

# CSI Incentive Calculator User Guide

## 1. Guide Overview

This User Guide provides background on the California Solar Initiative (CSI) Incentive Calculator, describes how the calculator determines the CSI incentives for a proposed system and detailed step by step instructions on its use. The calculator is web-accessible at <http://www.csi-epbb.com>.

The CSI-EPBB calculator is a tool available to participants of the CSI Program to determine the EPBB Design Factor and calculate an appropriate incentive level based on a reasonable expectation of performance for an individual system. The CSI-EPBB Calculator has also been created for consumer's to educate themselves on the differences of solar system design and how changes to the PV system's specifications will produce different kilowatt hour results over the course of a year. Please be aware that actual performance of an installed PV system is based on numerous factors, including some factors that may not be considered in the CSI-EPBB Calculator. While this calculator relies on industry-standard assumptions, and is driven by NREL's PV Watts v. 2 calculator (<http://www.nrel.gov/rredc/pvwatts/version2.html>), there may be other factors that affect the output of your PV System.

Senate Bill 1 (SB 1) directed 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. These guidelines may be found online at the Go Solar California website (<http://www.gosolarcalifornia.org/equipment/index.html>). The solar energy system component and design standards were mandated to be implemented no later than July 1, 2009. This User Guide provides information specific to the version of the CSI calculator that is compatible with these guidelines, and is identified by the header:

**Incentive Calculator - CSI Standard PV**

## 2. CSI Eligibility

Eligible photovoltaic (PV) projects must be located within sites where the Host Customer is a Pacific Gas & Electric (PG&E), Southern California Edison (SCE) or San Diego Gas & Electric (SDG&E) retail electric customer.<sup>1</sup> Systems between 1 kW and 5,000 kW are eligible to participate in CSI, however incentives are paid on the first 1,000 kW of installed capacity. Proposed systems that have a CEC-AC<sup>2</sup> rating less than 30 kW are

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<sup>1</sup> Note that the California Center for Sustainable Energy (CCSE) is the Program Administrator for CSI in SDG&E's service territory.

<sup>2</sup> The CEC-AC rating is the product of the number of PV panels, the PTC rating per panel and the inverter efficiency.

eligible for Expected Performance Based Buy down (EPBB) incentives. All systems are eligible for Performance Based Incentives (PBI).

All customer classes are eligible for CSI except for residential new construction systems which must apply to the New Solar Home Partnership (NSHP) program. NSHP details may be found at <http://www.gosolarcalifornia.ca.gov/nshp/>. The CSI calculator is currently not applicable to systems applying to the NSHP.

Program eligibility details can be found at the Go Solar California and CSI Program Administrators' websites listed below

- Go Solar California <http://www.gosolarcalifornia.ca.gov/>
- PG&E <http://www.pge.com/csi>
- SCE <http://www.sce.com/csi>
- CCSE <http://energycenter.org/index.php/incentive-programs/california-solar-initiative>

Municipal electric utility customers are not eligible to receive incentives from the above designated program administrators.

### 3. CSI Incentive Calculator Overview

The CSI calculator is an internet accessible tool (<http://www.csi-epbb.com>) used to determine the Design Factor and the resulting EPBB or PBI incentive for eligible CSI proposed systems.<sup>3</sup>

The calculator determines the CSI incentive for a single type of PV panel and inverter combination. The incentive for multiple units of the same type of PV panel and/or inverter can be accommodated by the calculator in a single calculation. Mixed systems that use different types of inverters, PV panels, tilts and/or azimuths require individual incentive calculations for each combination and the incentives summed. More details on mixed system CSI incentive calculation can be found in Section 6 of this guide.

When first opened, the calculator has an input page, where the user inputs the zip code location of the system, the customer's electric utility, type of customer, incentive type, the type and number of PV modules, mounting method, the type and number of inverters, and the proposed system's tilt and azimuth.

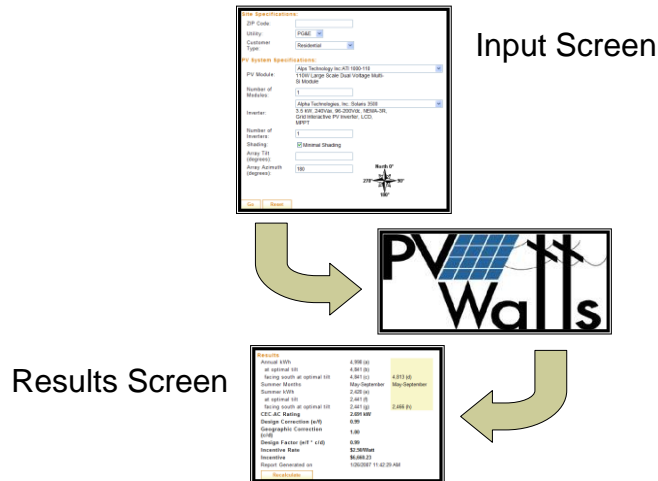
Once all required data is entered, the user initiates the calculator by pressing the "GO" button. The calculator then calls the National Renewable Energy Laboratory's (NREL's) PV Watts version 2 (PV Watts) performance calculator passing to it information on the proposed system and its location. The PV Watts model returns to the calculator the monthly electric energy production of the proposed PV system.

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<sup>3</sup> Note that CSI calculator PBI results are used by the Program Administrator to set-aside funds for future PBI payments. The CSI PBI results are not a guarantee of payment. PBI payments are based on the actual metered output of the proposed system.

The calculator then uses the PV Watts results to determine the resulting CSI incentive for the proposed system.

The overall process is illustrated below.



The user can press the “Recalculate” button, found at the bottom of the results screen, to return to the input page and make adjustments to their original inputs.

## 4. Required Calculator Inputs

The CSI calculator is configured to calculate the incentive for a single PV panel type, inverter type with one tilt and azimuth. For example if a system utilizes two different inverter models, but the same type of PV panel, the calculator must be run twice. More details on mixed system EPBB incentive calculation can be found in Section 6 of this guide.

The inputs for the CSI EPBB Design Factor calculator are described below.

**ZIP Code:** This is the zip code of the location of the proposed PV system. Note that this zip code must be located within the specified utility’s service territory where the system is or will be located.

**Utility:** This is the utility in whose service territory the proposed PV system is or will be located. Note that the zip code inputted must be located within the specified utility’s service territory.

**Customer Type:** Select the customer classification associated with the Host Customer. For definitions of the various customer types, refer to the latest California Solar Initiative Program Handbook.

**Incentive Type:** Select the incentive type, EPBB or PBI, being sought for the proposed system.<sup>4</sup> Proposed systems that have a CEC-AC rating less than 50 kW are eligible for EPBB incentives. All systems are eligible for PBI. The incentive type changes how the calculator determines the incentive and changes the format of the results report.

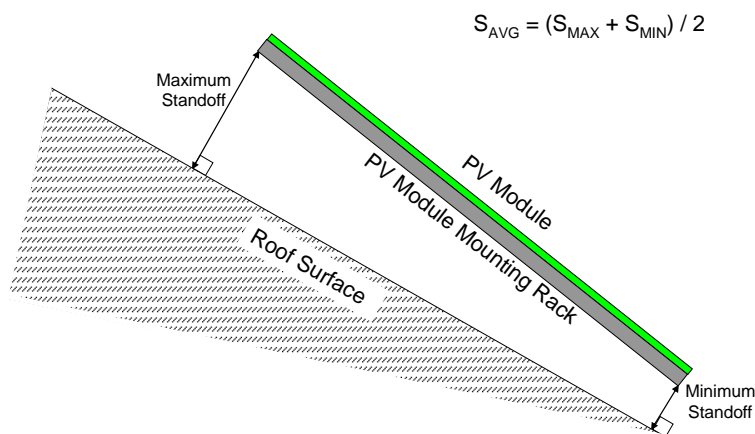
**PV Module:** Select the module that will be used in the proposed PV system. The options in this pull-down are based on the CEC's list of eligible photovoltaic modules, which can be found at [http://www.consumerenergycenter.org/cgi-bin/eligible\\_pvmodules.cgi](http://www.consumerenergycenter.org/cgi-bin/eligible_pvmodules.cgi). If multiple module types are to be used, you must make multiple CSI calculator runs.

**Number of Modules:** This is the total number of PV modules of the selected type that will be connected to the inverter(s) that are selected below.

**Mounting Method:** This is the “average standoff” between the mounting surface and bottom of the PV module frame or mounting rack, which ever is closest to the mounting surface. The selections are –

- *0" average standoff (flush mount or BIPV)* – Where the PV mounting rack is in direct contact with the mounting surface or the PV modules lack outdoor air ventilation.
- *> 0" to 1" average standoff* – The average standoff is 1" or less
- *> 1" to 3" average standoff* – The average standoff is 3" or less, but greater than 1"
- *> 3" to 6" average standoff* – The average standoff is 6" or less, but greater than 3"
- *> 6" average standoff* – The average standoff is greater than 6"

“Average standoff” ( $S_{AVG}$ ) is the sum of the minimum and maximum standoff divided by two. Standoff is the distance perpendicular from the mounting surface to the bottom of the PV module frame. One minimum and maximum standoff distance must be established per array. See illustration below.



<sup>4</sup> Refer to the latest CSI Program Handbook for incentive type definitions and detailed eligibility requirements.

**Inverter:** This is the type of inverter that will be used with the proposed PV system. The options in this pull-down are based on the CEC's list of eligible inverters found at [http://www.consumerenergycenter.org/cgi-bin/eligible\\_inverters.cgi](http://www.consumerenergycenter.org/cgi-bin/eligible_inverters.cgi). If multiple inverter types are to be used, you must make multiple CSI calculator runs. Also, if the CEC-AC rating of the proposed system is greater than 125% of the inverter rating, an error is flagged which must be corrected (by reducing the number of panels, choosing a lower PTC rated panel, increasing the number of inverters or choosing a larger capacity inverter) before being allowed to proceed to the results page. See description of "CEC-AC Rating" in Section 5 of this guide for more discussion on oversized systems.

**Number of Inverters:** This is the total number of inverters of the selected type that will be installed for use with the PV modules selected above.

**Minimal Shading:** This criterion, if checked, indicates that no solar obstruction is closer than a distance twice the height it extends above the PV modules. If this criterion is met and Minimal Shading is checked, no derating due to shading is applied. Note that the reference optimal systems at the proposed and reference locations are always specified to meet the "Minimum Shading Criteria".

**Shading Derate Factors (%):** If the proposed system does not meet the "Minimum Shading Criteria", the user is required to input monthly non-shaded results from a shading study conducted at the proposed system site. If the Minimal Shading box is unchecked, a table form will appear where the user is to input each month's non-shaded results from the shading study. See Section 7 for more details on obtaining and inputting the shading derate factors. The reference optimal system is specified to meet the "Minimum Shading Criteria" and thus has no derating of its monthly output due to shading.

**Tracking (PBI Only):** The calculator can accommodate single axis or double axis tracking systems that are applying for PBI. Tracking systems are eligible to apply for EPBB incentives but will be treated as fixed systems for purposes of calculating the eligible incentive.

**Array Tilt (degrees):** This is the proposed system tilt from horizontal. Flat (horizontal) systems have a 0° tilt. For single axis tracking systems (PBI Only), this is the tilt of the axis of rotation. This input is not used for double axis tracking systems.

**Array Azimuth (degrees):** This is the horizontal direction ("true" north-south) the proposed system is pointing; due South is 180° azimuth and due North is 0° azimuth. For single axis tracking systems (PBI Only), this is the direction that the axis of rotation is facing. This input is not used for double axis tracking systems. The optimal reference system for proposed flat (horizontal) systems is assumed to have a 180° azimuth. Magnetic direction measured by a compass can be converted to "true" direction by adding the appropriate magnetic declination for the specific location. Magnetic declination can be determined at the NOAA website (<http://www.ngdc.noaa.gov/geomagmodels/Declination.jsp>).

After the inputs are set, the user can click the “GO” button and the calculations will be executed. If an input error is detected, the calculator will refresh the input page and note the error with a comment at the bottom and an asterisk next to the field containing the error. The error must be corrected before the calculator will proceed to the results output page.

## 5. Description of the Outputs

Once the calculator has completed its computations, it will display a results page containing inputs (Site Specifications and PV System Specifications) and outputs (Results) for the proposed and reference optimal system, as well as the Design Factor and calculated incentive. If the user wishes to apply to the CSI program, they must include a hardcopy of the CSI Calculator results screen in their application materials.

All production estimates are obtained from running NREL’s PV Watts v2 photovoltaic performance model using the proposed system parameters and weather data for the proposed and reference locations.

The outputs are described below. Note that there are differences in what results are reported for EPBB versus PBI incentives.

### ***EPBB Incentives***

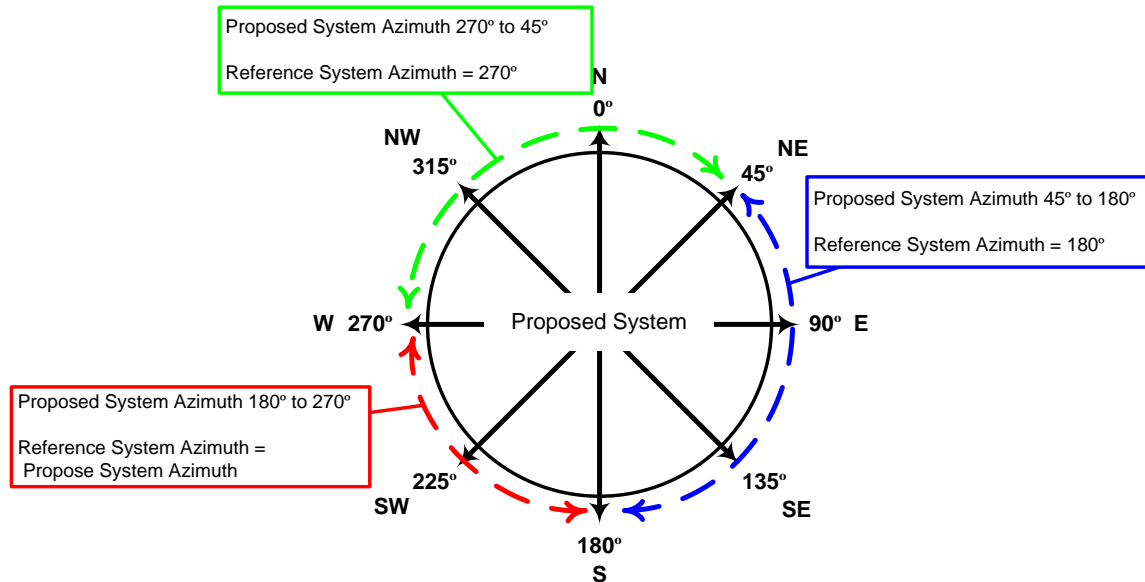
**PV Module:** Lists the specified PV module name and module DC rating per panel; STC, PTC and PTC<sub>adj</sub>. The PTC<sub>adj</sub> rating is not reported on the CEC website and is not equivalent to the PVUSA Test Conditions. It is calculated depending on the mounting method, NOCT and power temperature coefficient for that specific module. See Appendix A of this User Guide for a detailed description of the modified PTC calculation.

**DC Rating (kW STC):** This is the calculated total DC STC rated capacity of the PV modules and is calculated by multiplying the STC module rating by the number of panels. This capacity is used as an input to PV Watts to determine the performance of the system.

**DC Rating (kW PTC):** This is the calculated total DC PTC rated capacity of the PV modules and is calculated by multiplying the PTC module rating by the number of panels. This capacity is used to calculate the CEC-AC rating of the system.

**Estimated Monthly Production:** The estimated monthly kWh production of the proposed system is displayed along with the estimated production of one or two systems at optimal tilt. If the reference system (below) has an azimuth other than 180°, the chart will include optimal tilt systems at both the reference azimuth and 180° (south facing). Note that the sum of the monthly values may not equal the annual kWh that is displayed due to rounding issues.

**Optimal Tilt (proposed azimuth):** This is the system's optimal tilt, maximizing summer output, at the proposed location. The optimal tilt also depends on the azimuth of the optimal reference system. The following illustrates how the reference system azimuth is set to equally treat south and west facing proposed systems.



**Optimal Tilt (facing south):** This is the tilt of summer optimal south facing systems at the proposed and reference locations.

**Annual kWh:** This is the estimated annual energy output of the proposed system. This value is reported for the sole purpose of transparency of the calculator and is not a guarantee of future system performance.

**at optimal tilt:** This is the estimated annual energy output of the summer optimized system at the proposed location. This value is reported for the sole purpose of transparency of the calculator.

**facing south at optimal tilt:** This is the estimated annual energy output of south facing summer optimized systems at the proposed and reference locations. These values are used to determine the Geographic Correction.

**Summer Months:** These are the months that define the summer period. The proposed and reference optimal system output for these months is used to determine the "Summer kWh".

**Summer kWh:** This is the estimated summer energy output of the proposed system.

**at optimal tilt:** This is the estimated summer energy output of the proposed system, optimized to maximize summer output.

**facing south at optimal tilt:** This is the estimated summer energy output of the proposed and reference location systems, both optimized to maximize summer output.

**CEC-AC Rating:** This is the product of the PV module PTC rating, module count and inverter efficiency. If the CEC-AC rating exceeds the rated capacity of the inverter by no more than 125%, a warning is displayed on the results page. This warning is only informational and does not prevent the user from proposing the system in a CSI application.<sup>5</sup>

**Design Correction:** This is the ratio of the Summer Output of the Proposed System and the Summer Output of the Optimal System at the Proposed Location. It indicates how well optimized the proposed system is configured.

**Geographic Correction:** This is the ratio of the annual output of the summer optimal south facing system at the proposed location and the annual output of the summer optimal south facing system at the reference location. It indicates how well a PV system installed at the proposed location performs relative to the reference location. Note that this ratio is capped at 1.0.

**Installation Correction:** This is the ratio of  $PTC_{adj}$  and PTC of the proposed system. The PTC is the DC rating of the panels at PVUSA Test Conditions and is listed on the CEC eligible equipment website. The  $PTC_{adj}$  rating is not reported on the CEC eligible equipment website and is not equivalent to the PVUSA Test Conditions. It is calculated depending on the mounting method, NOCT and power temperature coefficient for that specific module. See Appendix A of this User Guide for a detailed description of the modified PTC calculation. It accounts for the effects of mounting method on cell temperature and resulting power output. Note that this ratio is capped at 1.0.

**Design Factor:** This is the product of the Design Correction, Geographic Correction and Installation Correction. This Design Factor is used in the EPBB incentive calculation.

**Incentive Rate:** This is the current CSI EPBB incentive rate (\$/W) and depends on the selected utility and customer type. It is obtained directly from the CSI Trigger Tracker located at [www.csi-trigger.com](http://www.csi-trigger.com).

**Incentive:** This is the total incentive for the proposed system.

**Report Generated on:** is a date and time stamp to document when the report run occurred.

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<sup>5</sup> Some inverters allow operation above their rated capacity, to a degree, for at least short periods limited by their operating temperature and amperage carrying capability. In addition, some PV systems will not achieve their CEC-AC rating in the field due to local weather conditions and system configuration. Allowing proposed oversized systems, up to 125% of inverter rated capacity, to calculate an EPBB incentive does not guarantee eligibility. The CSI Program Administrators reserve the right to seek justification for proposed oversized systems which may result in poor reliability due to mis-matched equipment.



## ***PBI Incentive Calculator Outputs (Differences from EPBB Outputs Only)***

**Estimated Monthly Production:** The PBI calculator does not calculate any reference systems. The chart of estimated monthly production will only show the results for the proposed system. Unlike EPBB systems that use a reference point to compare against the proposed system, PBI incentives are paid via actual production therefore negating the need for a reference point. Note that the sum of the monthly values may not equal the annual kWh that is displayed due to rounding issues.

**Capacity Factor:** This is the estimated annual output of the proposed system divided by the product of 8760 annual hours and the proposed system's CEC-AC rating.

**Prevailing Capacity Factor:** This is 18% for incentive steps 2 and 3 and 20% for incentive steps 4 through 10.

**Design Factor:** This is the ratio of the Capacity Factor and the Prevailing Capacity Factor. This Design Factor is not used to directly calculate the PBI incentive amount. The Program Administrators use it to modify the CEC-AC rating of the system for incentive trigger tracking purposes.

**Incentive Rate:** This is the current CSI PBI incentive rate (\$/kWh) and depends on the selected utility and customer type. It is obtained directly from the CSI Trigger Tracker located at [www.csi-trigger.com](http://www.csi-trigger.com).

**Incentive:** This is the estimated total incentive for the proposed system, and is calculated as the estimated annual output times the incentive rate times 5 years. The incentive paid will be based on the actual production of the installed system.

## **6. Multiple Arrays, Module or Inverter Types**

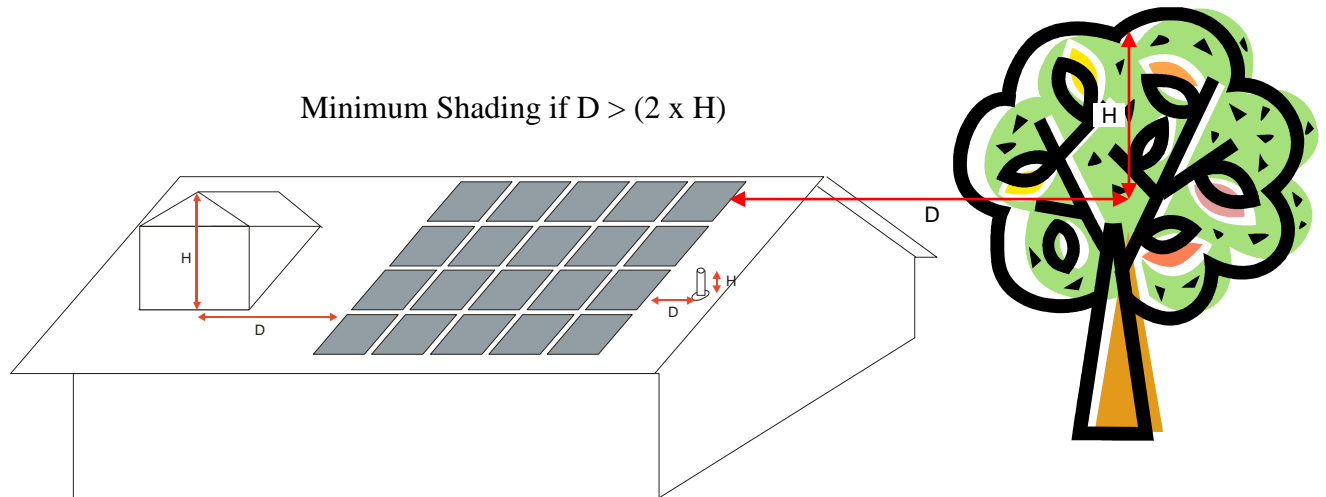
If a proposed system consists of PV arrays with different azimuths and tilts or if different PV module or inverter types will be installed as part of a PV system, a CSI calculator run must be done for each configuration and the resulting incentives totaled.

For example, a system with 30 PV panels type "A" with the same tilt and azimuth, and 2 inverters of type "Z" is proposed; only one calculator run has to be made for this type of system.

However, if a single system with 15 panels of type "A" and 15 panels of type "B", with 1 inverter of type "Z" is proposed, the user must make one calculator run with 15 "A" panels and 1 "Z" inverter and a second calculator run with 15 "B" panels and 1 "Z" inverter. The incentives from the two runs must then be added together.

## 7. Shading Input Requirements

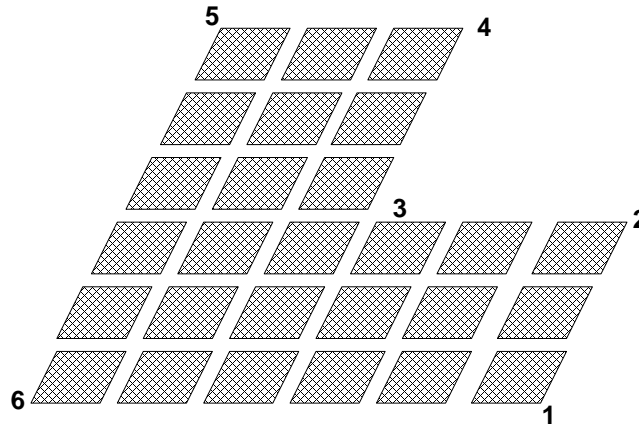
Proposed systems meet the “Minimum Shading Criteria” if any surrounding object is no closer than a distance twice the height it extends above the PV modules (see illustration below). If this criterion is met and Minimal Shading is checked, no derating due to shading is applied.



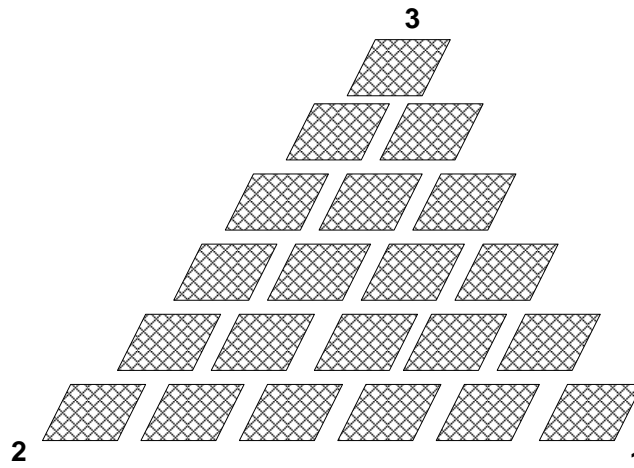
For systems that do not meet the “Minimum Shading Criteria”, the user is required to input monthly shade impact results from a shading study conducted at the proposed system site. The study must use a shade analysis tool (and accompanying software) such as the Solar Pathfinder (<http://www.solarpathfinder.com>) or the Solmetric SunEye™ (<http://www.solmetric.com>). These inputs are used as monthly derate factors (100% = no shading, 0% = total shading) to adjust the PV Watts output for shading. The shade analysis tool must be specific to the location, azimuth and tilt of the system being measured and must correct for magnetic declination. Do not use a shade analysis tool that is only applicable to south facing systems if your system’s azimuth is different than 180°. Please reference the shade analysis tool documentation for more instructions on their use and interpretation.

The shading study must consist of shading measurements taken at of the system array’s major corners with no adjacent measurement being more than 40 feet apart, and the average monthly derate factors input into the calculator. Additional measurements must be taken along any edge that is longer than 40 feet. The points of measurement shall be distributed evenly between two major corners if they are more than 40 feet apart such that the linear distance between any sequential points is no more than 40 feet. However, if any linear edge of the array has no obstructions that are closer than two times the height they project above the lowest point on the array, then the intermediate measurements along that edge do not need to be made.

For rectangular areas, a minimum of four shading measurements must be taken, one at each corner. For irregular areas, a shading measurement is taken at each corner as shown below.



It is not necessary to take measures at each panel corner, for example, in the case of staggered panels. Shade measurements should be made at the major corners of the array as shown below.



It is critical that the positions of the shade measurements are documented and communicated to the CSI field inspector so they may duplicate the measurement. The measurement locations must be accessible after the PV system has been installed for purposes of field verification by the CSI Program Administrators. It is the applicant’s responsibility to document the study.

## 8. EPBB Incentive & Design Factor Computation Details

The EPBB incentive is calculated with the following formula.

$$\text{EPBB Incentive} = \text{Incentive Rate} \times \text{System Rating} \times \text{Design Factor}$$

Where,

**EPBB Incentive** – is the monetary incentive paid upfront.

**Incentive Rate** – is the maximum EPBB incentive rate (\$/Watt) available at the time of application. The table below presents the EPBB incentive rate schedule.

**Maximum EPPB Payment Amounts**

MW Step	MW per step	EPBB payments (per watt)		
		Residential	Non-Residential	
			Commercial	Government/ Non-Profit
1	50	n/a	n/a	n/a
2	70	\$2.50	\$2.50	\$3.25
3	100	\$2.20	\$2.20	\$2.95
4	130	\$1.90	\$1.90	\$2.65
5	160	\$1.55	\$1.55	\$2.30
6	190	\$1.10	\$1.10	\$1.85
7	215	\$0.65	\$0.65	\$1.40
8	250	\$0.35	\$0.35	\$1.10
9	285	\$0.25	\$0.25	\$0.90
10	350	\$0.20	\$0.20	\$0.70

**System Rating** – is the product of the PV module PTC rating, module count and inverter efficiency.

**Design Factor** – is a factor used to modify the maximum incentive rate based on the proposed system’s estimated performance relative to an optimal system at the proposed location, an optimal system at a reference location and a well ventilated module installation. This is the product of the Design Correction (Dcorr), Geographic Correction (Gcorr) and Installation Correction (Icorr). Dcorr is the ratio of the estimated summer kWh production for the proposed system at the proposed location and the estimated summer kWh production for a summer optimal system at the proposed location. Gcorr is the ratio of the estimated annual kWh production for a summer optimal system at the proposed location and the estimated annual kWh production for a summer optimal system at a reference location. Icorr is the ratio of PTC<sub>adj</sub> and PTC ratings of the proposed system. The PTC<sub>adj</sub> is calculated depending on the mounting method, NOCT and power temperature coefficient for that specific module.

The Design Factor (DF) calculation is -

$$DF = Dcorr * Gcorr * Icorr$$

$$Dcorr \text{ (Design Correction)} = S_{s,p,p} / S_{s,p,o}$$

$S_{s,p,p}$  = The system's estimated summer kWh output at the proposed location, with proposed tilt & azimuth

$S_{s,p,o}$  = The system's estimated summer kWh output at the proposed location, with summer optimized tilt & azimuth allowing for equal treatment of proposed systems oriented from South to West (i.e. the optimized system's orientation shall be the same as the proposed system for orientations due south to due west).

$$G_{corr} \text{ (Geographic Correction)} = A_{s,p,o} / A_{s,r,o}$$

$A_{s,p,o}$  = The system's estimated annual kWh output at the proposed location, with summer optimized tilt & south azimuth

$A_{s,r,o}$  = The system's estimated annual kWh output at the reference location, with summer optimized tilt & south azimuth

$$I_{corr} \text{ (Installation Correction)} = PTC_{adj} / PTC$$

$PTC_{adj}$  = The adjusted PTC DC rating accounting for mounting method, NOCT and power temperature coefficient for that specific module. See Appendix A of this User Guide for a detailed description of the modified PTC calculation.

$PTC$  = The DC rating of the panels at PVUSA Test Conditions.

In addition, the calculator has these characteristics and features,

- The Summer Period is defined as May 1 through October 31. This encompasses the summer periods as defined by the three California investor-owned electric utilities.
- All estimated kWh outputs are determined from NREL's PV Watt v2 performance model.
- $G_{corr}$  is capped at 1.0 to prevent areas with higher performance than the reference location from obtaining incentives larger than the maximum incentive rate.
- All systems oriented between 180° and 270° are treated equally.
- The "optimal reference orientation tilt" is optimized for summer production corresponding to the different acceptable compass directions from 180° to 270°.
- Location-specific criteria which account for weather variation and varying degrees of solar insolation, based on local climate and geography.

- An “optimal reference latitude tilt” that relates to local latitude.

## 9. PBI Incentive Computation Details

The PBI incentive is calculated with the following formula.

$$\text{PBI Incentive} = \text{Incentive Rate} \times \text{Est. Annual Output} \times \text{Five Years}$$

Where,

**PBI Incentive** – is the total estimated monetary incentive paid monthly over a five year period. Note that this estimate is used by the Program Administrators to set-aside funds for future payments. It is not a guarantee of payment. Actual payments are based on the metered output of the PV system, which may vary significantly from the PBI Incentive estimate provided by the calculator.

**Incentive Rate** – is the PBI incentive rate (\$/kWh) available at the time of application. The table below presents the PBI incentive rate schedule.

**PBI Payment Amounts**

MW Step	MW per step	PBI payments (per kWh)		
		Residential	Non-Residential	
			Commercial	Government Non-Profit
1	50	n/a	n/a	n/a
2	70	\$0.39	\$0.39	\$0.50
3	100	\$0.34	\$0.34	\$0.46
4	130	\$0.26	\$0.26	\$0.37
5	160	\$0.22	\$0.22	\$0.32
6	190	\$0.15	\$0.15	\$0.26
7	215	\$0.09	\$0.09	\$0.19
8	250	\$0.05	\$0.05	\$0.15
9	285	\$0.03	\$0.03	\$0.12
10	350	\$0.03	\$0.03	\$0.10

**Annual kWh:** This is the estimated annual energy output of the proposed system. This value is not a guarantee of future system performance.

## 10. Calculator Interaction with PV Watts v2

The CSI EBPP calculator utilizes NREL’s PV Watts v2 to estimate the performance of proposed and optimal systems. PV Watts v2 calculates electrical energy produced by a grid-connected photovoltaic (PV) system. PV Watts v2 uses hourly Typical Meteorological Year (TMY) weather data and a PV performance model based on Sandia National Laboratories' PVFORM to estimate monthly and annual AC energy production

(kWh). PV Watts v2 extends the capabilities of PV Watts v1 by incorporating NREL's 40 km resolution solar resource data to permit site-specific calculations.

PV Watts v2 calculates performance using hourly data for a nearby TMY2 site that is climatologically similar, and then the output is adjusted based on differences between the TMY2 site and the grid cell with respect to the solar resource (direct, diffuse horizontal, and global horizontal radiation) and daily maximum temperature.

PV Watts v2 has a number of default derate factors that it includes to account for various system losses. The CSI calculator assumes a fixed set of losses in the proposed and optimal systems totaling 16.3%, which is the default in PV Watts v2. These derate factors include –

<b>PV Watts Default Derate Factors for AC Power Rating at STC</b>		
<b>Component Derate Factors</b>	<b>PVWATTS Default</b>	<b>Range</b>
PV module nameplate DC rating	0.95	0.80 - 1.05
Inverter and Transformer	User Input	0.88 - 0.96
Mismatch	0.98	0.97 - 0.995
Diodes and connections	0.995	0.99 - 0.997
DC wiring	0.98	0.97 - 0.99
AC wiring	0.99	0.98 - 0.993
Soiling	0.95	0.30 - 0.995
System availability	0.98	0.00 - 0.995
Shading	1.00	0.00 - 1.00
Sun-tracking	1.00	0.95 - 1.00
Age	1.00	0.70 - 1.00

Reference: [http://rredc.nrel.gov/solar/codes\\_algs/PVWATTS/system.html](http://rredc.nrel.gov/solar/codes_algs/PVWATTS/system.html)

Note that the CSI Incentive calculator adopts these factors as defaults except for “Inverter and Transformer”. The CSI calculator uses the proposed inverter efficiency specified by the user. A detailed discussion of appropriate derate factors can be found at <http://www.nrel.gov/docs/fy05osti/37358.pdf>.

NREL reports that PV Watts v2 results may vary due to weather patterns and other uncertainties associated with the weather data and the model used to model the PV performance. The variations may be as much as  $\pm 20\%$  when compared to individual years. Compared to long-term performance over many years, the values in the table are accurate to within 10% to 12%. NREL also cautions that the energy production values in the table are valid only for crystalline silicon PV systems. In addition to these uncertainties, PV Watts v2 utilizes NREL's 40 km resolution solar resource data to permit site-specific calculations. However, if the locations are within the same 40 km x

40 km geographical cell area, this may result in the same system production for different locations, even though it may appear that local weather patterns would dictate that they should be different.

Detailed information on PV Watts v2 and how it works may be found at –

[http://rredc.nrel.gov/solar/codes\\_algs/PVWATTS/moreabout.html](http://rredc.nrel.gov/solar/codes_algs/PVWATTS/moreabout.html) - Overview of NREL's PV Watts calculator.

[http://rredc.nrel.gov/solar/codes\\_algs/PVWATTS/system.html](http://rredc.nrel.gov/solar/codes_algs/PVWATTS/system.html) - Discussion of PV Watts' parameters.

[http://rredc.nrel.gov/solar/codes\\_algs/PVWATTS/pvwatts2.pdf](http://rredc.nrel.gov/solar/codes_algs/PVWATTS/pvwatts2.pdf) - Paper discussing how PV Watts v2 incorporates NREL's 40 km resolution solar resource data to permit site-specific calculations.

[http://rredc.nrel.gov/solar/codes\\_algs/PVWATTS/interp.html](http://rredc.nrel.gov/solar/codes_algs/PVWATTS/interp.html) - Discussion of interpreting the results.

[http://rredc.nrel.gov/solar/codes\\_algs/PVWATTS/revhist.html](http://rredc.nrel.gov/solar/codes_algs/PVWATTS/revhist.html) - Lists the revision history for PV Watts

## **11. Getting Help & Providing Comments**

Questions and comments regarding the CSI EPBB Design Factor Calculator or this User Guide should be emailed to [CSI-EPBB@aesc-inc.com](mailto:CSI-EPBB@aesc-inc.com). Questions will be addressed on a first-come first-served basis.



## Appendix A – CSI Calculator Modifications for BIPV

On September 26, 2007, a compliance filing was made by CCSE on behalf of the CSI Program Administrators setting forth revised EPBB calculation methodology incorporating BIPV system data. This filing included a detailed explanation of the modified calculation methodology.

R.06-03-004

BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking Regarding Policies,  
Procedures and Rules for the California Solar Initiative,  
the Self-Generation Incentive Program and Other  
Distributed Generation Issues.

RULEMAKING 06-03-004  
(Filed March 2, 2006)

**Compliance Filing in Response to Ordering Paragraph No. 3 of Decision 07-08-007, *Opinion Modifying Decision (D.) 06-08-028 and D.06-12-033 regarding Building Integrated Photovoltaic Systems and the Incentive Adjustment Mechanism***

California Center for Sustainable Energy

September 26, 2007

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R.06-03-004

**BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA**

Order Instituting Rulemaking Regarding Policies,  
Procedures and Rules for the California Solar Initiative,  
the Self-Generation Incentive Program and Other  
Distributed Generation Issues.

RULEMAKING 06-03-004  
(Filed March 2, 2006)

**Compliance Filing in Response to Ordering Paragraph No. 3 of Decision  
07-08-007, *Opinion Modifying Decision (D.) 06-08-028 and D.06-12-033*  
regarding *Building Integrated Photovoltaic Systems and the Incentive  
Adjustment Mechanism***

The California Center for Sustainable Energy (CCSE), formerly known as the San Diego Regional Energy Office (SDREO), on behalf of the California Solar Initiative (CSI) Program Administrators (PAs), hereby files the report of Alternative Energy Systems Consulting, Inc., titled, "CSI EPBB Calculator Modifications for BIPV Systems", attached herein as Attachment A. This filing is in compliance with Ordering Paragraph No. 3 of Decision (D.) 07-08-007, *Opinion Modifying Decision (D.) 06-08-028 and D.06-12-033 regarding Building Integrated Photovoltaic Systems and the Incentive Adjustment Mechanism*.

The report provides the Commission with the modifications to the CSI EPBB calculator, and supporting rationale to implement those modifications, necessary to accommodate Building Integrated Photovoltaic (BIPV) systems within the CSI program.

Respectfully Submitted,



Andrew McAllister  
Director of Operations  
California Center for Sustainable Energy

Dated September 26, 2007

CSI PAs' Compliance Filing 09-26-07


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R.06-03-004

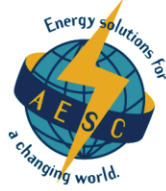
**CERTIFICATE OF SERVICE**

I hereby certify that I have this day served a copy of this Compliance Filing in response to Ordering Paragraph No. 3 of Decision (D.) 07-08-007, *Opinion Modifying Decision (D.) 06-08-028 and D.06-12-033 regarding Building Integrated Photovoltaic Systems and the Incentive Adjustment Mechanism* on all known parties of record in this proceeding by delivering a copy via email to the current service list.

Executed on September 26, 2007, in San Diego, CA.



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September 25, 2007

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**Subject:** CSI EPBB Calculator Modifications to Accommodate BIPV

Dear CSI Program Administrators,

Per Commission order<sup>1</sup>, the attached report (see Attachment A) describes the modifications to the CSI EPBB calculator, and supporting rationale to implement those modifications, necessary to accommodate BIPV systems within CSI.

These modifications were developed in collaboration with Bill Marion, National Renewable Energy Laboratory.

Sincerely,

A handwritten signature in black ink that reads 'Ronald K. Ishii'.

Ronald K. Ishii, P.E.  
Vice President

Cc Smita Gupta, CEC  
Bill Marion, NREL

<sup>1</sup> CPUC Decision 07-08-007, August 23, 2007, Ordering Paragraph #3.

ATTACHMENT A

## CSI EPBB Calculator Modifications for BIPV Systems

Alternative Energy Systems Consulting, Inc.

September 17, 2007

### Background

The CSI EPBB calculator is a web-accessible tool (<http://www.csi-epbb.com>) used to determine the Design Factor and the resulting EPBB incentive for eligible CSI proposed systems. It has been in use since CSI program start, January 1, 2007.

The current version of the calculator works as follows.

1. When first opened, the calculator has an input page, where the user inputs the zip code location of the system, the applicable utility, the type and number of PV panels, the type and number of inverters; the proposed system's tilt and azimuth.
2. Once all required data is entered, the user initiates the calculator by pressing the "GO" button. The calculator then calls the National Renewable Energy Laboratory's PV Watts version 2 (PV Watts) performance calculator passing to it information on the proposed systems size (STC DC Watts) and its location. The PV Watts model returns to the calculator the monthly electric energy production of the proposed PV system.
3. The calculator then uses the PV Watts results to determine the Design Factor and the resulting EPBB incentive for the proposed system.

The following sections describe the proposed modifications to the CSI EPBB calculator so BIPV systems can be accommodated.

### Inputs

In order to accommodate BIPV, a "mounting method" field will be added to the EPBB calculator input page. This field will be a pull down list of installation methods, expressed as distances from the building surface to the PV modules; rack mounted, 6" standoff mount, 3" standoff mount, 1" standoff mount and direct mounted (BIPV).

### PV Watts Interaction

To account for BIPV, the EPBB calculator will utilize two additional inputs to PV Watts. The first of these, INOCT, is the nominal operating cell temperature (NOCT) of the PV module, modified to account for the installation method. The user indicated mounting method will be used to determine whether the BIPV NOCT is used or if a modifier is used to change the NOCT.<sup>2</sup> The second input is the power temperature coefficient of the module. This will allow PV Watts to account for differences in power degradation due to temperature among the various PV modules. The combination of these two inputs should result in more realistic monthly production estimates when BIPV installations are being evaluated. The reference system will be evaluated using the same mounting method (INOCT) and power temperature coefficient as the proposed system. These improved production

---

<sup>2</sup> The BIPV NOCT is supplied by the CEC for panels tested under BIPV conditions. The "modifier" used to change NOCT is: +18°C for direct mount (if CEC values are not available), +11°C for 1" standoff, +2°C for 3" standoff, -1°C for 6" standoff, -3°C for rack mount.

## ATTACHMENT A

estimates will then be used by the EPBB calculator to calculate the geographic correction, design correction, and design factor.

### Post Performance Calculations

After calculating the design factor, we will calculate an adjusted PTC rating for the PV modules. When installed in a BIPV system, the PV modules have a higher NOCT, which results in a reduced efficiency. The adjusted PTC rating will account for this loss. The adjusted PTC rating is then multiplied with the module count and inverter efficiency to calculate the CEC-AC rating. Finally, this CEC-AC rating is multiplied by the design factor and current incentive rate to obtain the eligible incentive amount.

The adjusted PTC rating is calculated as follows<sup>3</sup>:

$$PTC_{adj} = STC * (1 + \frac{PwrTempCoeff}{100} * (T_{mod} - 25))$$

$$T_{mod} = 20 + 1.389 * (NOCT - 20) * (0.9 - n)$$

$$n = STC / (1000W / m^2) / Area$$

Where:

- “PTC<sub>adj</sub>” is the adjusted module DC power (watts) rating at the installed NOCT
- “STC” is the module DC power (watts) rating at Standard Test Conditions
- “PwrTempCoeff” is the power temperature coefficient of the module (%/C°)
- “T<sub>mod</sub>” is the module temperature at PVUSA Test Conditions
- “NOCT” is the Nominal Cell Operating Temperature for BIPV installations
- “n” is the panel solar to DC electric conversion efficiency
- “Area” is the panel cell area in square meters

### Outputs

The layout of the EPBB calculator results page will only change slightly. The new input (mounting method) will be reflected in the “PV System Specifications” section of the results page. Also, the adjusted PTC rating will be displayed alongside the published PTC rating. This will allow the applicant to gauge the degradation in system performance due to their choice of mounting method.

<sup>3</sup> The equations for calculating the adjusted PTC rating were provided by Smita Gupta of the California Energy Commission.