_INVERTER_TEST.PDF)].

## Meters

Performance meters,<sup>23</sup> whether stand alone or integrated with the inverters, shall be required to meet the following eligibility criteria:

- Meters with  $\pm 2$  percent accuracy shall be installed for all performance-based incentive applicants
- All  $\pm 2$  percent accuracy meters shall be tested according to all applicable ANSI C-12 testing protocols
- Meters with  $\pm 5$  percent accuracy (these are primarily inverter integrated) shall be allowed for expected performance incentive applicants
- All meters shall measure and display, both instantaneous (kW or W) and cumulative energy produced (kWh or Wh)
- All meters shall retain production data during power outages
- All meters shall be easy to read for the customer's benefit
- All meters shall have a communication port capable of enabling connection to remote performance monitoring and reporting service (PMRS).

Eligible meters are listed with the Energy Commission.<sup>24</sup>

---

<sup>23</sup> The CPUC's CSI Program is considering proposed requirements related to the following: a) testing standards for the  $\pm 5$  percent accuracy meters; b) metering requirements for non PV incentives; c) monitoring the interaction between the solar production meters, renewable energy credits, advanced meter and time of use meters and other metering applications. Future updates of these Guidelines will consider these and subsequent recommendations.

<sup>24</sup> [http://www.consumerenergycenter.org/cgi-bin/eligible\\_meters.cgi](http://www.consumerenergycenter.org/cgi-bin/eligible_meters.cgi)



## CHAPTER 4. Solar Energy System Design and Installation Standards and Incentives

SB 1 requires high quality design and installation of solar energy systems to promote the greatest energy production per ratepayer dollar, and directs the Energy Commission to establish design and installation standards or incentives. This chapter establishes the Guidelines for design and installation standards and incentives needed to achieve this mandate. Program administrators shall comply with these Guidelines by **no later than January 1, 2009**. POU's with peak demand of 200 MW or less as reported for calendar year 2006 shall comply with the requirements in this chapter no later than January 1, 2010.

To achieve high performing solar energy systems, the incentive structures shall be performance-based to reward performance. There are two acceptable performance-based approaches: the performance-based incentive (PBI) approach and the expected performance-based incentive (EPBI) approach. These are discussed further in this chapter.

### Performance-Based Incentives

Providing a PBI is the preferred way to promote high performing systems since the solar energy systems are incentivized based on their actual production (kWh) over the period during which the incentives are being paid. The PBI incentive payment is calculated by multiplying the incentive rate (\$/kWh) by the measured kWh output.

Program administrators may choose to voluntarily use the PBI approach for any size solar energy systems.<sup>25</sup>

The PBI payments shall be made over a minimum 5-year period following system installation, submission, and approval of incentive claim materials. Payments shall be based on a \$/kWh incentive rate and the actual electricity (kWh) produced in time periods established by the program administrator.

---

<sup>25</sup> As an example, the CPUC's California Solar Initiative program requires larger solar energy systems (e.g., those 100 kW<sub>AC</sub> or larger capacity beginning in 2007) to use PBI. The CSI program also requires PBI for systems 50 kW<sub>AC</sub> and larger beginning January 1, 2008, and for systems 30 kW<sub>AC</sub> and larger beginning January 1, 2010. Projects below these size thresholds may voluntarily use the PBI approach.

## Expected Performance-Based Incentives

The expected performance-based incentive (EPBI) approach pays an up-front incentive that is based on calculated expected performance, taking into account all major factors that affect performance of the particular installation in the given location. This incentive method may be more appropriate than a PBI approach for systems installed on newly constructed buildings or for smaller systems. The EPBI approach shall be used for systems that do not use the PBI approach.

To meet the expectations of SB 1 for optimal system performance during periods of peak demand and IEPR policy to target PV deployment to achieve the greatest cost benefit, EPBI shall be based on time-dependent value (time-of-use) weighted energy. The incentive calculation shall ensure all interactive component performance characteristics, determined by independent testing, are used for establishing expected time dependent valuation (TDV)-weighted kWh performance.<sup>26</sup>

The EPBI calculation shall be based on hourly modeling of the interactive performance of solar energy systems using the third-party tested performance characteristics of the specific modules and the inverter over the range of conditions that impact component performance. This calculation addresses all installation characteristics that are expected to have significant impacts on the performance of the components and the solar radiation, ambient temperature and wind conditions expected at the site.

The hourly performance of the system shall be based on the interaction of the components due to the expected conditions during each hour. The hourly production shall be weighted in each hour to account for the time-dependent value to the utility of that hour's production to obtain the annual time-dependent weighted energy results for the system (kWh<sub>TDV</sub>). The annual kWh<sub>TDV</sub> performance establishes the total incentive for the solar energy system.

---

<sup>26</sup> Information on TDV can be referenced at [\[http://www.energy.ca.gov/title24/2008standards/documents/E3/index.html\]](http://www.energy.ca.gov/title24/2008standards/documents/E3/index.html).

## *Hourly Photovoltaic Production Calculation*

The PV production shall be calculated using a model that complies with the following minimum requirements:

1. The calculation model shall cover fixed flat plate collector technologies at a minimum and include single and dual axis tracking and concentrating solar collectors if the program administrators allow for these technologies to be incentivized under the EPBI approach.<sup>27</sup>
2. Use hourly weather data for one of the 16 climate zones in California, with the use of solar radiation (global horizontal, direct normal and diffused), dry bulb temperature and wind speed as minimum parameters in calculation to describe the conditions for the hour.
3. Determine the incident solar radiation on the modules based on the azimuth and tilt angle of the installation using the weather data and location longitude and latitude information.
4. Use the detailed performance characteristics data for modules (listed in Appendix 1, Table 1) in determining the hourly production at given conditions for the hour (both weather and electrical). This data shall be obtained from the library of eligible modules listed with the Energy Commission.
5. Have the ability to determine the operating voltage of a system at a given hour by discerning the circuit design of the system in terms of the number of modules in series strings and the number of strings in parallel.
6. Account for the mounting offset of the array from a surface below to assess the change in operating temperature (Normal Operating Cell Temperature impact). This is especially important to determine the performance of building integrated photovoltaics (BIPV), as compared to rack mounted modules.
7. Account for the height above the ground that the array is mounted to capture the impact of wind speed on the module operating temperature.
8. Use detailed performance data for inverters (performance curves over range of voltage and power conditions applicable) in determining the hourly production at given conditions for the hour (both weather and electrical). This data shall be obtained from the library of eligible inverters listed with the Energy Commission.<sup>28</sup>
9. Limit the production of the system based on the size and voltage of the array and inverter voltage and power capacity.
10. Generate hourly estimates of PV production for the entire year, which can then be weighted by time dependent value (TDV) multipliers.

---

<sup>27</sup> Systems employing tracking and concentrating solar collectors may be offered incentives using the PBI approach as an alternative to developing a calculation of expected performance for these systems.

<sup>28</sup> The list of eligible inverters referred here is the list maintained by the Energy Commission at [http://www.consumerenergycenter.org/cgi-bin/eligible\\_inverters.cgi](http://www.consumerenergycenter.org/cgi-bin/eligible_inverters.cgi).

11. Determine the solar position for each hour of the year in terms of altitude and azimuth (used to determine the impact of shading from an obstruction).
12. Determine the hourly impact of shading on each string from obstructions that are outside of the minimal shading criteria definition (using shading protocol as described in Appendix 2, Shading Verification).
13. Report the effective hourly production values for the entire year after factoring the impact of shading and applying the appropriate TDV multipliers for the climate zone and building type (residential or non residential).
14. Generate a performance verification table for each specific system that reports the expected production for the specific system and installation as a function of incident solar radiation and ambient temperature. This performance verification table shall enable field verification of actual vs. expected instantaneous production through the comparison of the output reported by the performance meter to the value in the performance verification table at the specific incident radiation and ambient temperature measured at the site at the time of the verification.
15. Generate a certificate of compliance form as a printable report which shall be used for incentive application and field verification purposes. The certificate of compliance shall include, at a minimum, the entire system description including installation specifics for the system, location, shading details, echo all the inputs for the calculation, and the performance verification table.

### *Reference System and Location*

The incentive calculation shall use a reference system and location established by the program administrator to convert an incentive level established in terms of \$/W to the \$/kWh<sub>TDV</sub> equivalent through the following calculation:

$$\$/\text{kWh}_{\text{TDV}} = \frac{\text{Reference System Watts}_{\text{CEC-AC}} \times \$/\text{Watt (incentive level)}}{\text{Reference System Annual kWh}_{\text{TDV}}}$$

The specification of the reference system should include:<sup>29</sup>

1. Location of the system to determine the weather data and corresponding applicable TDV factors to be used.
2. Size of a system that is representative of the median in the applicable utility program.
3. Selection of a reference module from the Energy Commission's Eligible Equipment List, along with all its performance characteristics, that is considered as a median for the applicable utility program.
4. Selection of an inverter from the Energy Commission's Eligible Equipment List that is considered a median for the applicable utility program.

---

<sup>29</sup> For an example of a reference system specification, see the Energy Commission's NSHP Guidebook at [<http://www.gosolarcalifornia.ca.gov/documents/CEC-300-2007-008-CMF.PDF>]

5. The installation characteristics that comprehensively describe the system, including, but not limited to:
  - a. Azimuth
  - b. Tilt
  - c. Mounting offset (BIPV or rack with specific height above substrate)
  - d. Height above ground (one story or higher)
  - e. Electrical circuit design (modules in series and parallel)
  - f. Shading conditions (minimal shading)
  - g. Other system losses (such as dirt, dust and wiring losses)

The \$/kWh<sub>TDV</sub> (or the \$/W before the above conversion) shall be chosen to ensure that the full range of improvement in performance (in kWh<sub>TDV</sub>) is provided with increasing incentives.

### *Incentive calculation*

The total incentive for the applicant system shall be determined by multiplying the TDV weighted annual kWh production with the \$/kWh<sub>TDV</sub> determined in the previous step (using the reference system).

$$\text{Total Incentive \$} = \text{Applicant System Annual kWh}_{\text{TDV}} \times \text{\$/kWh}_{\text{TDV}}$$

The basic structure of the Energy Commission's PV calculator<sup>30</sup> can be used to meet these requirements. The calculator can be modified as long as it meets requirements 1 through 15 of the Hourly PV Production Calculation. The reference system and location and the incentive level is specified by the program administrator. POU program administrators may use time of use multipliers that are applicable to their service territories instead of TDV.

## **Shading**

The methodology that shall be used as the minimum criteria for addressing shading is detailed in Appendix 2, Field Verification and Diagnostic Testing of Photovoltaic Systems.

---

<sup>30</sup> The Energy Commission PV calculator is a spreadsheet-based tool and runs the five-parameter PV model to determine the hourly production. The calculator will be made available upon request to any program administrator.

## Peak Load

For systems receiving incentives under the expected performance calculation approach, the incentive shall be based on weighting the hourly production with TDV factors to promote systems with higher performance at peak load conditions. TDV factors have been developed for the 16 Building Energy Efficiency Standards climate zones in California using IOU generation, transmission and distribution cost data.<sup>31</sup>

*POU program administrators should use either the TDV factors determined for the 16 climate zones or hourly time of use weighting factors that are applicable for their service territories.*

## Field Verification

PV systems shall be required to successfully complete third party field verification on a sampling basis to be eligible for incentive payment. The field verification, at a minimum, shall include visually checking components, installation characteristics, shading conditions and verifying performance using the protocol described in Appendix 2 - Field Verification and Diagnostic Testing of Photovoltaic Systems.

The third party field verification shall be carried out on a minimum sample size of one in seven by a qualified Home Energy Rating System (HERS) rater; or by the program administrator; or their designated qualified contractor, as determined by the program administrator.

Field verification shall be required on a sampling basis for EPBI applicants and is encouraged for PBI applicants.

## Installation

The installers shall certify all aspects of the installation using the protocol for field verification (Appendix 2). This includes the actual components used, the installation characteristics, shading conditions and the specified onsite instantaneous performance verification. The same protocol will be used by both the installer and the verifier, with the difference of the installer having better access to the installation in some cases. It will be the responsibility of the installer to document all proof for items that may be more easily observed and measured by the installer than by the verifier.

---

<sup>31</sup> More information on TDV can be referenced at [\[http://www.energy.ca.gov/title24/2008standards/documents/E3/index.html\]](http://www.energy.ca.gov/title24/2008standards/documents/E3/index.html).

## Performance Monitoring and Maintenance

All systems using the PBI approach shall have a five year service contract<sup>32</sup> with a performance monitoring and reporting service (PMRS).<sup>33</sup>

For systems using the EPBI approach, a PMRS shall be required if the program administrator determines that it is economically reasonable, comparing the cost of available PMRS to the cost caps shown in the table below.

	<b>5% accuracy meters</b>	<b>2% accuracy meters</b>	<b>PMRS</b>
EPBI < 30kW	Required	Optional	Cost cap – 1% of entire system
EPBI 30kW and greater	Required	Optional	Cost cap – 0.5% of entire system
PBI	N/A	Required	Required

For all systems, it is recommended that program administrators ensure that information regarding system maintenance is provided to the owner or facility manager of the property who has oversight of the system. The information should address, at a minimum, the following considerations:

- Cleaning schedule for the array to remove dirt and dust build up.
- Periodic checking of electrical connections (for corrosion, etc.).
- Checking the inverter for instantaneous power, long term energy output, and diagnosing and taking corrective action if production is significantly lower than expected.
- Checking for tree/plant growth or other obstructions that are causing shading on the array and advise how to eliminate that shading.

---

<sup>32</sup> The applicant has the option of switching PMRS providers during this period if necessary, but must demonstrate that the minimum 5-year term of PBI payments is covered through one or another PMRS provider.

<sup>33</sup> The CPUC’s CSI program is currently developing requirements related to independence of the PMRS provider, as well as the specification of the data streams that is a minimum requirement. These requirements will be considered for possible future updates to these guidelines.

## CHAPTER 5: Energy Efficiency

This chapter specifies energy efficiency requirements that shall be met as conditions for ratepayer funded incentives for newly constructed and existing residential and commercial buildings. The chapter identifies separate energy efficiency requirements for each type of building. As an alternative to meeting these requirements for specific buildings, program administrators may choose to use the Alternative Portfolio Energy Savings Approach described at the end of this chapter. The energy efficiency requirements specified in this chapter are minimum requirements. Program administrators are encouraged to promote greater levels of energy efficiency as they find feasible.

Program administrators shall comply with the requirements in this chapter **no later than January 1, 2009**. POU's with peak demand of 200 MW or less as reported for calendar year 2006 shall comply with the requirements in this chapter no later than January 1, 2010.

### Newly Constructed Buildings

Minimum energy efficiency criteria beyond California's Building Energy Efficiency Standards (Title 24, Part 6) shall be conditions for the solar energy system incentive programs overseen by the CPUC, the Energy Commission, and POU's for all newly constructed buildings statewide.<sup>34</sup>

#### *Residential Buildings*

Newly constructed residential buildings shall achieve higher energy efficiency levels than the requirements of the 2005 Building Energy Efficiency Standards (Title 24, Part 6).<sup>35</sup> The builder is required to meet either of the following two tiers of energy efficiency:

- Tier I – 15 percent reduction in the residential building's combined space heating, space cooling and water heating energy compared to the 2005 Title 24 Standards.<sup>36</sup>
- Tier II – 35 percent reduction in the residential building's combined space heating, space cooling and water heating energy and 40 percent reduction in the residential building's space cooling energy compared to the 2005 Title 24 Standards.<sup>37</sup>

---

<sup>34</sup> Newly constructed buildings are ones for which the building permit for the solar energy system is approved prior to the original occupancy of the newly constructed structure.

<sup>35</sup> The level of required performance in the future will be reevaluated when new standards are adopted.

<sup>36</sup> Tier I was developed to match the energy efficiency requirements of the New Construction Programs for investor-owned utilities such as those implemented by PG&E, SCE, and SDG&E.

<sup>37</sup> Tier II was developed to encourage builders to go beyond the minimum requirements of Tier I. Tier II efficiency level was developed to match the Building America program requirements.



The Tier I level is a minimum condition for participation. Tier II is the Energy Commission's preferred level that builders are encouraged to meet. For either Tier I or II, each appliance provided by the builder shall be ENERGY STAR<sup>®38</sup> labeled if this designation is applicable for that appliance.

Solar water heating may be used to assist in meeting the energy efficiency requirements of either Tier I or Tier II.<sup>39</sup>

Field verification of energy efficiency measures shall be required and be consistent with 2005 Title 24 Standards field verification procedures and protocols. The CF-1R<sup>40</sup> form used to demonstrate Title 24 compliance with the current Building Energy Efficiency Standards shall be provided with the solar incentive application to the program administrator as proof of attainment of the Tier I or Tier II level. Compliance documents shall be completed by persons who are Certified Energy Plans Examiners (CEPE) by the California Association of Building Energy Consultants (CABEC).

Investor-owned utilities (IOUs) fund energy efficiency programs through a public goods charge (PGC) with program oversight by the CPUC. POU's conduct and oversee their own energy efficiency programs. IOUs and POU's are strongly encouraged to provide energy efficiency incentives for each Tier described in these Guidelines.

## *Commercial Buildings*

Newly constructed commercial buildings<sup>41</sup> shall achieve higher energy efficiency levels than the requirements of the 2005 Building Energy Efficiency Standards (Title 24, Part 6).<sup>42</sup> The builder is required to meet either of the following two tiers of energy efficiency:

- Tier I – 15 percent reduction in the commercial building's combined space heating, space cooling, lighting and water heating energy compared to the 2005 Title 24 Standards.<sup>43</sup>

---

<sup>38</sup> ENERGY STAR is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy. An ENERGY STAR designation is available for appliances that exceed minimum federal energy efficiency standards. For more information on the ENERGY STAR designation, go to [[www.energystar.gov](http://www.energystar.gov)].

<sup>39</sup> For more information on using solar water heating to meet the energy efficiency requirements, please refer to the Go Solar California website [<http://www.gosolarcalifornia.ca.gov/nshp/swh.html>].

<sup>40</sup> This Certificate of Compliance form summarizes the minimum energy performance specifications needed for compliance including the results of the heating and cooling load calculations.

<sup>41</sup> For purposes of these guidelines "commercial buildings" include all non-residential buildings and structures.

<sup>42</sup> The level of required performance in the future will be reevaluated when new standards are adopted.

<sup>43</sup> Tier I was developed as the minimum level of participation and matches the Leadership in Energy and Environmental Design (LEED) New Construction Energy and Atmosphere prerequisite.

- Tier II – 30 percent reduction in the commercial building’s combined space heating, space cooling, lighting and water heating energy compared to the 2005 Title 24 Standards.<sup>44</sup>

The Tier I level is a minimum condition of participation. Tier II is the Energy Commission’s preferred level that builders are encouraged to meet. For either Tier I or II, any equipment or appliance provided by the builder must be ENERGY STAR labeled if this designation is applicable to that equipment or appliance.

Solar water heating may be used to assist in meeting the energy efficiency requirements of either Tier I or Tier II.<sup>45</sup>

Compliance documents used to demonstrate Title 24 compliance, including the PERF-1 form<sup>46</sup> and accompanying supporting forms, shall be provided as proof of attainment of the Tier I or Tier II levels. Compliance documents shall be completed by persons who are Certified Energy Plan Examiners (CEPE) by the California Association of Building Energy Consultants (CABEC).

For commercial buildings that are constructed in phases with the shell built first and further energy systems installed in later phases as tenant improvements, an agreement shall be made between the building owner<sup>47</sup> and the tenant. This agreement shall obligate future tenant improvements to install lighting, HVAC and water heating equipment necessary to meet the overall building Tier level that was committed to by the building owner. A copy of the agreement shall be included with the solar energy system incentive application.

Investor-owned and publicly owned electric utilities are strongly encouraged to provide energy efficiency incentives for each Tier described in these Guidelines.

---

<sup>44</sup> Tier II was developed to encourage developers to go beyond the minimum requirements of Tier I. Tier II is in line with the 2030 Challenge [<http://www.architecture2030.org>].

<sup>45</sup> For more information on using solar water heating to meet the energy efficiency requirements, please refer to the Go Solar California website [<http://www.gosolarcalifornia.ca.gov/nshp/swh.html>].

<sup>46</sup> The PERF-1 form is the Performance Certificate of Compliance that is produced by compliance software used to show compliance with Title 24.

<sup>47</sup> An agreement may be made with a developer/property manager and the tenant.

## Existing Buildings

### *Energy Audit, Information and Disclosure*

Specific information about energy efficiency measures shall be provided to the building owner. The intent of the information is for the person who is responsible for paying the utility bill and the person who is responsible for building operations to receive information on: 1) building energy use, 2) energy efficiency investigation options and 3) possible energy efficiency improvements. These persons may not be the same entity for all applications. For purposes of these Guidelines, these persons are referred to as the building owner/manager/ratepayer.

The program administrator or the utilities covered by the program administrators shall provide information to the building owner/manager/ratepayer prior to the installation of the photovoltaic system to enable the building owner/manager/ratepayer to make informed decisions on energy efficiency investments. The building owner/manager/ratepayer shall sign and provide to the program administrator a disclosure which certifies that this information was provided to them and identifies which, if any, energy efficiency measures will be taken. If measures are to be installed after the installation of the solar energy system, then the building owner/manager/ratepayer shall declare on the disclosure when the measures are expected to be installed.<sup>48</sup>

For existing commercial buildings with conditioned floor area of less than 100,000 square feet and for existing residential buildings, an energy efficiency audit shall be conducted. The program administrator may allow online or telephone audits or may require onsite energy audits, as they specify for particular categories of customers. Building owners, managers and/or ratepayers shall be responsible for submitting a copy of the audit results with their solar incentive applications.

The information and disclosure shall be provided to the building owner/manager/ratepayer via a web-based information portal or paper format. The building owner/manager/ratepayer shall complete and sign the disclosure form and submit it to the program administrator.

#### *Information to be provided to the building owner/manager/ratepayer:*

- most recent 12 months of energy consumption - this information may be provided directly by the utility; if so, the program administrator is obligated only to assure that it was provided;
- list of building energy use assessment services and tools available for use by the building owner for further investigation - for commercial buildings this shall include information on available retro-commissioning services;
- list of possible cost effective energy efficiency measures applicable to the building;
- list of specific utility energy efficiency incentives that are available.

---

<sup>48</sup> The data gathered as a result of the information and disclosure process will be used to develop future energy efficiency requirements for solar energy system incentive programs.

*Disclosures to be provided by the building owner/manager/ratepayer:*

- certification that the building owner/manager/ratepayer has received the above information;
- the energy use assessment services or tools the building owner/manager/ratepayer used to identify cost effective energy efficiency measures that could be installed in the building;
- the energy efficiency measures that have been installed, or will be installed prior to or in conjunction with the installation of the solar energy system;
- if energy efficiency measures are planned to be installed at a later time, the date by which these measures are planned to be installed; and
- energy audit report for existing residential buildings and commercial buildings less than 100,000 square feet.

## **Existing Commercial Buildings – Benchmarking, Retro-Commissioning and Efficiency Improvements**

### *Benchmarking*

For solar energy systems to be eligible for incentives when installed to serve an existing commercial building, the energy use intensity (EUI) shall be benchmarked<sup>49</sup> using Portfolio Manager or the equivalent benchmark rating for building types that cannot receive a rating by Portfolio Manager. Portfolio Manager can be accessed on the internet at [<https://www.energystar.gov/istar/pmpam/>].

Building types that are not able to be benchmarked using Portfolio Manager, shall be benchmarked using the Energy Commission’s equivalent benchmark rating.<sup>50</sup>

---

<sup>49</sup> Benchmarking is a process that compares the energy use of the building to the energy use of a population of similar buildings.

<sup>50</sup> The Energy Commission is working with US EPA on an equivalent system that can be used to benchmark commercial buildings not able to be benchmarked using Portfolio Manager.

## *Retro-Commissioning*

Retro-commissioning<sup>51</sup> shall be required for all existing commercial buildings that are 100,000 square feet or larger and have a benchmark rating of less than 75, or an equivalent energy use intensity as determined by the Energy Commission. Retro-commissioning is required to begin no later than one year after the completion of the installation of the PV system. Systems to be retro-commissioned include but are not limited to:

- heating, ventilation, and air conditioning systems and controls
- lighting systems and controls
- daylighting systems and controls
- domestic hot water systems and controls
- renewable energy systems and associated equipment and controls
- process equipment and appliances specific to hospital, restaurant and hotel/motel operations
- refrigeration in supermarket and refrigerated warehouses.

Equipment repairs and adjustments and cost effective energy efficiency measures identified in the building retro-commissioning assessment shall be implemented to improve the building's benchmark rating. If a building is improved to exceed a rating of 75, further energy efficiency measures are not required. A building does not need to be re-benchmarked to receive an incentive. If equipment/appliance replacement is recommended during the retro-commissioning process, the replacement shall be made with ENERGY STAR equipment or appliances, or equipment or appliances that qualify for utility energy efficiency incentives, whichever is more efficient.

IOUs and POU's are strongly encouraged to provide energy efficiency incentives for retro-commissioning and for the installation of cost effective energy efficiency measures, appliances and equipment.

## *Commitment Agreement*

For buildings equal to or larger than 100,000 square feet and with a benchmark or equivalent rating of less than 75, retro-commissioning, equipment repairs and adjustments, and energy efficiency improvements that are identified through retro-commissioning shall either be completed prior to or in conjunction with the installation of the solar energy system. Alternatively, retro-commissioning shall be committed to be completed at a later date by the building owner/manager/ratepayer through a Commitment Agreement. The Commitment Agreement shall indicate when the retro-

---

<sup>51</sup> Retro-commissioning is a process to identify how major energy using equipment are being operated and maintained and to identify specific improvements to the performance of those energy using systems. The process uses a whole building systems approach to identify problems and needed repairs or adjustments to achieve energy savings, occupant comfort and improved systems performance. A commissioning agent identifies and makes the necessary equipment adjustments and identifies energy efficiency projects that will improve overall building performance.

commissioning will begin, and commit the owner/manager/ratepayer to complete equipment adjustments, or cost effective efficiency improvements identified in the retro-commissioning process. The retro-commissioning shall begin no later than one year after the completion of the installation of the PV system.

### ***Energy Efficiency Exceptions for Existing Commercial Buildings***

The specific energy efficiency requirements in these Guidelines for existing commercial buildings are not required for the following:

- agricultural and industrial facilities which are not covered by Portfolio Manager or the Energy Commission's equivalent benchmark rating are not required to be benchmarked;
- energy efficiency is not required to be addressed when solar energy systems are not serving electricity to a building;
- the energy audit, benchmarking and retro-commissioning are not required for buildings that have complied with Title 24 requirements for newly constructed buildings during the last 12 months prior to applying for the solar energy incentive; proof of Title 24 compliance shall be included with the solar energy system incentive application; and
- retro-commissioning is not required for existing commercial buildings that have a current ENERGY STAR label;
- benchmarking and retro-commissioning are encouraged but not required for PBI applicants.

## **Existing Residential Buildings**

For solar energy systems serving an existing residential building, the energy audit, information and disclosure requirements shall be met as discussed above.

### ***Energy Audit Exception for Existing Residential Buildings***

The energy audit is not required for buildings that have complied with Title 24 requirements for newly constructed buildings in the past three years prior to application for a solar energy incentive; proof of Title 24 compliance shall be included with the solar energy system incentive application. There is no exception for the other information and disclosure requirements.

## **Alternative Portfolio Energy Savings**

As an alternative to the requirements discussed above, program administrators may instead conduct a program which achieves a total 20 percent energy efficiency savings over the group of EPBI participants in their SB 1 participation portfolio. This alternative enables program administrators to pursue different levels of energy efficiency with different customers over time. Program administrators shall provide the Energy Commission with a three year plan that describes the initiatives that they will take to achieve this level of energy efficiency savings. Program administrators shall report annually to the Energy Commission on progress in achieving a total 20 percent energy efficiency savings over the group of EPBI participants in their SB 1 portfolio. Plans shall be reviewed by Energy Commission staff to determine that they will successfully achieve the 20 percent savings.

The Energy Commission may return the plan for further development if it deems necessary. Plans shall be considered for possible approval at a regularly scheduled Energy Commission Business Meeting, and once approved and implemented shall be used as an alternative to the specific energy efficiency requirements otherwise required in these Guidelines. Alternative Portfolio Energy Saving Plans shall be approved by the Energy Commission at its discretion, and may be rejected if the Energy Commission determines the plan will not result in the requisite 20 percent energy efficiency savings. If a plan is approved, the program administrators shall be required to report annually on their progress of achieving the 20 percent savings. The Energy Commission may discontinue its approval of a plan or direct an expansion or modification of the plan if the Energy Commission determines that progress under the plan to achieve the 20 percent energy savings is not being achieved.

Program administrators may conform to the requirements in the previous sections of this Chapter for any particular EPBI participating buildings in their SB 1 portfolio, and establish an alternative portfolio energy savings plan covering just the remaining EPBI participating buildings. For example, a program administrator may conform to the requirements in the previous sections for newly constructed buildings, both residential and commercial, and establish an alternative portfolio energy savings plan just for existing EPBI participating buildings, both residential and commercial.

## CHAPTER 6: Reporting Requirements

Under SB 1, local publicly owned electric utilities are required to make available key solar program information. This information must be made available, beginning June 1, 2008, to its utility customers, the California State Legislature and the Energy Commission.<sup>52</sup> This information must be made available no later than June 1 of **each** subsequent year for the duration of the ten-year program.

These reporting requirements will provide state officials the information needed to monitor how these programs are progressing, ensure consistent program design and implementation, and determine what changes may be needed to effectively meet goals and targets established under SB 1.

### Reporting Requirements for 2008

For 2008 only, the reporting period shall be from January 1, through March 31, 2008. For this initial reporting period, each POU must report, at a minimum, the following information.

1. Solar program overview and contribution toward goals, including:
  - a. Outreach and marketing, overview of program administration and activity during reporting period
  - b. Problems identified and resolutions or recommended mitigation
  - c. Opportunities for the year ahead
2. Number of submitted applications, including:
  - a. Number of applications received,
  - b. Number of EPBI and PBI applications approved and rejected,
  - c. Primary reasons for application rejections.
3. Total incentives awarded, including:
  - a. Total public goods charge funds collected during reporting period,
  - b. Total solar incentive expenditures,
  - c. All other program expenses, by category.
4. The total number of systems installed, including:
  - a. Breakdown for installations serving newly constructed buildings and existing buildings
  - b. Breakdown by category type, including:
    1. Residential
      - a) Market-rate housing
      - b) Affordable housing/low-income

---

<sup>52</sup> Public Utilities Code, Section 387.5 (e).



2. Commercial
3. Non profit
4. Government
5. Industrial
6. Agricultural
7. Mixed-use

5. Amount of added solar capacity installed and expected generation:
  - a. Solar electric capacity (PV) and non-PV solar systems added in kilowatts (kW), AC
  - b. Estimated annual electrical generation in kilowatt hours (kWh)

## Reporting Requirements Beginning in 2009

For years 2009 and later, the reporting period shall be from January 1 to December 31 of the prior year. In addition to the reporting requirements described above (1 through 5), beginning June 1, 2009, each POU must also provide all of the following:

6. Program support activities and goals, including:
  - a. Outreach and marketing,
  - b. Any training or builder/installer assistance,
  - c. Auditing of installed systems,
  - d. Goals of installed systems (kW, AC) for each reporting period and total for program duration.
7. Amount of added solar capacity installed and expected performance, including:<sup>53</sup>
  - a. Solar electric capacity (PV) and non-PV solar systems added,
    1. List and description of PV technologies
    2. List and description of non-PV technologies
8. Solar energy system and energy efficiency implementation impacts, including:<sup>54</sup>
  - a. New buildings: average efficiency increase over Title 24 Standards.
  - b. Known impacts on the distribution, transmission, and supply of electricity.

---

<sup>53</sup> Additional information regarding annual electric and natural gas savings and information on the expected costs and benefits attributed to the solar energy system incentive programs may be requested in future reporting requirements after 2009.

<sup>54</sup> Additional information regarding energy efficiency implementation impacts attributed to the solar energy system incentive programs may be requested in future reporting requirements after 2009. The Energy Commission will make an effort to meet these requirements consistent with Assembly Bill 2021 reporting requirements.

Each local publicly owned electric utility shall submit five copies of their report and an electronic version to the Energy Commission not later than June 1 of each program year. Electronic copies can be sent to [[renewable@energy.state.ca.us](mailto:renewable@energy.state.ca.us) ]; paper copies can be sent to:

California Energy Commission  
Renewable Energy Office, MS 45  
Attn: SB 1 Reporting  
1516 Ninth Street  
Sacramento, CA 95814

# APPENDIX 1: Criteria for Testing, Certification and Listing of Eligible Components

This Appendix summarizes the criteria used for determining the components that can be used to create a photovoltaic (PV) system that is eligible for an incentive. Certified equipment (solar modules, inverters, and performance meters) is periodically added to and removed from the lists of eligible equipment.

The equipment shall be certified to meet nationally or internationally recognized standards, information submittal requirements, and other criteria specified by the Energy Commission to be listed. Until the equipment is listed, it is not eligible and no funding can be reserved or payment made.

## Photovoltaic Modules

All flat plate PV modules shall be certified by a nationally recognized testing laboratory as meeting the requirements of and being listed to be in conformance to the Underwriters Laboratory (UL) Standard 1703 and any subsequent testing standard adopted by UL.

All flat plate PV modules shall also be tested by a laboratory accredited by the International Laboratory Accreditation Cooperation according to the following sections of either the International Electrotechnical Commission (IEC) Standard 61215, *Crystalline Silicon Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval, Second Edition 2005-04*, or the (IEC) Standard 61646, *Thin-film Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval, First Edition, 1996-11*, except as specified in Notes 3, 6 and 7 of Table 1 below.

### IEC Standard 61215 Sections

- 10.2 Maximum Power Determination
- 10.4 Measurement of Temperature Coefficients
- 10.5 Measurement of Nominal Operating Cell Temperature (NOCT)
- 10.6 Performance at Standard Test Conditions (STC) and NOCT
- 10.7 Performance at Low Irradiance

### IEC Standard 61646 Sections

- 10.2 Performance at STC
- 10.4 Measurement of Temperature Coefficients
- 10.5 Measurement of NOCT
- 10.6 Performance at NOCT
- 10.7 Performance at Low Irradiance
- 10.18 Light-Soaking

### Grouping of modules for testing purposes

For testing and reporting of performance values by an accredited laboratory, families of similar modules shall have the option to be grouped based on type.

Multiple models may be included under a specific type, provided that the models are identical to the type, except for the STC power rating. Identical includes, but is not limited to, all structural components, materials, processes (including cell process), cell technology, encapsulation system, superstrate, backsheet/substrate, frame and/or mounting structure, junction box/electrical termination, cell interconnection materials and techniques, and internal electric circuitry.

For each type, the following tests shall be performed on the model with the highest STC power rating: Nominal Operating Cell Temperature (NOCT), temperature coefficient of short-circuit current, temperature coefficient of open-circuit voltage, temperature coefficient of maximum power current, temperature coefficient of maximum power voltage, and temperature coefficient of maximum power.

For each type, the models under that type shall be categorized into the smallest number of groups such that the STC power rating of the models within the group have a maximum range of  $\pm 5$  percent. For each of these groups, the model with the STC power rating closest to the average STC power rating of the models in the group shall be used for testing. If there are two models equally close to the average, the model with the highest STC power rating shall be selected. For each group, the following tests shall be performed on the model with the STC power rating closest to the average STC power rating of the group: short-circuit current, open-circuit voltage, maximum power current, maximum power voltage, maximum power, maximum power and low irradiance current, maximum power and low irradiance voltage, current at NOCT, and voltage at NOCT.

Each model shall be associated with the two types (groups) that have reported test values, if scaling of performance characteristics is applicable.

The factory measured maximum power of each production module, as specified in UL 1703, Section 44.1, and the lower bound of the manufacturer's stated tolerance range, pursuant to UL 1703, Section 48.2, shall be no less than 95 percent of the Maximum Power reported to the Energy Commission.

The following performance data and information shall be certified and provided to the Energy Commission.

Table 1. Module Performance Parameter Testing

Parameter	Symbol	Units	Notes
Maximum Power	$P_{max}$	Watts	1, 7
Voltage at maximum power	$V_{pmax}$	Volts	1, 7
Current at maximum power	$I_{pmax}$	Amps	1, 7
Open Circuit Voltage	$V_{oc}$	Volts	1, 7
Short Circuit Current	$I_{sc}$	Amps	1, 7
Nominal Operating Cell Temperature	NOCT	°C	3, 7
Temperature Coefficients	$\beta_{Voc}$ (at $V_{oc}$ ) $\beta_{Vpmax}$ (at $V_{pmax}$ ) $\alpha_{Isc}$ (at $I_{sc}$ ) $\alpha_{Ipmax}$ (at $I_{pmax}$ ) $\gamma_{Pmax}$ (at $P_{max}$ )	%/°C	2, 7
Voltage at maximum power and low irradiance	$V_{low}$	Volts	4, 6
Current at maximum power and low irradiance	$I_{low}$	Amps	4, 6
Voltage at NOCT	$V_{NOCT}$	Volts	5, 6
Current at NOCT	$I_{NOCT}$	Amps	5, 6
<b>Notes:</b> <ol style="list-style-type: none"> <li>1) Values shall be measured at Standard Test Conditions after Preconditioning according to IEC Standard 61215, Section 5, or after Light-soaking according to IEC Standard 61646, Section 10.18.</li> <li>2) Values shall be measured and calculated according to IEC Standards 61215 and 61646, Section 10.4.</li> <li>3) Values shall be measured according to IEC Standards 61215 and 61646, Section 10.5.2. For BIPV modules the measurements shall be made using the mounting specified below. Prior to January 1, 2009 manufacturers may provide NOCT values for BIPV modules that are not tested according to IEC Standards 61215 and 61646 with the mounting below; these values for performance calculations will be adjusted by adding 20 ° C to be consistent with the Sandia National Laboratories Report, <i>A Simplified Thermal Model for Flat-Plate Photovoltaic Arrays</i> by Martin K. Fuentes, 1987, page 11, Table 4.</li> <li>4) Values shall be measured at low irradiance according to IEC Standards 61215 and 61646, Section 10.7.</li> <li>5) Values shall be measured at NOCT according to IEC Standards 61215 and 61646, Section 10.6.</li> <li>6) Prior to January 1, 2009, the provision of this data is optional.</li> <li>7) Prior to January 1, 2009 manufacturers will provide this data based on IEC Standard 61215 or IEC Standard 61646 if available or based on test procedures specified in UL 1703, Section 18.1 (in-house laboratory and flash test data is permissible prior to January 1, 2009), if testing for the module according to one of these IEC Standards has not been completed.</li> </ol>			

## Mounting Specifications for NOCT testing for Building Integrated Photovoltaic (BIPV) Modules Intended for Roof Integrated Installations:

*Tilt angle:* the test modules shall be positioned so that they are tilted at  $23^{\circ} \pm 5^{\circ}$  (5:12 roof pitch) to the horizontal.

*Configuration:* the test modules shall be located in the middle of an array that is at least four feet high and four feet wide. The array shall be surrounded on all sides with a minimum of three feet of the building system for which the BIPV system is designed to be compatible, and the entire assembly shall be installed and sealed as specified by the manufacturer for a normal installation.

*Substrate and Underlayment:* the test modules shall be installed on a substrate of oriented strand board with a minimum thickness of 15/32 inch that is covered by #30 roofing felt with a minimum R-10 continuous insulation under and in contact with the oriented strand board and include any other manufacturer-recommended underlayments.

## **Inverters**

All inverters shall be certified as meeting the requirements of UL 1741. Each model of inverter shall be tested by a qualified Nationally Recognized Test Laboratory<sup>55</sup> to be eligible for this program. Performance ratings for each model will be determined according to sections of the test protocol entitled, *Performance Test Protocol for Evaluating Inverters Used in Grid-Connected Photovoltaic Systems*, prepared by Sandia National Laboratories, Endecon Engineering, BEW Engineering, and Institute for Sustainable Technology, October 14, 2004 version<sup>56</sup> and the "Guidelines for the Use of the Performance Test Protocol for Evaluating Inverters Used in Grid-Connected Photovoltaic Systems." This version of the test protocol and Guidelines are available on the Energy Commission website at [[http://energy.ca.gov/renewables/02-REN-1038/documents/2004-12-01\\_INVERTER\\_TEST.PDF](http://energy.ca.gov/renewables/02-REN-1038/documents/2004-12-01_INVERTER_TEST.PDF)]. The tests shall be performed in accordance with sections 3, 4, 5.1 and 5.2 of the test protocol, as further clarified in the Guidelines. The following tests are required:

---

<sup>55</sup> Nationally Recognized Testing Laboratories shall be those laboratories that have been recognized by the U.S. Department of Labor, Occupational Safety & Health Administration (OSHA), in accordance with Title 29 of the Code of Federal Regulations, section 1910.7, and are approved to conduct test UL 1741 under the scope of their OSHA recognition. A list of all current Nationally Recognized Testing Laboratories is available on OSHA's web page at [[www.osha.gov/dts/otpca/nrtl/index.html](http://www.osha.gov/dts/otpca/nrtl/index.html)]. Please note, not all of the Nationally Recognized Testing Laboratories identified on OSHA's list are approved to conduct test UL 1741.

<sup>56</sup> This version of the test protocol is identified by the file name "InvertrTestProto\_041014.doc" as shown in the left-hand side of the footer on each page of the protocol.

- **Maximum Continuous Output Power.** Section 5.4 shall be performed in its entirety for test condition A of Table 5-2 with the following exceptions: 1) the test shall be performed at an ambient temperature of 40°C, rather than 45°C, and 2) the dc  $V_{nom}$  may be selected by the manufacturer at any point between  $V_{min} + 0.25 * (V_{max} - V_{min})$  and  $V_{min} + 0.75 * (V_{max} - V_{min})$ . It is not necessary to perform Section 5.4 for test conditions B through E of Table 5-2.
- **Conversion Efficiency.** Section 5.5 shall be performed for test conditions A, B and C of Table 5.3, subject to the following: 1) the tests shall be performed with dc  $V_{nom}$  equaling the same voltage as selected above for the Maximum Continuous Power Output test, 2) steps 1 through 8 of the test procedure (Section 5.5.1) shall be performed at 25°C, and not at 45°C, and 3) to reduce time for each test condition, begin at the highest power level and go to the lower power levels. If done in this order it will only be necessary to wait for temperature stabilization at the 100 percent power level. In addition, the unit only needs to be operated at full output power for one hour, rather than 2.5 hours, and no preheating is necessary if the Conversion Efficiency test is performed within 1 hour of full operation under test 5.4 provided the unit has not been exposed to ambient temperature of less than 22°C.
- **Tare Losses.** Section 5.7.1 shall be performed in its entirety. It is not necessary to perform the tests under Section 5.7.2 or Section 5.7.3.

All of the above data will be used as inputs for the calculation of expected performance of the system.

The tests for Power Foldback (Section 5.8) and Inverter Performance Factor/Inverter Yield (Section 5.9) are NOT required.

The data and reports resulting from the tests for Maximum Continuous Output Power (Section 5.4), Conversion Efficiency (Section 5.5) and Tare Losses (Section 5.7.1) shall be provided to the Energy Commission and will be made public. The inverter tested shall utilize the same hardware and software configuration evaluated during the UL 1741 certification test.

## Meters

All eligible meters shall comply with the requirements<sup>57</sup> stated below, to be listed as eligible equipment with the Energy Commission.

- Meter Measurement: Meters shall measure net generated energy output as well as instantaneous power.
- Meter Testing Standards:  $\pm 2$  percent meters shall be tested according to all applicable ANSI C-12 testing protocols. Testing protocols for  $\pm 5$  percent meters are being developed for the CSI Program and will be incorporated into future revisions of these Guidelines.
- Meter Certification: The accuracy rating of  $\pm 2$  percent meters shall be certified by an independent testing body (i.e., a NRTL). Certification standards for  $\pm 5$  percent meters are being developed<sup>58</sup> and will be incorporated into future revisions of these Guidelines. Until these standards have been developed, the accuracy rating of all  $\pm 5$  percent meters shall be certified by the manufacturer of the  $\pm 5$  percent meter or an independent testing body. All test results or NRTL documentation supporting the certification shall be maintained on file for inspection by the Energy Commission.
- Meter Data Access: All meters shall provide the PMRS provider with the ability to access and retrieve the minimum required Solar Performance / Output Data from the meter using the Meter Communication / Data Transfer Protocols. In the event that the system is not required to have a PMRS provider, the System Owner shall have a means to retrieve the minimum required Solar Performance/Output Data from the meter.
- Meter Display: All meters shall provide a display showing measured net generated energy output and measured instantaneous power. This display shall be easy to view and understand. This display shall be physically located either on the meter, inverter, or on a remote device.
- Meter Memory and Storage: All meters shall have the ability to retain collected data in the event of a power outage. Meters that are reporting data remotely shall have sufficient memory to retain 60 days of data if their standard reporting schedule is monthly and 7 days of data if their standard reporting schedule is daily. Meters that do not remotely report their data shall retain 60 days of data. In all cases meters shall be able to retain lifetime production.

---

<sup>57</sup> The meter requirements listed here are based on the CSI Handbook, Appendix B.

<sup>58</sup> The testing requirements for 5 percent accuracy meters are being developed by the CSI Metering subcommittee and will be reviewed for possible inclusion in a future update of these Guidelines.



# APPENDIX 2: Field Verification and Diagnostic Testing of Photovoltaic Systems

## Background

This appendix covers the minimum requirements of the field verification protocol to be followed for applicant systems using the EPBI approach. It addresses systems that use fixed flat plate collector technology at this time.<sup>59</sup> Third-party field verification shall be conducted on a minimum sample of 1 in 7 systems to ensure that the components of the solar system, its installation, and performance and shading estimation are consistent with the characteristics used to determine its estimated performance. The EPBI incentive amount is based on a determination of the expected performance of the solar system, which accounts for the tested and certified performance of the specific module and inverter, the mounting type and cell temperature, the orientation and tilt of the module and the extent to which the system is shaded. The PV calculator tool accounts for these parameters that are under the control of the owner and installer, as well as the solar and climatic conditions for the locale of the building to determine hourly estimated performance, which is weighted to account for the time-dependent valuation of the electricity that is produced. Third-party field verification shall be conducted to ensure that the components of the solar system and its installation are consistent with the characteristics used to determine its estimated performance. Field verification can be carried out by a HERS rater or the program administrator (or their designated qualified contractor) as determined by the program administrator.

The field verification and diagnostic testing procedures described in this Appendix are intended to ensure that the:

- PV modules and inverters used in the expected performance calculations are actually installed at the applicable site;
- PV modules are minimally shaded, or if shaded, that the actual shading does not exceed the shading characteristics that were included in the expected performance calculations; and
- Measured output power from the system matches that expected by the PV Calculator within the specified margin at the prevailing conditions at the time of field verification and diagnostic testing.

---

<sup>59</sup> Tracking and concentrating solar technologies may be addressed in a future update of these Guidelines. Program administrators may specify a field verification protocol for such technologies.

## Responsibilities

Field verification and diagnostic testing is the responsibility of both the PV system installer and with the verifier who completes the third-party field verification. The PV installer shall perform the field verification and diagnostic testing procedures in this document for every system that they install. The verifier then performs independent third-party field verification and diagnostic testing of the systems. For new housing developments, the builder may choose to have the verifier complete field verification using the sampling approach described in Section 7.5, including subsections 7.5.1, 7.5.2 and 7.5.3, of the *2005 Building Energy Efficiency Standards Residential Alternative Calculation Methods Approval Manual*.

The field verification and diagnostic testing protocol is the same for both the PV installer and the verifier. The protocol anticipates that the PV installer will have complete access to the system which the verifier may not have, due to constraints of liability and insurance of getting on top of a roof. The measurements required by this protocol are not required to be completed on the roof, but more accurate measurement techniques are possible with roof access. The measurements required by the protocol may be performed in multiple ways as described in the subsections below.

## Field Verification and Diagnostic Testing Process

The field verification and diagnostic testing of solar systems follows the process described below. Note a solar system is one or more strings of PV modules connected to one inverter. Documentation of the process uses three forms that are counterparts to the compliance forms used for the *Building Energy Efficiency Standards*.

1. The applicant/builder's representative enters the necessary input data into the PV Calculator, which produces an output report **Certificate of Compliance Form** that documents the specific modules, inverters and meters that are used in each solar system that is installed on the building, the anticipated shading of each system (either the intent for the system to meet the minimal shading requirements or the actual shading that is anticipated), and a table of predicted electric power for each system for a range of solar irradiation and ambient air temperature. The Certificate of Compliance Form shall be provided to the program administrators at application time.
2. Once each solar system is installed, the PV installer completes the field verification and diagnostic testing protocol for each solar system on the building and documents the results on the **Installation Certificate**, verifying that the installation is consistent with the Certificate of Compliance. The PV installer documents and certifies that the PV system meets the requirement of this appendix and provides a copy of the Installation Certificate to the owner/builder and to the verifier.

3. The verifier completes independent third-party field verification and diagnostic testing of each solar system and documents the results on the **Certificate of Field Verification and Diagnostic Testing**, independently verifying that the installation is consistent with the Certificate of Compliance. The verifier provides a copy of the Certificate of Field Verification and Diagnostic Testing to the owner/builder (and the HERS provider in the case where HERS raters are used for field verification).
4. The payment claim shall be based on system characteristics that produce expected performance calculations that are no better than calculations based on the characteristics reported in the Certificate of Field Verification and Diagnostic Testing.

In conjunction with the Installation Certificate, the applicant must provide to the installer and verifier a site plan that for each lot:

- a) identifies the species of all pre-existing, planted and planned trees and the location and height of any structures which will be built on the lot and neighboring lots of the building with the solar system; and
- b) shows the bearing of the property lines and the azimuth and tilt or roof pitch of each PV array.

The applicant shall also provide the verifier a product specification (cut-sheet) for the modules, inverter and meter for the specific system, along with an invoice or purchase document, which lists the make and model of PV modules installed in the project.

## **Relationship to Other Codes, Standards and Verification**

The local jurisdiction must issue a building permit for the qualifying PV system, either as a separate permit or as part of the new construction building permit or retrofit application, and the PV system must meet all applicable electrical code, structural code and building code requirements. In addition, the local electric utility will have standards regarding interconnection to the electric grid and other matters which shall be complied with.

The field verification and diagnostic testing procedures described in this document do not substitute for normal electrical, structural or building plan check or field inspection. Nor do they substitute for field verification by the local utility regarding interconnection to the electric grid.

## Field Verification Visual Inspection

The purpose of the visual inspection described in this protocol is to verify that the module, inverter and meter specified in the Certificate of Compliance for each residential building is properly installed in the field. The verifier shall use binoculars or another means to view the installation if access to the system is restricted due to insurance and liability reasons (sloping or unprotected roof top access for example), and shall verify the models and numbers of modules against the cut sheet/invoices. The verifier may rely on photographic evidence provided by the installer on the models and numbers of modules, standoff distance and shading, but in the absence of such evidence, must rely on a conservative determination based solely on their own observation.

### *Photovoltaic Modules*

The PV installer and the verifier shall verify that the same number of each make and model number of PV modules used in the expected performance calculations are installed in the field. The PV installer and verifier shall also verify the module mounting type (flush mounted BIPV or rack mounted) and in the case of rack mounted modules, the standoff distance of the modules above the mounting surface. The PV installer and the verifier shall also observe and verify the mounting height of the modules (one story, two stories or measured minimum distance above the ground).

### *Inverters*

The PV installer and the verifier shall verify that the make and model of inverters used in the expected performance calculations are installed in the field.

### *System Performance Meters*

The PV installer and the verifier shall verify that either a separate system performance meter or an inverter with an integral system performance meter is installed that is the same make and model specified on the Reservation Application Form and meets all eligibility requirements for system performance meters.

### *Tilt and Azimuth*

The PV installer and the verifier shall verify that the tilt and azimuth (orientation) of the PV modules installed in the field match the values that were used to determine the expected performance of each solar system, *within  $\pm 5$  degrees*. In some systems, PV modules may be

installed in multiple arrays with different tilts and azimuths; in these cases the tilt and azimuth of each array shall be verified.

### Determining Tilt

The tilt angle of the PV modules is measured in degrees from the horizontal (e.g. horizontal PV modules will have a tilt of zero and vertically mounted PV modules will have a tilt of 90 degrees). The tilt of the PV modules may be determined in the following ways:

*i. Using the building plans*

The as-built or construction drawings for the building will state the slope of the roof, usually as the ratio of rise to run. If the PV modules are mounted in the plane of the roof then the slope of the PV modules is the same as the slope of the roof. Table 1 may be used to convert rise to run ratios to degrees of tilt.

**Table 1 – Conversion of Roof Pitch to Tilt**

Roof Pitch (Rise:Run)	Tilt (degrees)
2:12	9.5
3:12	14.0
4:12	18.4
5:12	22.6
6:12	26.6
7:12	30.3
8:12	33.7
9:12	36.9
10:12	39.8
11:12	42.5
12:12	45.0

*ii. Using a digital protractor*

A digital protractor may be used to measure either horizontal or vertical angles (see Figure 1). These devices, when sighted up the slope of the PV modules from the ground, will display the slope relative to the horizontal.



*Figure 1 – Digital Protractor*

### Determining Orientation (Azimuth)

The PV installer and the verifier shall determine the orientation by measuring the azimuth of the PV modules and verify that the azimuth is the same as that used to determine the expected performance of each solar system. The convention that is used for measuring azimuth is to determine the degrees of angle clockwise from north, e.g., north azimuth is zero degrees, east is 90 degrees, south is 180 degrees and west is 270 degrees (see Figure 2).

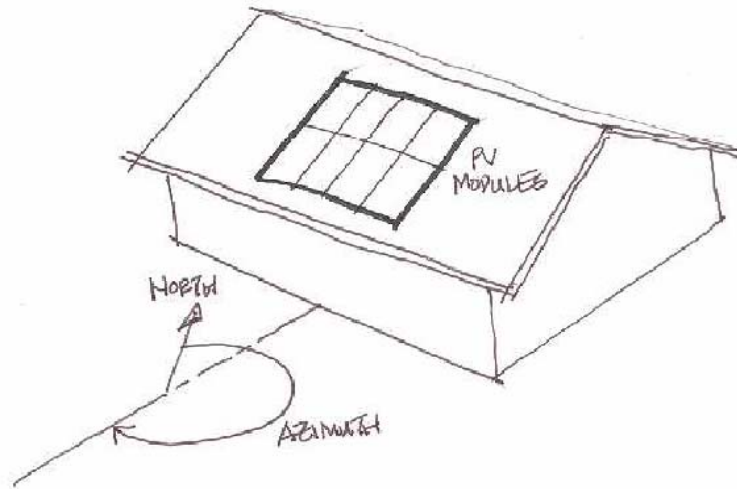


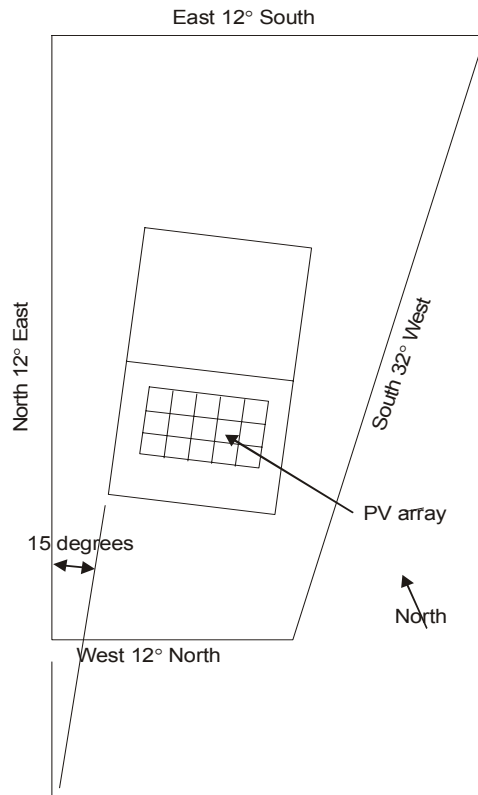
Figure 2 – Azimuth of the PV Array

The following methods may be used to determine the azimuth.

*i. Using the Plot Plans*

In new subdivisions, the house plans will often not show the property lines since the plans are used on multiple lots. However, the subdivision plot plan will show the property lines of the lots. The plot plan will show the bearing of the property lines, and from this information the azimuth of the roof surfaces where the PV modules are mounted may be determined from the position of the house on the lot relative to the bearings of the property lines.

Figure 3 shows an example plot plan with a house located on it. In this case, the house does not align with any of the property lines, but is rotated 15 degrees from the westerly property line as shown. Property lines on plot plans are typically labeled in terms of their bearing, which is the direction of the line. The westerly property line is labeled "North 12° East". If the house was aligned with this property line, the southerly exposure of the house would have an azimuth of 192° (180° plus the 12° bearing of the property line). Since the house is rotated an additional 15°, the azimuth of the southerly face of the house and the azimuth of the PV array is 207° (192° plus 15°). Usually, the house will be aligned with one of the property lines and the calculation described above will be simplified.



*Figure 3 – Example Plot Plan*

ii. *Using a Compass with a Sighting Feature and an Adjustment for Magnetic Declination.* The installer and verifier shall ensure that the compass has a sighting feature. The compass may have an adjustment built in for magnetic declination so that the reading on the compass is true north or the installer and the verifier shall determine the magnetic declination using the tool available at [[www.ngdc.noaa.gov/seg/geomag/jsp/Declination.jsp](http://www.ngdc.noaa.gov/seg/geomag/jsp/Declination.jsp)] and adjust the compass reading to account for the magnetic declination. Position the compass and determine the array azimuth angle between compass north and the direction that the PV modules face. It's usually convenient and most accurate to align the compass along the edge of the array using the sighting feature (see Figure 4).



*Figure 4 – Compass with a sighting feature*

## **Shading Verification**

The PV installer and the verifier shall verify that the shading conditions on each string of the system in the field are consistent with those used in the expected performance calculations (Certificate of Compliance). The estimated performance calculations will be done either assuming that the “minimal shading” criterion is met or based on the specific shading characteristics of each string in the system.

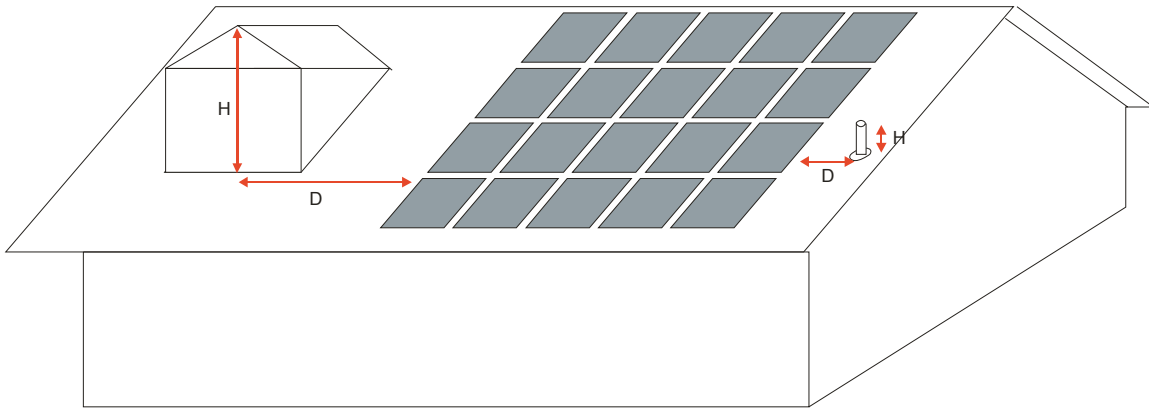
### *Minimal Shading Criterion*

The “minimal shading” criterion is that no obstruction is closer than a distance (“D”) of twice the height (“H”) it extends above the PV modules (see Figure 5 for an artistic depiction of “H” and “D”). As the figure illustrates the distance “D” must be at least two times greater than the distance “H.” Any obstruction that projects above any portion of the PV array must meet this criterion for the PV array to be considered minimally shaded. Obstructions that are subject to this criterion include:

- i. Any vent, chimney, architectural feature, mechanical equipment or other obstruction that projects above the roof of the residential building;
- ii. Any part of the neighboring terrain that projects above the roof;
- iii. Any tree that is mature at the time of installation of the solar system;
- iv. Any tree that is planted or planned to be planted as part of the landscaping for the residential building (the expected performance must be based on the expected mature height of any tree planted or planned to be planted as part of the landscaping for the residential building);
- v. Any existing neighboring building;
- vi. Any planned neighboring building; if the builder does not know what building or other structure is planned for construction on land that is neighboring the solar system, the shading must be based on the highest and closest dimensions of the building model and setbacks offered by the builder on that land or if the land is not



- planned for development by the builder, the highest and closest dimensions allowed by zoning.
- vii. Any telephone or other utility pole that is closer than thirty feet from the nearest point of the array.



*Figure 5 – The Minimal Shading Criterion - Artistic Depiction of “H” and “D”*

Neither the PV array nor the shading obstruction are single points in space, so it is the responsibility of the PV installer and the verifier to determine the worst condition by determining the point on the array and the point on the obstruction that would result in the smallest ratio of distance from the obstruction point to the array point divided by the height of the obstruction point above the array point. Generally, the portion of the array that will most likely be shaded and thus represents the worst condition is the lower corner of the array that is closest to the obstruction and the portion of the obstruction that is the worst condition is the highest point of the obstruction, but this may not always be the case. *Obstructions that are located north of the array at azimuths between 305 degrees and 55 degrees from north relative to the most northerly points on the PV array need not be considered as shading obstructions.*

The PV installer and the verifier may verify through visual inspection that most obstructions above the roof meet the 2:1 criterion. For obstructions that visual inspection indicates potentially do not meet the criterion, the PV installer and verifier shall measure the height and distance of the obstruction(s) relative to the PV array as described above to verify that the 2:1 shading criterion is met. A tolerance of  $\pm 5$  percent will be permissible when determining the ratio.

### ***Accounting for Actual Shading***

When a PV installation does not meet the minimal shading criterion, it can still qualify for an incentive and participate in the program, but the shading conditions for each PV system at the site must be accounted for in the expected performance calculation as described in this section.

If shading (other than shading that meets the “minimal shading” criterion) is accounted for in the expected performance calculation, then the PV Calculator will produce on the Certificate of

Compliance a table similar to Table 2 that shows the altitude angle between the PV array and obstructions that shade the PV modules. This table divides the compass into 22.5 degree segments, progressing clockwise around the compass from north. The altitude angle is the angle from the point on the lowest shaded point on the PV array to the highest point on the shading obstruction in each direction segment around the compass. The table also shows the distance-to-height ratio for existing obstructions including mature trees. This will be a number less than or equal to two, because if it is greater than two, the minimal shading criterion is satisfied in that direction and shading is not considered in the expected performance calculation for that segment. The table also shows the minimum distance to small, medium and large trees to meet the minimal shading criterion for trees that are not at their mature heights. The data in Table 2 is specific to a particular PV system installation on the specific residential building. In this example the minimal shading condition is exceeded for four segments of the compass, ESE, SSE, S and WNW.

The PV installer and the verifier shall verify that the shading conditions that exist (or are expected to exist in the case of the mature heights of trees in the landscaping plan or unbuilt residential buildings or structures on neighboring lots) at the site will not cause greater shading of the modules than the shading characteristics that were used in the expected performance calculations.

Table 2 – Example Certificate of Compliance Format for PV Shading

Orientation	Obstruction Type	Altitude Angle to Shading Obstruction	Distance to Height Ratio	Minimum Distance to Small Tree	Minimum Distance to Medium Tree	Minimum Distance to Large Tree
ENE (55 – 79)	NA	Minimal Shading	2.00	16	46	76
E (79 -101)	NA	Minimal Shading	2.00	16	46	76
ESE (101 – 124)	Neighboring structure	45 degrees	1.00			
SE (124 – 146)		Minimal Shading	2.00	16	46	76
SSE (146 – 169)	On roof obstruction	50 degrees	0.84			
S (169 – 191)	Tree (existing-mature)	70 degrees	0.36			
SSW (191 – 214)		Minimal Shading	2.00	16	46	76
SW (214 – 236)	Tree (existing-not mature)	30 degrees	1.5			
WSW (236 – 259)		Minimal Shading	2.00	16	46	76
W (259 – 281)		Minimal Shading	2.00	16	46	76
WNW (281 – 305)	Tree (planned)	65 degrees	0.49			

## *Measuring Heights and Distances or Altitude Angles*

One of the following procedures may be used to measure heights and distances or altitude angles to obstructions.

### Using a Tape Measure

The simplest measurement technique is to use a tape measure or other measuring device to measure the distance from the point on the PV module to the worst shading condition point on obstructions in each 22.5 degree compass segment. The distance to a tree that has not reached its mature height is measured to the nearest edge of the trunk of the tree. Once the elevation difference (H) and distance (D) are determined in each compass segment, the ratio is calculated and must be greater than the value used in the expected performance calculation as reported on the Certificate of Compliance (see the third column in Table 2 labeled Distance to Height Ratio). This method can be employed from the ground without access to the roof, when factoring in the roof top dimensions from construction drawings.

### Using a Digital Protractor

A digital protractor (see Figure 1) may be used to measure the altitude angle. The measured altitude angle must be smaller than or equal to that used in the expected performance calculation as reported on the Certificate of Compliance (see the second column of Table 2). To use the digital protractor measurement directly, the measurement must be made from the roof. Alternatively, the digital protractor measurement may be made from the ground and trigonometric adjustments will be required to adjust for the height difference between the ground where the measurements are made and the point of maximum shading of the PV modules in that compass segment.

### Using a Solar Access and Shading Analysis Instrument

For shading from existing obstructions, such as neighboring buildings or other structures, terrain or already mature trees, on-site shading conditions can be verified using an instrument such as the Solar Pathfinder (see Figure 6). This instrument shall be positioned at the point on the PV array that has the maximum shading. Generally, this will be one of the two lower corners of the array, but depending on the conditions of the site, other locations may be subject to more shading by adjacent buildings or structures, trees, terrain or other obstructions. This procedure will typically be used by the PV installer, but the verifier may not have direct access to the array on a roof top and would rely on the adequacy of documentation by the installer to verify the shading in this case..

Once the instrument is placed at the point on the PV array that has the maximum shading, it is leveled and oriented with true north. The orientation may be determined by using the site plan or a compass as described above. Once the instrument is properly positioned, objects that will cast a shadow on the PV modules will be shown for the month and time of day when shading will occur (see Figure 7). These results are then converted into the format used by the PV Calculator, shown in Figure 7(b) by using an Angle Estimator grid overlay (shown in Figure 6) to determine the altitude angle of an obstruction in each compass segment. The installer shall

attach the diagram shown in Figure 7(b) to the Installation Certificate form, along with photographic evidence of the shading shown on the instrument, the location of the instrument on the array, and the shading obstructions that are indicated on the instrument, for the verifier to verify the results shown on the diagram. The results determined by the instrument are compared to the data that was used in the expected performance calculations to ensure that there is not greater shading at the site than was used in the expected performance calculations.

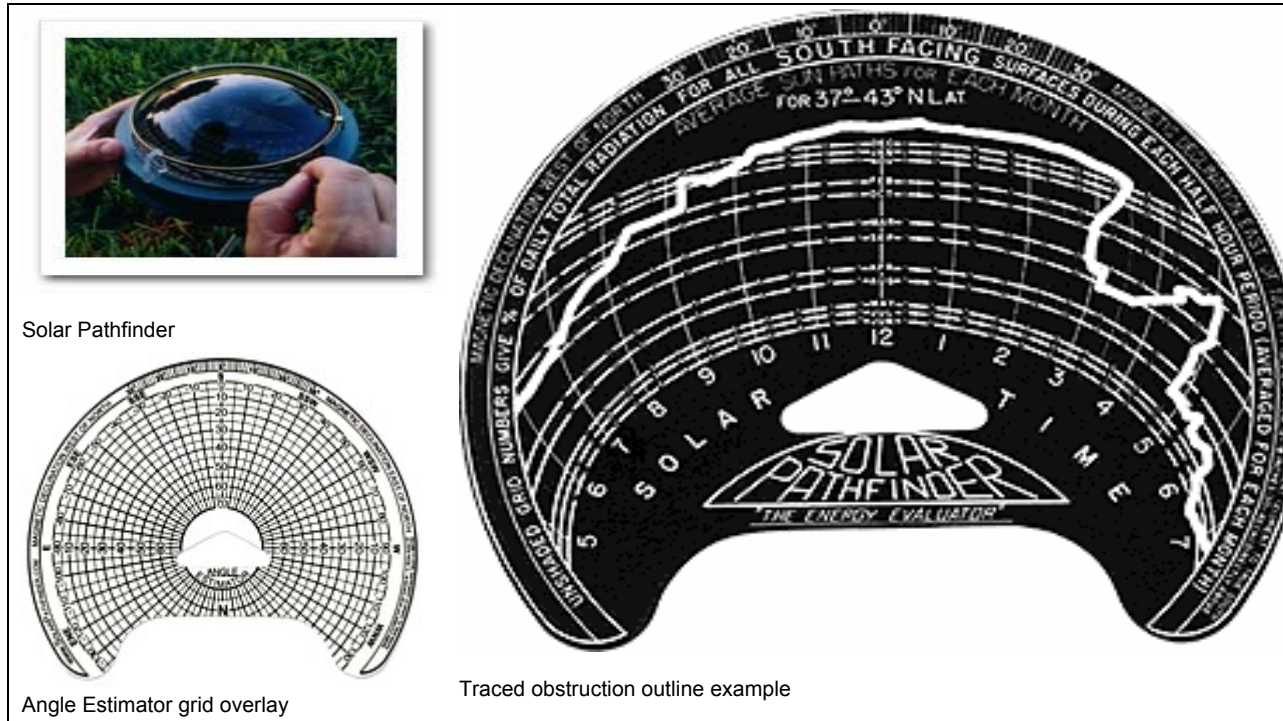


Figure 6 – Example Solar Access and Shading Analysis Instrument

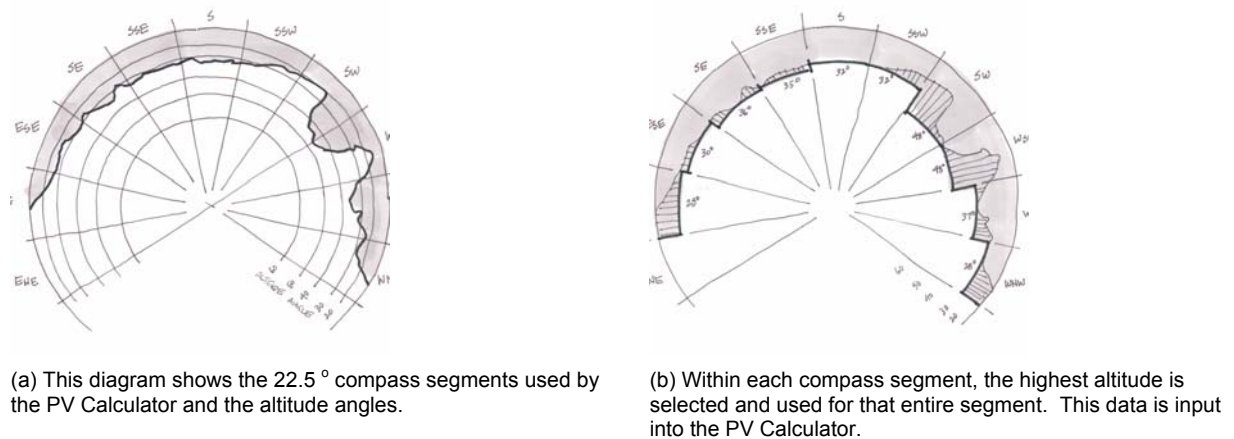


Figure 7 – Conversion of Results from Solar Pathfinder to PV Calculator Input

This method does not address expected shading resulting from the mature heights of planted or planned trees in the landscaping plan or expected construction of buildings or other structures on neighboring lots. Determining distances for planted trees should use a tape measure. Determining distances for planned trees should use the landscape plan provided by the builder. The height measurement for trees that are not yet mature shall be based on the Mature Tree Height discussed below. Determining the distances and heights of obstructions for buildings and structures that have not yet been constructed on neighboring lots shall be based on plans for those structures assuming that they will be located at the closest setbacks to the residential building that is being field-verified or the highest and closest dimensions allowed by zoning for future buildings on neighboring land.

#### Using a Digital Camera with Fisheye Lens

An electronic enhancement of the Solar Pathfinder uses a digital camera with a fisheye lens that is mounted looking up. An image is taken that is automatically processed to produce data similar to the solar pathfinder. The data must be converted to the format used for determining expected performance as described above for the Solar Pathfinder. Determining distances and heights for trees that are not yet at mature heights and unconstructed buildings and structures on neighboring lots must be addressed as described above for the Solar Pathfinder. The installer shall attach the diagram shown in Figure 7(b) to the Installation Certificate form, along with photographic evidence of the shading shown on the instrument, the location of the instrument on the array, and the shading obstructions that are indicated on the instrument, for the verifier to verify the results shown on the diagram. This method does not address expected shading resulting from the mature heights of planted or planned trees in the landscaping plan or expected construction of buildings or other structures on neighboring lots. Such shading shall be addressed separately.

### *Mature Tree Height*

The expected performance calculations require the mature height to be used when accounting for the shading impact of planted and planned trees in the landscaping plan that have not yet reached their mature heights. This section provides guidelines for determining the mature height of such trees. Builders must identify the species of all planted and planned trees in the landscaping plans. That information shall be documented in conjunction with the Installation Certificate and provided to the verifier for verification.

All trees are classified as small, medium or large by species. Trees with a mature height of 20 feet or smaller are small trees. Trees with a mature height greater than 20 feet but less than 50 feet are medium trees. Trees with a mature height greater to or equal to 50 feet are large trees. If the type of tree is unknown, it must be assumed to be large. The mature heights of small, medium and large trees that must be used in the expected performance calculations are 20 feet, 35 feet, and 50 feet, respectively.

The Center for Urban Forestry Research of the U.S. Department of Agriculture's Forest Service has published tree guides for tree zones that are applicable to California. Table 3 shows the

appropriate tree guide to use for each of California’s climate zones for the expected performance calculations.

The guides provide tree selection lists for each tree zone. The lists provide either the mature height or the size category in that tree zone for each species. These tree guides are posted at [[www.fs.fed.us/psw/programs/cufr/tree\\_guides.php](http://www.fs.fed.us/psw/programs/cufr/tree_guides.php)].

For trees not listed in the tree selection tables of the tree guides, the Sunset Western Garden book should be consulted. This document provides the mature height range or maximum height for each species. If a range is given, the average of the maximum height range should be used to determine if the tree is large, medium or small.

**Table 3 – Appropriate Tree Guide to Use for each California Climate Zone**

CEC Climate Zones	Tree Regions	Tree Guide to Use	
1, 2, 3, 4, 5	Northern California Coast	Under Development (Use Sunset Western Garden Book)	
6, 7, 8	Southern California Coast	McPherson, E.G., et al. 2000. Tree guidelines for coastal Southern California communities. Sacramento, CA: Local Government Commission	Chapter 5, pages 57-65
9, 10	Inland Empire	McPherson, E.G., et al. 2001. Tree guidelines for Inland Empire communities. Sacramento, CA: Local Government Commission	Chapter 6, pages 65-82
11, 12, 13	Inland Valleys	McPherson, E.G., et al. 1999. Tree guidelines for San Joaquin Valley communities. Sacramento, CA: Local Government Commission	Chapter 5, pages 50-55
14, 15	Southwest Desert	McPherson, E.G., et al. 2004. Desert southwest community tree guide: benefits, costs and strategic planting. Phoenix, AZ: Arizona Community Tree Council, Inc.	Chapter 7, pages 51-53
16	Northern Mountain and Prairie	McPherson, E.G., et al. 2003. Northern mountain and prairie community tree guide: benefits, costs and strategic planting. Center for Urban Forest Research, USDA Forest Service, Pacific Southwest Research Station.	Chapter 5, pages 47-55

Table 4 shows the horizontal distance that trees of each mature height category would need to be located from nearest point of the PV modules in order to meet the condition of minimal shading.

**Table 4 – Horizontal Distance Trees Would Need to be located from the Closest Point of a PV Array to Qualify for Minimal Shading**

Mounting Location	Small Tree (20 ft)	Medium Tree (35 ft)	Large Tree (50 ft)
1 Story (Lowest Point of Array at 12 ft)	16	46	76
2 Story (Lowest Point of Array at 22 ft)	Any Distance	26	56
3 Story (Lowest Point of Array at 32 ft)	Any Distance	6	36

## Verification of System Performance

The PV installer and verifier must verify that the AC output power from the PV system is consistent with that predicted by the PV Calculator. The PV Calculator will determine an estimate of system AC output power for a range of solar irradiance and outdoor air temperature conditions, and print a table on the Certificate of Compliance form. The values in the table will be 90 percent of the output estimated by the PV Calculator for each set of conditions in the table (the calculations also include the default adjustment of 0.88 for losses such as dirt, dust and mismatched wiring). An example of the data that will be produced is shown in Table 5. The data calculated by the PV Calculator is specific to each PV system.

Verification of system performance shall be performed after the PV system is installed and connected to the electricity grid. Measurements shall be made with a minimum irradiance of 300 W/m<sup>2</sup> in a plane parallel to the array. The PV installer and/or the verifier shall 1) measure the solar irradiance in a plane parallel to the array 2) measure the ambient air temperature and 3) determine the expected output power for the measured field conditions from the table on the Certificate of Compliance form. The PV installer or the verifier shall then observe the output AC power displayed on the inverter and verify that the output AC power is at least the amount shown in the table for the field measured conditions. To qualify for incentives under these Guidelines, PV systems must have a performance meter or an inverter that has a built in meter that measures output AC power.

The PV installer and verifier shall observe the output AC power on the inverter after waiting for a five minute time period during which the measured solar irradiation level has stayed constant within  $\pm 5$  percent. If the solar irradiation level changes outside of these ranges during the five minute waiting period, the PV installer and verifier shall start over the five minute waiting period.

*Table 5 – Example Table of Expected Output AC Power from PV Calculator (Watts)*

(W/m <sup>2</sup> )	T=15	T=20	T=25	T=30	T=35	T=40	T=45	T=50	T=55	T=60	T=65	T=70	T=75	T=80	T=85	T=90	T=95	T=100	T=105	T=110	T=115	T=120
300	614	606	599	591	584	576	568	560	553	544	536	528	520	512	504	496	487	479	471	463	454	446
325	665	657	648	640	632	623	615	607	598	590	581	572	564	555	546	537	528	519	510	501	492	483
350	716	707	698	689	680	671	662	653	643	634	625	616	606	597	588	578	569	559	550	540	530	520
375	766	757	747	738	728	718	708	699	689	679	669	659	649	639	629	619	609	598	588	578	568	557
400	817	807	797	786	776	765	755	745	734	723	713	702	691	681	670	659	648	637	626	615	604	593
425	868	857	846	835	824	813	802	790	779	768	757	745	734	722	711	699	688	676	664	653	641	629
450	918	907	895	883	872	860	848	836	824	812	800	788	776	764	752	739	727	715	702	690	677	665
475	967	955	943	931	919	907	894	882	869	856	843	831	818	805	792	779	766	753	740	727	714	700
500	1016	1004	991	978	966	953	940	927	913	900	887	873	860	846	832	819	805	791	777	763	750	736
525	1065	1052	1038	1025	1012	998	984	971	957	943	929	915	901	887	872	858	843	829	814	800	785	770
550	1113	1099	1085	1071	1057	1043	1029	1014	1000	986	971	956	942	927	912	897	882	866	851	836	820	805
575	1161	1147	1132	1117	1102	1088	1073	1058	1043	1027	1012	997	982	966	951	935	919	903	887	871	855	839
600	1209	1194	1178	1163	1147	1132	1116	1100	1085	1069	1053	1037	1021	1005	989	972	956	940	923	906	890	873
625	1256	1240	1224	1208	1192	1176	1159	1143	1126	1110	1093	1077	1060	1043	1026	1009	992	975	958	941	924	906
650	1302	1286	1269	1252	1236	1219	1202	1185	1168	1150	1133	1116	1098	1081	1063	1046	1028	1010	992	974	957	939
675	1348	1331	1314	1296	1279	1261	1244	1226	1208	1190	1172	1154	1136	1118	1100	1081	1063	1045	1026	1007	989	970
700	1394	1376	1358	1340	1322	1304	1285	1267	1248	1230	1211	1192	1174	1155	1136	1117	1098	1078	1059	1040	1021	1001
725	1439	1420	1401	1383	1364	1345	1326	1307	1288	1269	1249	1230	1210	1191	1171	1151	1132	1112	1092	1072	1052	1032
750	1483	1464	1444	1425	1405	1386	1366	1346	1327	1307	1287	1267	1246	1226	1206	1185	1165	1144	1124	1103	1082	1061
775	1526	1506	1487	1466	1446	1426	1406	1385	1365	1344	1323	1303	1282	1261	1240	1219	1198	1176	1155	1134	1112	1090
800	1569	1549	1528	1507	1486	1466	1445	1423	1402	1381	1360	1338	1317	1295	1273	1252	1230	1208	1186	1164	1141	1119
825	1611	1590	1569	1547	1526	1504	1483	1461	1439	1417	1395	1373	1351	1328	1306	1284	1261	1238	1216	1193	1170	1147
850	1653	1631	1609	1587	1565	1542	1520	1498	1475	1452	1430	1407	1384	1361	1338	1315	1292	1268	1245	1221	1198	1174
875	1693	1671	1648	1626	1603	1580	1557	1534	1510	1487	1464	1440	1417	1393	1369	1345	1322	1298	1273	1249	1225	1200
900	1733	1710	1687	1663	1640	1616	1593	1569	1545	1521	1497	1473	1449	1424	1400	1375	1351	1326	1301	1276	1251	1226
925	1772	1748	1725	1701	1676	1652	1628	1603	1579	1554	1529	1505	1480	1455	1430	1404	1379	1354	1328	1302	1277	1251
950	1811	1786	1762	1737	1712	1687	1662	1637	1612	1586	1561	1536	1510	1484	1459	1433	1407	1381	1354	1328	1302	1275
975	1980	1823	1798	1772	1747	1721	1696	1670	1644	1618	1592	1566	1540	1513	1487	1460	1434	1407	1380	1353	1326	1299
1000	1980	1980	1980	1807	1781	1755	1729	1702	1676	1649	1622	1595	1569	1542	1514	1487	1460	1432	1405	1377	1349	1322
1025	1980	1980	1980	1980	1815	1788	1761	1734	1706	1679	1652	1624	1597	1569	1541	1513	1486	1457	1429	1401	1372	1344
1050	1980	1980	1980	1980	1980	1820	1792	1765	1737	1709	1681	1653	1624	1596	1568	1539	1511	1482	1453	1424	1395	1365
1075	1980	1980	1980	1980	1980	1980	1823	1795	1767	1738	1709	1680	1652	1623	1593	1564	1535	1506	1476	1446	1417	1387
1100	1980	1980	1980	1980	1980	1980	1980	1825	1796	1766	1737	1708	1678	1648	1619	1589	1559	1529	1499	1468	1438	1407
1125	1980	1980	1980	1980	1980	1980	1980	1980	1824	1794	1764	1734	1704	1674	1643	1613	1582	1551	1520	1490	1458	1427
1150	1980	1980	1980	1980	1980	1980	1980	1980	1980	1822	1791	1760	1729	1698	1667	1636	1605	1573	1542	1510	1479	1447
1175	1980	1980	1980	1980	1980	1980	1980	1980	1980	1980	1817	1786	1754	1722	1691	1659	1627	1595	1563	1530	1498	1466
1200	1980	1980	1980	1980	1980	1980	1980	1980	1980	1980	1980	1810	1778	1746	1714	1681	1649	1616	1583	1550	1517	1484



### *Measuring Solar Irradiance*

Solar irradiance shall be measured by using a solar pyranometer. When making this measurement, the PV installer or verifier must place the pyranometer in a plane that is parallel to the PV modules. The PV installer should position the pyranometer on top of the PV modules or on the roof next to the PV modules. The verifier if they are not likely to be able to get on the roof shall position the pyranometer such that it is in full sun and is in plane that is parallel to the PV modules. Digital protractors or other instruments may be used to properly position the pyranometer.

### *Measuring Ambient Air Temperature*

Ambient air temperature must be measured with a digital thermometer in the shade. The instrument must have an accuracy of  $\pm 2^{\circ}$  C.

### *Observing Output AC Power at the Inverter*

The PV installer and the verifier shall observe and record the reading within five minutes of the time the measurements of solar irradiation and ambient temperature were made. The inverter may cycle between multiple readings (total kWh of production, output power, etc.), so the PV installer or verifier will need to wait until the power is displayed and record this reading; several readings should be made to make sure that they are consistent and stable.

### *Multiple Orientation Arrays*

For larger systems, PV modules connected to the same inverter may be installed with strings of equal numbers of modules connected in parallel in more than one orientation, each with its own tilt and azimuth (note that it is bad practice to install such strings in series or with a different number of modules in each string; either of these installations will lead to substantial reductions in performance). When strings are installed in multiple orientation arrays to the same inverter, separate Certificate of Compliance forms shall be prepared for each orientation, and solar irradiance shall be measured separately in a plane parallel to each string that has a different azimuth and tilt. The expected output AC power is determined separately for each condition and the sum is used for verification purposes.

For example a qualifying 3 kW PV system has 42 PV modules grouped in two parallel strings, one south (azimuth of 170 degrees) and one west (azimuth of 260 degrees). The south facing array has 21 PV modules and the west facing array has 21 PV modules connected in parallel to maintain system voltage. The verifier verified system performance at 11:30 AM in March and measured a solar irradiance of 950 W/m<sup>2</sup> in a

plane parallel to the south array and 500 W/m<sup>2</sup> in a plane parallel to the west facing array. The ambient temperature at the time of the testing is 62° F.

The expected AC output power table on the Certificate of Compliance indicates that the system should be producing 1,200 W at 950 W/m<sup>2</sup> and 700 W at 500 W/m<sup>2</sup> of solar irradiance. The expected output AC power to be compared to the inverter display is calculated to be 1,900 W based on the following equation.

$$\begin{aligned}\text{Expected AC Output Power (W)} &= 1,200 + 700 \\ &= 1,900 \text{ W}\end{aligned}$$

To test systems with multiple arrays the solar irradiance levels on all of the arrays must stay constant for the five-minute waiting period discussed in Verification of System Performance above.

# APPENDIX 3: Senate Bill 1 (Murray, Statutes of 2006)

## SENATE BILL NO. 1

### CHAPTER 132

An act to add Sections 25405.5 and 25405.6 to, and to add Chapter 8.8 (commencing with Section 25780) to Division 15 of, the Public Resources Code, and to amend Section 2827 of, and to add Sections 387.5 and 2851 to, the Public Utilities Code, relating to solar electricity.

### LEGISLATIVE COUNSEL'S DIGEST

SB 1, Murray Electricity: solar energy: net metering.

(1) Existing law requires the State Energy Resources Conservation and Development Commission (Energy Commission) to expand and accelerate development of alternative sources of energy, including solar resources. Existing law requires the Energy Commission to develop and adopt regulations governing solar devices, as defined, designed to encourage the development and use of solar energy and to provide maximum information to the public concerning solar devices.

This bill would require beginning January 1, 2011, a seller of production homes, as defined, to offer the option of a solar energy system, as defined, to all customers negotiating to purchase a new production home constructed on land meeting certain criteria and to disclose certain information. The bill would require the Energy Commission to develop an offset program that allows a developer or seller of production homes to forgo the offer requirement on a project by installing solar energy systems generating specified amounts of electricity on other projects. The bill would require, not later than July 1, 2007, the Energy Commission to initiate a public proceeding to study and make findings whether, and under what conditions, solar energy systems should be required on new residential and nonresidential buildings and to periodically update the study thereafter.

(2) Under existing law, the Public Utilities Commission (PUC) has regulatory authority over public utilities, including electrical corporations. Existing law required the PUC, on or before March 7, 2001, and in consultation with the Independent System Operator, to take

certain actions, including, in consultation with the Energy Commission, adopting energy conservation demand-side management and other initiatives in order to reduce demand for electricity and reduce load during peak demand periods, including differential incentives for renewable or super clean distributed generation resources. Pursuant to this requirement, the PUC has developed a self-generation incentive program to encourage customers of electrical corporations to install distributed generation that operates on renewable fuel or contributes to system reliability. Existing law requires the PUC, in consultation with the Energy Commission, to administer, until January 1, 2008, a self-generation incentive program for distributed generation resources in the same form that existed on January 1, 2004, subject to certain air emissions and efficiency standards. In a PUC decision, the PUC adopted the California Solar Initiative, which modified the self-generation incentive program for distributed generation resources and provides incentives to customer-side photovoltaics and solar thermal electric projects under one megawatt.

This bill would require the PUC, in implementing the California Solar Initiative, to authorize the award of monetary incentives for up to the first megawatt of alternating current generated by an eligible solar energy system, that meets the eligibility criteria established by the Energy Commission. The bill would authorize the commission, prior to the establishment of eligibility criteria by the Energy Commission, to determine the eligibility of a solar energy system, as defined, to receive monetary incentives. The bill would require that awards of monetary incentives decline at a rate of an average of at least 7% for each year following implementation, and be zero by December 31, 2016. The bill would require the PUC, by January 1, 2008, to adopt a performance-based incentive program, as specified. The bill would require that the PUC, by January 1, 2008, and in consultation with the Energy Commission, require reasonable and cost-effective energy efficiency improvements in existing buildings as a condition of providing incentives for eligible solar energy systems. The bill would require the commission to require time-variant pricing for all ratepayers with a solar energy system. The bill would prohibit costs of the program from being recovered from certain customers and would require the commission to ensure that the total cost over the duration of the program does not exceed \$3,350,800,000, consisting of 3 specified program components. The bill would authorize the PUC to award monetary incentives for solar thermal and solar water heating devices, in a total amount up to \$100,800,000. The bill would prohibit the PUC from allocating more than \$50,000,000 for certain research, development, and demonstration. The bill would require that by June 30, 2009, and by June 30 of every year thereafter, the PUC submit

to the Legislature an assessment of the success of the California Solar Initiative program, that includes specified information.

This bill would require the Energy Commission, by January 1, 2008, and in consultation with the PUC, local publicly owned electric utilities, and interested members of the public, to establish and thereafter revise eligibility criteria for solar energy systems and to establish conditions for ratepayer funded incentives that are applicable to the California Solar Initiative. The bill would require the Energy Commission to adopt guidelines for solar energy systems receiving ratepayer funded incentives at a publicly noticed meeting. The bill would, upon establishment of eligibility criteria by the Energy Commission, prohibit ratepayer funded incentives from being made for a solar energy system that does not meet the eligibility criteria. The bill would require the Energy Commission to make certain information available to the public, to provide assistance to builders and contractors, and to conduct random audits of solar energy systems to evaluate their operational performance.

This bill would require all local publicly owned electric utilities, as defined, that sell electricity at retail, on or before January 1, 2008, to adopt, implement, and finance a solar initiative program, as prescribed, for the purpose of investing in, and encouraging the increased installation of, residential and commercial solar energy systems. The bill would require a local publicly owned electric utility to make certain program information available to its customers, to the Legislature, and to the Energy Commission on an annual basis beginning June 1, 2008. By imposing additional duties upon local publicly owned electric utilities, the bill would thereby impose a state-mandated local program.

(3) Existing law requires all electric service providers, as defined, to develop a standard contract or tariff providing for net energy metering, and to make this contract available to eligible customer generators, upon request. Existing law requires all electric service providers, upon request, to make available to eligible customer generators contracts for net energy metering on a first-come-first-served basis until the time that the total rated generating capacity used by eligible customer generators exceeds 0.5% of the electric service provider's aggregate customer peak demand.

This bill would require the PUC to order electric service providers to expand the availability of net energy metering so that it is offered on a first-come-first-served basis until the time that the total rated generating capacity used by all eligible customer-generators exceeds 2.5% of the electric service provider's aggregate customer peak demand. The bill would require the PUC, by January 1, 2010, in consultation with the Energy Commission, to submit a report to the Governor and Legislature on the costs and benefits of net energy metering, wind energy co-metering, and co-energy metering to participating customers and

nonparticipating customers and with options to replace the economic costs of different forms of net metering with a mechanism that more equitably balances the interests of participating and nonparticipating customers.

(4) Existing law, the Contractors' State License Law, provides for the licensure and regulation of contractors by the Contractors' State License Board.

This bill would require the board to review and, if needed, revise its licensing classifications and examinations to ensure that contractors authorized to perform work on solar energy systems, as specified, have the requisite qualifications to perform the work.

(5) The California Constitution requires the state to reimburse local agencies and school districts for certain costs mandated by the state. Statutory provisions establish procedures for making that reimbursement.

This bill would provide that no reimbursement is required by this act for specified reasons.

THE PEOPLE OF THE STATE OF CALIFORNIA DO ENACT AS FOLLOWS:

SECTION 1. (a) The Legislature finds and declares that the Public Utilities Commission (PUC) adopted the California Solar Initiative in Decision 06-01-024.

(b) Nothing in this act shall be construed to codify PUC Decision 06-01-024.

SEC. 2. Section 25405.5 is added to the Public Resources Code, to read:

25405.5. (a) As used in this section, the following terms have the following meanings:

(1) "kW" means kilowatts or 1,000 watts, as measured from the alternating current side of the solar energy system inverter consistent with Section 223 of Title 15 of the United States Code.

(2) "Production home" means a single-family residence constructed as part of a development of at least 50 homes per project that is intended or offered for sale.

(3) "Solar energy system" means a solar energy device that has the primary purpose of providing for the collection and distribution of solar energy for the generation of electricity, that produces at least one kW, and not more than five megawatts, alternating current rated peak electricity, and that meets or exceeds the eligibility criteria established pursuant to Section 25782.

(b) A seller of production homes shall offer a solar energy system option to all customers that enter into negotiations to purchase a new production home constructed on land for which an application for a tentative subdivision map has been deemed complete on or after January 1, 2011, and disclose the following:

(1) The total installed cost of the solar energy system option.

(2) The estimated cost savings associated with the solar energy system option, as determined by the commission pursuant to Chapter 8.8 (commencing with Section 25780) of Division 15.

(c) The State Energy Resources Conservation and Development Commission shall develop an offset program that allows a developer or seller of production homes to forgo the offer requirement of this section on a project, by installing solar energy systems generating specified amounts of electricity on other projects, including, but not limited to, low-income housing, multifamily, commercial, industrial, and institutional developments. The amount of electricity required to be generated from solar energy systems used as an offset pursuant to this subdivision shall be equal to the amount of electricity generated by solar energy systems installed on a similarly sized project within that climate zone, assuming 20 percent of the prospective buyers would have installed solar energy systems.

(d) The requirements of this section shall not operate as a substitute for the implementation of existing energy efficiency measures, and the requirements of this section shall not result in lower energy savings or lower energy efficiency levels than would otherwise be achieved by the full implementation of energy savings and energy efficiency standards established pursuant to Section 25402.

SEC. 3. Section 25405.6 is added to the Public Resources Code, to read:

25405.6. Not later than July 1, 2007, the commission shall initiate a public proceeding to study and make findings whether, and under what conditions, solar energy systems should be required on new residential and new nonresidential buildings, including the establishment of numerical targets. As part of the study, the commission may determine that a solar energy system should not be required for any building unless the commission determines, based upon consideration of all costs associated with the system, that the system is cost effective when amortized over the economic life of the structure. When determining the cost-effectiveness of the solar energy system, the commission shall consider the availability of governmental rebates, tax deductions, net-metering, and other quantifiable factors, if the commission can determine the availability of these financial incentives if a solar energy system is made mandatory and not elective. The commission shall periodically update the study and incorporate any revision that the commission

determines is necessary, including revisions that reflect changes in the financial incentives originally considered by the commission when determining cost-effectiveness of the solar energy system. For purposes of this section, "solar energy system" means a photovoltaic solar collector or other photovoltaic solar energy device that has a primary purpose of providing for the collection and distribution of solar energy for the generation of electricity. This section is intended to be for study purposes only and does not authorize the commission to develop and adopt any requirement for solar energy systems on either residential or nonresidential buildings.

SEC. 4. Chapter 8.8 (commencing with Section 25780) is added to Division 15 of the Public Resources Code, to read:

CHAPTER 8.8. California Solar Initiative

25780. The Legislature finds and declares both of the following:

(a) It is the goal of the state to install solar energy systems with a generation capacity equivalent of 3,000 megawatts, to establish a self-sufficient solar industry in which solar energy systems are a viable mainstream option for both homes and businesses in 10 years, and to place solar energy systems on 50 percent of new homes in 13 years.

(b) A solar initiative should be a cost-effective investment by ratepayers in peak electricity generation capacity where ratepayers recoup the cost of their investment through lower rates as a result of avoiding purchases of electricity at peak rates, with additional system reliability and pollution reduction benefits.

25781. As used in this chapter, the following terms have the following meanings:

(a) "California Solar Initiative" means the program providing ratepayer funded incentives for eligible solar energy systems adopted by the Public Utilities Commission in Decision 06-01-024.

(b) "kW" means kilowatts or 1,000 watts, as measured from the alternating current side of the solar energy system inverter consistent with Section 223 of Title 15 of the United States Code.

(c) "kWh" means kilowatthours, as measured by the number of kilowatts generated in an hour.

(d) "MW" means megawatts or 1,000,000 watts.

(e) "Solar energy system" means a solar energy device that has the primary purpose of providing for the collection and distribution of solar energy for the generation of electricity, that produces at least one kW, and not more than five MW, alternating current rated peak electricity, and that meets or exceeds the eligibility criteria established pursuant to Section 25782.



25782. (a) The commission shall, by January 1, 2008, in consultation with the Public Utilities Commission, local publicly owned electric utilities, and interested members of the public, establish eligibility criteria for solar energy systems receiving ratepayer funded incentives that include all of the following:

(1) Design, installation, and electrical output standards or incentives.

(2) The solar energy system is intended primarily to offset part or all of the consumer's own electricity demand.

(3) All components in the solar energy system are new and unused, and have not previously been placed in service in any other location or for any other application.

(4) The solar energy system has a warranty of not less than 10 years to protect against defects and undue degradation of electrical generation output.

(5) The solar energy system is located on the same premises of the end-use consumer where the consumer's own electricity demand is located.

(6) The solar energy system is connected to the electrical corporation's electrical distribution system within the state.

(7) The solar energy system has meters or other devices in place to monitor and measure the system's performance and the quantity of electricity generated by the system.

(8) The solar energy system is installed in conformance with the manufacturer's specifications and in compliance with all applicable electrical and building code standards.

(b) The commission shall establish conditions on ratepayer funded incentives that require all of the following:

(1) Appropriate siting and high quality installation of the solar energy system by developing installation guidelines that maximize the performance of the system and prevent qualified systems from being inefficiently or inappropriately installed. The conditions established by the commission shall not impact housing designs or densities presently authorized by a city, county, or city and county. The goal of this paragraph is to achieve efficient installation of solar energy systems to promote the greatest energy production per ratepayer dollar.

(2) Optimal solar energy system performance during periods of peak electricity demand.

(3) Appropriate energy efficiency improvements in the new or existing home or commercial structure where the solar energy system is installed.

(c) The commission shall set rating standards for equipment, components, and systems to assure reasonable performance and shall develop standards that provide for compliance with the minimum ratings.

(d) Upon establishment of eligibility criteria pursuant to subdivision (a), no ratepayer funded incentives shall be made for a solar energy system that does not meet the eligibility criteria.

25783. The commission shall do all the following:

(a) Publish educational materials designed to demonstrate how builders may incorporate solar energy systems during construction as well as energy efficiency measures that best complement solar energy systems.

(b) Develop and publish the estimated annual electrical generation and savings for solar energy systems. The estimates shall vary by climate zone, type of system, size, lifecycle costs, electricity prices, and other factors the commission determines to be relevant to a consumer when making a purchasing decision.

(c) Provide assistance to builders and contractors. The assistance may include technical workshops, training, educational materials, and related research.

(d) The commission shall annually conduct random audits of solar energy systems to evaluate their operational performance.

(e) The commission, in consultation with the Public Utilities Commission, shall evaluate the costs and benefits of having an increased number of operational solar energy systems as a part of the electrical system with respect to their impact upon the distribution, transmission, and supply of electricity, using the best available load profiling and distribution operations data from the Public Utilities Commission, local publicly owned electric utilities, and electrical corporations, and performance audits of installed solar energy systems.

25784. The commission shall adopt guidelines for solar energy systems receiving ratepayer funded incentives at a publicly noticed meeting offering all interested parties an opportunity to comment. Not less than 30 days' public notice shall be given of the meeting required by this section, before the commission initially adopts guidelines. Substantive changes to the guidelines shall not be adopted without at least 10 days' written notice to the public. Notwithstanding any other provision of law, any guidelines adopted pursuant to this chapter shall be exempt from the requirements of Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code.

SEC. 5. Section 387.5 is added to the Public Utilities Code, to read:

387.5. (a) In order to further the state goal of encouraging the installation of 3,000 megawatts of photovoltaic solar energy in California within 10 years, the governing body of a local publicly owned electric utility, as defined in subdivision (d) of Section 9604, that sells electricity at retail, shall adopt, implement, and finance a solar initiative program, funded in accordance with subdivision (b), for the purpose of investing

in, and encouraging the increased installation of, residential and commercial solar energy systems.

(b) On or before January 1, 2008, a local publicly owned electric utility shall offer monetary incentives for the installation of solar energy systems of at least two dollars and eighty cents (\$2.80) per installed watt, or for the electricity produced by the solar energy system, measured in kilowatthours, as determined by the governing board of a local publicly owned electric utility, for photovoltaic solar energy systems. The incentive level shall decline each year thereafter at a rate of no less than an average of 7 percent per year.

(c) A local publicly owned electric utility shall initiate a public proceeding to fund a solar energy program to adequately support the goal of installing 3,000 megawatts of photovoltaic solar energy in California. The proceeding shall determine what additional funding, if any, is necessary to provide the incentives pursuant to subdivision (b). The public proceeding shall be completed and the comprehensive solar energy program established by January 1, 2008.

(d) The solar energy program of a local publicly owned electric utility shall be consistent with all of the following:

(1) That a solar energy system receiving monetary incentives comply with the eligibility criteria, design, installation, and electrical output standards or incentives established by the State Energy Resources Conservation and Development Commission pursuant to Section 25782 of the Public Resources Code.

(2) That solar energy systems receiving monetary incentives are intended primarily to offset part or all of the consumer's own electricity demand.

(3) That all components in the solar energy system are new and unused, and have not previously been placed in service in any other location or for any other application.

(4) That the solar energy system has a warranty of not less than 10 years to protect against defects and undue degradation of electrical generation output.

(5) That the solar energy system be located on the same premises of the end-use consumer where the consumer's own electricity demand is located.

(6) That the solar energy system be connected to the electric utility's electrical distribution system within the state.

(7) That the solar energy system has meters or other devices in place to monitor and measure the system's performance and the quantity of electricity generated by the system.

(8) That the solar energy system be installed in conformance with the manufacturer's specifications and in compliance with all applicable electrical and building code standards.

(e) A local publicly owned electric utility shall, on an annual basis beginning June 1, 2008, make available to its customers, to the Legislature, and to the State Energy Resources Conservation and Development Commission, information relating to the utility's solar initiative program established pursuant to this section, including, but not limited to, the number of photovoltaic solar watts installed, the total number of photovoltaic systems installed, the total number of applicants, the amount of incentives awarded, and the contribution toward the program goals.

(f) In establishing the program required by this section, no moneys shall be diverted from any existing programs for low-income ratepayers, or from cost-effective energy efficiency or demand response programs.

(g) The statewide expenditures for solar programs adopted, implemented, and financed by local publicly owned electric utilities shall be seven hundred eighty-four million dollars (\$784,000,000). The expenditure level for each local publicly owned electric utility shall be based on that utility's percentage of the total statewide load served by all local publicly owned electric utilities. Expenditures by a local publicly owned electric utility may be less than the utility's cap amount, provided that funding is adequate to provide the incentives required by subdivisions (a) and (b).

SEC. 6. Section 2827 of the Public Utilities Code is amended to read:

2827. (a) The Legislature finds and declares that a program to provide net energy metering for eligible customer-generators is one way to encourage substantial private investment in renewable energy resources, stimulate in-state economic growth, reduce demand for electricity during peak consumption periods, help stabilize California's energy supply infrastructure, enhance the continued diversification of California's energy resource mix, and reduce interconnection and administrative costs for electricity suppliers.

(b) As used in this section, the following definitions apply:

(1) "Electric service provider" means an electrical corporation, as defined in Section 218, a local publicly owned electric utility, as defined in Section 9604, or an electrical cooperative, as defined in Section 2776, or any other entity that offers electrical service. This section shall not apply to a local publicly owned electric utility, as defined in Section 9604 of the Public Utilities Code, that serves more than 750,000 customers and that also conveys water to its customers.

(2) "Eligible customer-generator" means a residential, small commercial customer as defined in subdivision (h) of Section 331, commercial,

industrial, or agricultural customer of an electric service provider, who uses a solar or a wind turbine electrical generating facility, or a hybrid system of both, with a capacity of not more than one megawatt that is located on the customer's owned, leased, or rented premises, is interconnected and operates in parallel with the electric grid, and is intended primarily to offset part or all of the customer's own electrical requirements.

(3) "Net energy metering" means measuring the difference between the electricity supplied through the electric grid and the electricity generated by an eligible customer-generator and fed back to the electric grid over a 12-month period as described in subdivision (h). Net energy metering shall be accomplished using a single meter capable of registering the flow of electricity in two directions. An additional meter or meters to monitor the flow of electricity in each direction may be installed with the consent of the customer-generator, at the expense of the electric service provider, and the additional metering shall be used only to provide the information necessary to accurately bill or credit the customer-generator pursuant to subdivision (h), or to collect solar or wind electric generating system performance information for research purposes. If the existing electrical meter of an eligible customer-generator is not capable of measuring the flow of electricity in two directions, the customer-generator shall be responsible for all expenses involved in purchasing and installing a meter that is able to measure electricity flow in two directions. If an additional meter or meters are installed, the net energy metering calculation shall yield a result identical to that of a single meter. An eligible customer-generator who already owns an existing solar or wind turbine electrical generating facility, or a hybrid system of both, is eligible to receive net energy metering service in accordance with this section.

(4) "Wind energy co-metering" means any wind energy project greater than 50 kilowatts, but not exceeding one megawatt, where the difference between the electricity supplied through the electric grid and the electricity generated by an eligible customer-generator and fed back to the electric grid over a 12-month period is as described in subdivision (h). Wind energy co-metering shall be accomplished pursuant to Section 2827.8.

(5) "Co-energy metering" means a program that is the same in all other respects as a net energy metering program, except that the local publicly owned electric utility, as defined in Section 9604, has elected to apply a generation-to-generation energy and time-of-use credit formula as provided in subdivision (i).

(6) "Ratemaking authority" means, for an electrical corporation as defined in Section 218, or an electrical cooperative as defined in Section 2776, the commission, and for a local publicly owned electric utility as

defined in Section 9604, the local elected body responsible for regulating the rates of the local publicly owned utility.

(c) (1) Every electric service provider shall develop a standard contract or tariff providing for net energy metering, and shall make this contract available to eligible customer-generators, upon request, on a first-come-first-served basis until the time that the total rated generating capacity used by eligible customer-generators exceeds 2.5 percent of the electric service provider's aggregate customer peak demand.

(2) On an annual basis, beginning in 2003, every electric service provider shall make available to the ratemaking authority information on the total rated generating capacity used by eligible customer-generators that are customers of that provider in the provider's service area. For those electric service providers who are operating pursuant to Section 394, they shall make available to the ratemaking authority the information required by this paragraph for each eligible customer-generator that is their customer for each service area of an electric corporation, local publicly owned electric utility, or electrical cooperative, in which the customer has net energy metering. The ratemaking authority shall develop a process for making the information required by this paragraph available to energy service providers, and for using that information to determine when, pursuant to paragraph (3), a service provider is not obligated to provide net energy metering to additional customer-generators in its service area.

(3) Notwithstanding paragraph (1), an electric service provider is not obligated to provide net energy metering to additional customer-generators in its service area when the combined total peak demand of all customer-generators served by all the electric service providers in that service area furnishing net energy metering to eligible customer-generators exceeds 2.5 percent of the aggregate customer peak demand of those electric service providers.

(4) By January 1, 2010, the commission, in consultation with the State Energy Resources Conservation and Development Commission, shall submit a report to the Governor and the Legislature on the costs and benefits of net energy metering, wind energy co-metering, and co-energy metering to participating customers and nonparticipating customers and with options to replace the economic costs and benefits of net energy metering, wind energy co-metering, and co-energy metering with a mechanism that more equitably balances the interests of participating and nonparticipating customers, and that incorporates the findings of the report on economic and environmental costs and benefits of net metering required by subdivision (n).

(d) Electric service providers shall make all necessary forms and contracts for net metering service available for download from the Internet.

(e) (1) Every electric service provider shall ensure that requests for establishment of net energy metering are processed in a time period not exceeding that for similarly situated customers requesting new electric service, but not to exceed 30 working days from the date the electric service provider receives a completed application form for net metering service, including a signed interconnection agreement from an eligible customer-generator and the electric inspection clearance from the governmental authority having jurisdiction. If an electric service provider is unable to process the request within the allowable timeframe, the electric service provider shall notify both the customer-generator and the ratemaking authority of the reason for its inability to process the request and the expected completion date.

(2) Electric service providers shall ensure that requests for an interconnection agreement from an eligible customer-generator are processed in a time period not to exceed 30 working days from the date the electric service provider receives a completed application form from the eligible customer-generator for an interconnection agreement. If an electric service provider is unable to process the request within the allowable timeframe, the electric service provider shall notify the customer-generator and the ratemaking authority of the reason for its inability to process the request and the expected completion date.

(f) (1) If a customer participates in direct transactions pursuant to paragraph (1) of subdivision (b) of Section 365 with an electric supplier that does not provide distribution service for the direct transactions, the service provider that provides distribution service for an eligible customer-generator is not obligated to provide net energy metering to the customer.

(2) If a customer participates in direct transactions pursuant to paragraph (1) of subdivision (b) of Section 365 with an electric supplier, and the customer is an eligible customer-generator, the service provider that provides distribution service for the direct transactions may recover from the customer's electric service provider the incremental costs of metering and billing service related to net energy metering in an amount set by the ratemaking authority.

(g) Except for the time-variant kilowatthour pricing portion of any tariff adopted by the commission pursuant to paragraph (4) of subdivision (a) of Section 2851, each net energy metering contract or tariff shall be identical, with respect to rate structure, all retail rate components, and any monthly charges, to the contract or tariff to which the same customer would be assigned if the customer did not use an eligible solar or wind

electrical generating facility, except that eligible customer-generators shall not be assessed standby charges on the electrical generating capacity or the kilowatthour production of an eligible solar or wind electrical generating facility. The charges for all retail rate components for eligible customer-generators shall be based exclusively on the customer-generator's net kilowatthour consumption over a 12-month period, without regard to the customer-generator's choice of electric service provider. Any new or additional demand charge, standby charge, customer charge, minimum monthly charge, interconnection charge, or any other charge that would increase an eligible customer-generator's costs beyond those of other customers who are not customer-generators in the rate class to which the eligible customer-generator would otherwise be assigned if the customer did not own, lease, rent, or otherwise operate an eligible solar or wind electrical generating facility are contrary to the intent of this section, and shall not form a part of net energy metering contracts or tariffs.

(h) For eligible residential and small commercial customer-generators, the net energy metering calculation shall be made by measuring the difference between the electricity supplied to the eligible customer-generator and the electricity generated by the eligible customer-generator and fed back to the electric grid over a 12-month period. The following rules shall apply to the annualized net metering calculation:

(1) The eligible residential or small commercial customer-generator shall, at the end of each 12-month period following the date of final interconnection of the eligible customer-generator's system with an electric service provider, and at each anniversary date thereafter, be billed for electricity used during that period. The electric service provider shall determine if the eligible residential or small commercial customer-generator was a net consumer or a net producer of electricity during that period.

(2) At the end of each 12-month period, where the electricity supplied during the period by the electric service provider exceeds the electricity generated by the eligible residential or small commercial customer-generator during that same period, the eligible residential or small commercial customer-generator is a net electricity consumer and the electric service provider shall be owed compensation for the eligible customer-generator's net kilowatthour consumption over that same period. The compensation owed for the eligible residential or small commercial customer-generator's consumption shall be calculated as follows:

(A) For all eligible customer-generators taking service under tariffs employing "baseline" and "over baseline" rates, any net monthly consumption of electricity shall be calculated according to the terms of



the contract or tariff to which the same customer would be assigned to or be eligible for if the customer was not an eligible customer-generator. If those same customer-generators are net generators over a billing period, the net kilowatthours generated shall be valued at the same price per kilowatthour as the electric service provider would charge for the baseline quantity of electricity during that billing period, and if the number of kilowatthours generated exceeds the baseline quantity, the excess shall be valued at the same price per kilowatthour as the electric service provider would charge for electricity over the baseline quantity during that billing period.

(B) For all eligible customer-generators taking service under tariffs employing "time of use" rates, any net monthly consumption of electricity shall be calculated according to the terms of the contract or tariff to which the same customer would be assigned to or be eligible for if the customer was not an eligible customer-generator. When those same customer-generators are net generators during any discrete time of use period, the net kilowatthours produced shall be valued at the same price per kilowatthour as the electric service provider would charge for retail kilowatthour sales during that same time of use period. If the eligible customer-generator's time of use electrical meter is unable to measure the flow of electricity in two directions, paragraph (3) of subdivision (b) shall apply.

(C) For all residential and small commercial customer-generators and for each billing period, the net balance of moneys owed to the electric service provider for net consumption of electricity or credits owed to the customer-generator for net generation of electricity shall be carried forward as a monetary value until the end of each 12-month period. For all commercial, industrial, and agricultural customer-generators the net balance of moneys owed shall be paid in accordance with the electric service provider's normal billing cycle, except that if the commercial, industrial, or agricultural customer-generator is a net electricity producer over a normal billing cycle, any excess kilowatthours generated during the billing cycle shall be carried over to the following billing period as a monetary value, calculated according to the procedures set forth in this section, and appear as a credit on the customer-generator's account, until the end of the annual period when paragraph (3) shall apply.

(3) At the end of each 12-month period, where the electricity generated by the eligible customer-generator during the 12-month period exceeds the electricity supplied by the electric service provider during that same period, the eligible customer-generator is a net electricity producer and the electric service provider shall retain any excess kilowatthours generated during the prior 12-month period. The eligible customer-generator shall not be owed any compensation for those excess

kilowatthours unless the electric service provider enters into a purchase agreement with the eligible customer-generator for those excess kilowatthours.

(4) The electric service provider shall provide every eligible residential or small commercial customer-generator with net electricity consumption information with each regular bill. That information shall include the current monetary balance owed the electric service provider for net electricity consumed since the last 12-month period ended. Notwithstanding this subdivision, an electric service provider shall permit that customer to pay monthly for net energy consumed.

(5) If an eligible residential or small commercial customer-generator terminates the customer relationship with the electric service provider, the electric service provider shall reconcile the eligible customer-generator's consumption and production of electricity during any part of a 12-month period following the last reconciliation, according to the requirements set forth in this subdivision, except that those requirements shall apply only to the months since the most recent 12-month bill.

(6) If an electric service provider providing net metering to a residential or small commercial customer-generator ceases providing that electrical service to that customer during any 12-month period, and the customer-generator enters into a new net metering contract or tariff with a new electric service provider, the 12-month period, with respect to that new electric service provider, shall commence on the date on which the new electric service provider first supplies electric service to the customer-generator.

(i) Notwithstanding any other provisions of this section, the following provisions shall apply to an eligible customer-generator with a capacity of more than 10 kilowatts, but not exceeding one megawatt, that receives electrical service from a local publicly owned electric utility, as defined in Section 9604, that has elected to utilize a co-energy metering program unless the electric service provider chooses to provide service for eligible customer-generators with a capacity of more than 10 kilowatts in accordance with subdivisions (g) and (h):

(1) The eligible customer-generator shall be required to utilize a meter, or multiple meters, capable of separately measuring electricity flow in both directions. All meters shall provide "time-of-use" measurements of electricity flow, and the customer shall take service on a time-of-use rate schedule. If the existing meter of the eligible customer-generator is not a time-of-use meter or is not capable of measuring total flow of energy in both directions, the eligible customer-generator shall be responsible for all expenses involved in purchasing and installing a meter that is both time-of-use and able to measure total electricity flow in both directions. This subdivision shall

not restrict the ability of an eligible customer-generator to utilize any economic incentives provided by a government agency or the electric service provider to reduce its costs for purchasing and installing a time-of-use meter.

(2) The consumption of electricity from the electric service provider shall result in a cost to the eligible customer-generator to be priced in accordance with the standard rate charged to the eligible customer-generator in accordance with the rate structure to which the customer would be assigned if the customer did not use an eligible solar or wind electrical generating facility. The generation of electricity provided to the electric service provider shall result in a credit to the eligible customer-generator and shall be priced in accordance with the generation component, established under the applicable structure to which the customer would be assigned if the customer did not use an eligible solar or wind electrical generating facility.

(3) All costs and credits shall be shown on the eligible customer-generator's bill for each billing period. In any months in which the eligible customer-generator has been a net consumer of electricity calculated on the basis of value determined pursuant to paragraph (2), the customer-generator shall owe to the electric service provider the balance of electricity costs and credits during that billing period. In any billing period in which the eligible customer-generator has been a net producer of electricity calculated on the basis of value determined pursuant to paragraph (2), the electric service provider shall owe to the eligible customer-generator the balance of electricity costs and credits during that billing period. Any net credit to the eligible customer-generator of electricity costs may be carried forward to subsequent billing periods, provided that an electric service provider may choose to carry the credit over as a kilowatthour credit consistent with the provisions of any applicable tariff, including any differences attributable to the time of generation of the electricity. At the end of each 12-month period, the electric service provider may reduce any net credit due to the eligible customer-generator to zero.

(j) A solar or wind turbine electrical generating system, or a hybrid system of both, used by an eligible customer-generator shall meet all applicable safety and performance standards established by the National Electrical Code, the Institute of Electrical and Electronics Engineers, and accredited testing laboratories such as Underwriters Laboratories and, where applicable, rules of the Public Utilities Commission regarding safety and reliability. A customer-generator whose solar or wind turbine electrical generating system, or a hybrid system of both, meets those standards and rules shall not be required to install additional controls,

perform or pay for additional tests, or purchase additional liability insurance.

(k) If the commission determines that there are cost or revenue obligations for an electric corporation, as defined in Section 218, that may not be recovered from customer-generators acting pursuant to this section, those obligations shall remain within the customer class from which any shortfall occurred and may not be shifted to any other customer class. Net-metering and co-metering customers shall not be exempt from the public benefits charge. In its report to the Legislature, the commission shall examine different methods to ensure that the public benefits charge remains a nonbypassable charge.

(l) A net metering customer shall reimburse the Department of Water Resources for all charges that would otherwise be imposed on the customer by the commission to recover bond-related costs pursuant to an agreement between the commission and the Department of Water Resources pursuant to Section 80110 of the Water Code, as well as the costs of the department equal to the share of the department's estimated net unavoidable power purchase contract costs attributable to the customer. The commission shall incorporate the determination into an existing proceeding before the commission, and shall ensure that the charges are nonbypassable. Until the commission has made a determination regarding the nonbypassable charges, net metering shall continue under the same rules, procedures, terms, and conditions as were applicable on December 31, 2002.

(m) In implementing the requirements of subdivisions (k) and (l), a customer-generator shall not be required to replace its existing meter except as set forth in paragraph (3) of subdivision (b), nor shall the electric service provider require additional measurement of usage beyond that which is necessary for customers in the same rate class as the eligible customer-generator.

(n) On or before January 1, 2005, the commission shall submit a report to the Governor and the Legislature that assesses the economic and environmental costs and benefits of net metering to customer-generators, ratepayers, and utilities, including any beneficial and adverse effects on public benefit programs and special purpose surcharges. The report shall be prepared by an independent party under contract with the commission.

(o) It is the intent of the Legislature that the Treasurer incorporate net energy metering and co-energy metering projects undertaken pursuant to this section as sustainable building methods or distributive energy technologies for purposes of evaluating low-income housing projects.

SEC. 7. Section 2851 is added to Chapter 9 of Part 2 of Division 1 of the Public Utilities Code, to read:

2851. (a) In implementing the California Solar Initiative, the commission shall do all of the following:

(1) The commission shall authorize the award of monetary incentives for up to the first megawatt of alternating current generated by solar energy systems that meet the eligibility criteria established by the State Energy Resources Conservation and Development Commission pursuant to Chapter 8.8 (commencing with Section 25780) of Division 15 of the Public Resources Code. The commission shall determine the eligibility of a solar energy system, as defined in Section 25781 of the Public Resources Code, to receive monetary incentives until the time the State Energy Resources Conservation and Development Commission establishes eligibility criteria pursuant to Section 25782. Monetary incentives shall not be awarded for solar energy systems that do not meet the eligibility criteria. The incentive level authorized by the commission shall decline each year following implementation of the California Solar Initiative, at a rate of no less than an average of 7 percent per year, and shall be zero as of December 31, 2016. The commission shall adopt and publish a schedule of declining incentive levels no less than 30 days in advance of the first decline in incentive levels. The commission may develop incentives based upon the output of electricity from the system, provided those incentives are consistent with the declining incentive levels of this paragraph and the incentives apply to only the first megawatt of electricity generated by the system.

(2) The commission shall adopt a performance-based incentive program so that by January 1, 2008, 100 percent of incentives for solar energy systems of 100 kilowatts or greater and at least 50 percent of incentives for solar energy systems of 30 kilowatts or greater are earned based on the actual electrical output of the solar energy systems. The commission shall encourage, and may require, performance-based incentives for solar energy systems of less than 30 kilowatts. Performance-based incentives shall decline at a rate of no less than an average of 7 percent per year. In developing the performance-based incentives, the commission may:

(A) Apply performance-based incentives only to customer classes designated by the commission.

(B) Design the performance-based incentives so that customers may receive a higher level of incentives than under incentives based on installed electrical capacity.

(C) Develop financing options that help offset the installation costs of the solar energy system, provided that this financing is ultimately repaid in full by the consumer or through the application of the performance-based rebates.

(3) By January 1, 2008, the commission, in consultation with the State Energy Resources Conservation and Development Commission, shall

require reasonable and cost-effective energy efficiency improvements in existing buildings as a condition of providing incentives for eligible solar energy systems, with appropriate exemptions or limitations to accommodate the limited financial resources of low-income residential housing.

(4) Notwithstanding subdivision (g) of Section 2827, the commission shall require time-variant pricing for all ratepayers with a solar energy system. The commission shall develop a time-variant tariff that creates the maximum incentive for ratepayers to install solar energy systems so that the system's peak electricity production coincides with California's peak electricity demands and that assures that ratepayers receive due value for their contribution to the purchase of solar energy systems and customers with solar energy systems continue to have an incentive to use electricity efficiently. In developing the time-variant tariff, the commission may exclude customers participating in the tariff from the rate cap for residential customers for existing baseline quantities or usage by those customers of up to 130 percent of existing baseline quantities, as required by Section 80110 of the Water Code. Nothing in this paragraph authorizes the commission to require time-variant pricing for ratepayers without a solar energy system.

(b) Notwithstanding subdivision (a), in implementing the California Solar Initiative, the commission may authorize the award of monetary incentives for solar thermal and solar water heating devices, in a total amount up to one hundred million eight hundred thousand dollars (\$100,800,000).

(c) (1) In implementing the California Solar Initiative, the commission shall not allocate more than fifty million dollars (\$50,000,000) to research, development, and demonstration that explores solar technologies and other distributed generation technologies that employ or could employ solar energy for generation or storage of electricity or to offset natural gas usage. Any program that allocates additional moneys to research, development, and demonstration shall be developed in collaboration with the Energy Commission to ensure there is no duplication of efforts, and adopted by the commission through a rulemaking or other appropriate public proceeding. Any grant awarded by the commission for research, development, and demonstration shall be approved by the full commission at a public meeting. This subdivision does not prohibit the commission from continuing to allocate moneys to research, development, and demonstration pursuant to the self-generation incentive program for distributed generation resources originally established pursuant to Chapter 329 of the Statutes of 2000, as modified pursuant to Section 379.6.

(2) The Legislature finds and declares that a program that provides a stable source of monetary incentives for eligible solar energy systems will encourage private investment sufficient to make solar technologies cost effective.

(3) On or before June 30, 2009, and by June 30th of every year thereafter, the commission shall submit to the Legislature an assessment of the success of the California Solar Initiative program. That assessment shall include the number of residential and commercial sites that have installed solar thermal devices for which an award was made pursuant to subdivision (b) and the dollar value of the award, the number of residential and commercial sites that have installed solar energy systems, the electrical generating capacity of the installed solar energy systems, the cost of the program, total electrical system benefits, including the effect on electrical service rates, environmental benefits, how the program affects the operation and reliability of the electrical grid, how the program has affected peak demand for electricity, the progress made toward reaching the goals of the program, whether the program is on schedule to meet the program goals, and recommendations for improving the program to meet its goals. If the commission allocates additional moneys to research, development, and demonstration that explores solar technologies and other distributed generation technologies pursuant to paragraph (1), the commission shall include in the assessment submitted to the Legislature, a description of the program, a summary of each award made or project funded pursuant to the program, including the intended purposes to be achieved by the particular award or project, and the results of each award or project.

(d) (1) The commission shall not impose any charge upon the consumption of natural gas, or upon natural gas ratepayers, to fund the California Solar Initiative.

(2) Notwithstanding any other provision of law, any charge imposed to fund the program adopted and implemented pursuant to this section shall be imposed upon all customers not participating in the California Alternate Rates for Energy (CARE) or family electric rate assistance (FERA) programs as provided in paragraph (2), including those residential customers subject to the rate cap required by Section 80110 of the Water Code for existing baseline quantities or usage up to 130 percent of existing baseline quantities of electricity.

(3) The costs of the program adopted and implemented pursuant to this section may not be recovered from customers participating in the California Alternate Rates for Energy or CARE program established pursuant to Section 739.1, except to the extent that program costs are recovered out of the nonbypassable system benefits charge authorized pursuant to Section 399.8.

(e) In implementing the California Solar Initiative, the commission shall ensure that the total cost over the duration of the program does not exceed three billion three hundred fifty million eight hundred thousand dollars (\$3,350,800,000). The financial components of the California Solar Initiative shall consist of the following:

(1) Programs under the supervision of the commission funded by charges collected from customers of San Diego Gas and Electric Company, Southern California Edison Company, and Pacific Gas and Electric Company. The total cost over the duration of these programs shall not exceed two billion one hundred sixty-six million eight hundred thousand dollars (\$2,166,800,000) and includes moneys collected directly into a tracking account for support of the California Solar Initiative and moneys collected into other accounts that are use to further the goals of the California Solar Initiative.

(2) Programs adopted, implemented, and financed in the amount of seven hundred eighty-four million dollars (\$784,000,000), by charges collected by local publicly owned electric utilities pursuant to Section 387.5. Nothing in this subdivision shall give the commission power and jurisdiction with respect to a local publicly owned electric utility or its customers.

(3) Programs for the installation of solar energy systems on new construction, administered by the State Energy Resources Conservation and Development Commission pursuant to Chapter 8.6 (commencing with Section 25740) of Division 15 of the Public Resources Code, and funded by nonbypassable charges in the amount of four hundred million dollars (\$400,000,000), collected from customers of San Diego Gas and Electric Company, Southern California Edison Company, and Pacific Gas and Electric Company pursuant to Article 15 (commencing with Section 399).

SEC. 8. The Contractors' State License Board shall review and, if needed, revise its licensing classifications and examinations to ensure that contractors authorized to perform work on solar energy systems subject to Chapter 8.8 (commencing with Section 25780) of Division 15 of the Public Resources Code, have the requisite qualifications to perform the work.

SEC. 9. No reimbursement is required by this act pursuant to Section 6 of Article XIII B of the California Constitution because a local agency or school district has the authority to levy service charges, fees, or assessments sufficient to pay for the program or level of service mandated by this act, within the meaning of Section 17556 of the Government Code.