

CSI EPBB Design Factor Calculator Quick Start Guide

1. Guide Overview

This Quick Start Guide is intended to provide an overview on the California Solar Initiative (CSI) EPBB Design Factor Calculator, detailed step by step instructions on its use and instructions on how to calculate EPBB Incentives using the calculator results. The calculator is web accessible and its URL is <http://www.csi-epbb.com>.

2. CSI EPBB Eligibility

EPBB eligible photovoltaic projects must be located on sites where the Host Customer is a PG&E, SCE or SDG&E retail electric customer, and the proposed system's CEC-AC rating is less than 100 kW. All customer classes are eligible for CSI EPBB except for residential new construction systems, which should apply to the California Energy Commission's New Solar Homes Partnership Program.

The Host Customer must be the utility customer of record at the location where the generating equipment will be installed. Any class of customer (industrial, agricultural, commercial, or residential) is eligible to be a Host Customer. The project's site must be within the service territory of and receive retail level electric service¹ from, PG&E, SCE, or SDG&E. Municipal electric utility customers are not eligible to receive incentives from the above designated program administrators.

3. Required Inputs

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.

Utility: This is the utility where the proposed PV system is located. Note that is zip code inputted must be located within the specified utility's service territory.

DC Rating (kW): This is the total DC rating of the proposed PV system. It is determined by multiplying the number of panels times the Standard Test Condition (STC) rating of the panel (Watts/panel) and converting it to kW. The STC rating of the proposed panels can be obtained from the PV panel manufacturer.

Inverter Efficiency (%): This is the operating DC to AC conversion efficiency of the inverter. It can be obtained from the CEC's list of eligible inverters found at http://www.consumerenergycenter.org/cgi-bin/eligible_inverters.cgi.

¹ "...retail level electric service..." means that the Host Customer pays for and receives distribution services, as defined by their respective utility rate schedule.

Minimal Shading: This criteria, if checked, indicates that no object is closer than a distance twice the height it extends above the PV modules. If this criteria is met and Minimal Shading is checked, no derate due to shading is applied. Note that the reference optimal system is 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. Note that the reference optimal system is specified to meet the “Minimum Shading Criteria” and thus has no derating of its monthly output due to shading.

Array Type: Here the user is asked to specify whether the proposed PV system is a “Fixed Tilt” (both tilt and orientation are static), “1-Axis Tracking” (where tilt is static but the system rotates on an axis to follow the daily sun position, or “2-Axis Tracking” (where the system directly faces the sun anytime during the day).

Array Tilt (degrees): This is the proposed system tilt from horizontal. Flat (horizontal) systems are 0° tilt. Note for “2-Axis Tracking” systems, array tilt is not an input.

Array Azimuth (degrees): This is the horizontal direction the proposed system is pointing; due South is 180° azimuth and due North is 0° azimuth. Flat (horizontal) systems are assumed to be 180° azimuth. Note for “2-Axis Tracking” systems, array azimuth is not an input.

After the inputs are set, the user can click the “GO” button and the calculations will be executed. If an input error is present, 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.

4. Interpreting & Using the Output

Once the calculator has completed its computations, it will display a new webpage containing inputs and outputs for the proposed and reference optimal system, as well as the Design Factor.

The outputs are described below.

Annual kWh: This is the estimated annual energy output of the proposed and reference optimal system. This is reported for the convenience of the user and should be used with caution. NREL reports that PV Watts 2 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. So for systems using cells

composed of non-crystalline silicon, it is recommended that the annual energy output values estimated by PV Watts 2 not be used for performance or economic forecasting. In addition to these uncertainties, PV Watts 2 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.

Summer kWh: This is the estimated summer energy output of the proposed and reference optimal system. The summer period are the months specified by each utility for their service territory as defined by their time-of-use tariffs.

Summer Months: These are the months each utility defines as the summer period for their service territory in their time-of-use tariffs. It is the proposed and reference optimal system output for these months that is used to determine the “Summer kWh”.

Design Factor: This is the ratio of the proposed and optimal system summer output. This Design Factor is used in the EPBB incentive calculation.

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

After the run is complete, the user should print a hard copy of the results so they may reference it during their calculation of the EPBB incentive.

5. CSI EPBB Calculator Overview

The CSI EPBB calculator is a web accessible tool to determine the Design Factor used in calculating the EPBB incentive for eligible CSI proposed systems.

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	Commercial	Government/ Non-Profit
1	50	n/a	n/a	n/a
2	70	\$2.50	\$2.50	\$3.25

MW Step	MW per step	EPBB payments (per watt)		
		Residential	Commercial	Government/ Non-Profit
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 CEC-AC system rating and is calculated by multiplying the number of panels times the kW PTC (PVUSA Test Conditions) rating per panel times the inverter efficiency. The PTC rating per panel can be found at http://www.consumerenergycenter.org/cgi-bin/eligible_pvmodules.cgi. The inverter efficiency can be found at http://www.consumerenergycenter.org/cgi-bin/eligible_inverters.cgi. Note that the inverter efficiency is used twice; once to determine the system annual and summer energy production, and then to calculate the CSI EPBB Incentive. The user must use the inverter efficiency twice.

Design Factor – is a factor applied to the incentive and is calculated as the ratio of the summer output of the proposed system to the summer output of a reference optimal system.

$$\text{Design Factor} = \frac{\text{Simulated summer output of customer's proposed system}}{\text{Simulated summer output for optimal reference system}}$$

The CSI EPBB calculator determines the Design Factor based on the inputs for the proposed system. The calculator also configures an optimal system; using predetermined parameters and the inputs from the proposed system. A comparison of the system configuration inputs for the proposed and optimal systems is listed below.

Input Parameter	Definition	Proposed	Optimal
Zip Code	The zip code where the proposed or optimal system will be located.	User Input	93534 (Lancaster, CA)
Utility (PG&E, SCE or SDG&E)	The utility service territory where the proposed system is located. This determines the summer period used for the Design Factor.	User Input (Sets Summer Period)	User Input (Sets Summer Period)
DC Rating (kW)	The total DC rating of the proposed system. This is the product of the number of panels times the DC STC Watt rating per panel. The STC Watt rating is the Standard Test Condition and is available from the panel manufacturer.	User Input	User Input
Inverter Efficiency	This is the DC to AC conversion efficiency of the inverter and is available from the CEC's website at http://www.consumerenergycenter.org/cgi-bin/eligible_inverters.cgi	User Input	User Input

Input Parameter	Definition	Proposed	Optimal
Shading	Shading is a derate factor (100% is no derate) from shading on the proposed system.	Minimal Shading Criteria or Shading Derate Factors	No Shading Derate
Array Type (Fixed Tilt, 1-Axis Tracking or 2-Axis Tracking)	Type of system whether is fixed position, or axis tracking.	User Input	User Input
Array Tilt (degrees)	The tilt of the system (0° tilt is horizontal). Note that this is only relevant to fixed and 1-axis tracking systems.	User Input	Optimal for Lancaster for Summer Period at Optimal System Azimuth
Array Azimuth (degrees)	The horizontal direction of the panel. 180° is due south and 0° is due north. Note that flat systems (tilt = 0°) should input their azimuth as due south (180°).	User Input	User Input if 180° to 270°. 270° if User Input from 270° to 45°. 180° if User Input from 45° to 180°.

Once all inputs are set and the user initiates the calculations by pressing the “GO” button. The calculator then calls the National Renewable Energy Laboratory’s PV Watts 2 performance calculator. Detailed information on PV Watts 2 and how it works may be found at –

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 - Discussion of PV Watts’ parameters.

http://rredc.nrel.gov/solar/codes_algs/PVWATTS/pvwatts2.pdf - Paper discussing how PV Watts 2 incorporates NREL's 40 km resolution solar resource data to permit site-specific calculations.

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 - Lists the revision history for PV Watts

The CSI EPBB calculator makes one call to PV Watts to determine the estimated month by month output (kWh/month) of the proposed system. It then looks up the optimal system output in a table that was pre-developed using multiple PV Watts 2 runs for a 1 kW DC located in Lancaster.² The reference optimal system energy output is then scaled by the STC DC Watt rating. The process is illustrated below.

² The performance table was developed to reduce the computation time of the CSI EPBB calculator.



California Solar Initiative
Expected Performance Based Buydown Calculator

Site Specifications: ZIP Code: _____ Utility: PG&E Links & Resources: PG&E SCE SPPREO

PV System Specifications: DC Rating (kW): _____ Inverter Efficiency: 100 Shading: Minimal Shading Array Type: Fixed Tilt

Fixed Tilt or 1-Axis Tracking System: Array Tilt (degrees): _____ Array Azimuth (degrees): 180.0 (Default=South)

Go

E-mail CSI-EPBB@nrel.gov with questions or comments.
Copyright, 2006 NREL

Proposed System Arguments (Inputs)

Optimal System Argument Generator

Optimal System Azimuth

Azimuth to Optimal Tilt Table for Lancaster

Optimal System Arguments

Optimal System Tilt

System Energy Output Table for Lancaster

Optimal System PV Watts 2 Output

Proposed System PV Watts 2 Output

Results	Proposed	Optimal
Annual kWh	131,534	131,031

Results	Proposed	Optimal
Annual kWh	131,534	131,031
Summer kWh	58,473	70,503
Summer Months	May-September	May-September
Design Factor	0.83	
Report Generated on	11/20/2006 11:42:56 AM	

Results		
Month	Solar Radiation (kWh/m ² /day)	AC Energy (kWh)
1	3.47	317
2	4.64	375
3	5.63	497
4	6.44	542
5	6.78	569
6	7.30	577
7	7.28	587
8	7.30	596
9	6.90	560
10	6.19	534
11	4.67	402
12	3.21	287
Year	5.82	5842

Summer Production Outputs for Proposed & Optimal

PV Watts has a number of derate factors that it includes to account for various system losses. This derate factors include –

PV Watts Default Derate Factors for AC Power Rating at STC		
Component Derate Factors	PVWATTS Default	Range
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

Note that the CSI EPBB Design Factor calculator adopts these factors as defaults except for “Inverter and Transformer”. The CSI EPBB 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>.

The CSI EPBB calculator uses a “Minimum Shading Criteria” to screen those applications where shading is not a significant factor affecting their system production. To meet this criterion users are to perform a visual inspection of the location of the proposed system and no obstruction can be closer than a distance twice the height it extends above the PV modules.

For systems that do 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. The study must use a shade analysis tool such as the Solar Pathfinder (<http://www.solarpathfinder.com>), the Solmetric SunEye™ (<http://www.solmetric.com>), or similar instrument. These inputs are used as monthly derate factors to account for shading in the PV Watts output.

6. Getting Help & Providing Comments

Questions and comments regarding the CSI EPBB Design Factor Calculator or this Quick Start Guide should be emailed to CSI-EPBB@aesc-inc.com. Questions will be addressed on a first-come first-served basis.

7. Software & Guide Revision History

Quick Start Guide Revisions

Revision #	Revision Description	Date Implemented
Rev 0	Initial guide is published.	November 20, 2006
Rev 1	- Shading study instrument is diversified & made more generic. - Added revision history section.	November 22, 2006
Rev 2	- Added calculator's URL to introduction. - Removed reference to Design Factor 0 to 1 range since it can be larger than 1	November 29, 2006
Rev 3	- Change references of San Jose as the reference location to Lancaster	December 20, 2006

CSI-EPBB Design Factor Calculator Revisions

Version #	Version Description	Date Implemented
Version Beta	- Beta version of calculator is released.	November 20, 2006
Version 1.0	- Fixed error message & minimal shading reset after recalculation - Removed Beta notification in header of webpage - Removed DC kW size limit. - Blanked optimal system utility. - Added shading to optimal system inputs & results column - Shading input description made more generic	November 22, 2006
Version 1.1	- Moved the reference location from San Jose to Lancaster - Round the tilt and azimuth fields in the results to whole degrees	December 12, 2006