ACM RESIDENTIAL MANUAL APPENDIX RB-2008

Appendix RB – Algorithms and Procedures for Calculating PV Production

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RB1. Purpose and Scope

ACM RB documents the methods and assumptions used for simulating the hourly electricity production for residential photovoltaic systems. The documented method is used to qualify for the New Solar Homes Partnership compliance option. The NSHP compliance option requires TDV energy production of PV systems, which is based on system performance as a whole, rather than on installed capacity. The calculation method described in this document accounts for the rated performance of the PV modules and the inverter. It also accounts for climate, number of PV modules, wiring configuration, tilt, azimuth, and shading conditions.

The calculation method uses publicly available algorithms to estimate PV system output at each hour of the year[1]. Inverter performance data is used to determine electrical AC output. These algorithms are implemented in a software module that can be licensed at no cost from the CEC. The algorithms incorporated in the PC calculation engine were developed by the Solar Energy Laboratory at the University of Wisconsin and are referred to as the Five Parameter Model. The CEC software module was written by Dr. William Beckman. The calculation procedure is a simulation whereby energy production is calculated for each hour of the year and summed. An hourly simulation is needed since time dependent valued (TDV) weights must be applied for each hour of the year.

The software module accepts a text file as input and produces a text file as output. The format of both the input and output text files is described in this document to enable software developers to interface with the engine. The CEC software module does not produce reports, although standard reports are required in order to qualify for the NSHP compliance option. The Residential Compliance Manual documents the reports required for the New Solar Homes Partnership.

These calculation procedures apply only to grid-tied systems with fixed tilt and orientation. Tracking systems are not handled in these calculation procedures.

[1] From DeSoto, W., Klein S. and Beckman, W, Improvement and Validation of a Model for Photovoltaic Array Performance, *Solar Energy*, Volume 80, Issue 1, January 2006, pp. 78-88.

RB2. PV Calculation Process

The CEC software module (referred to the "calculation engine" in this document) determines hourly system production from inputs of module and inverter information and site-specific installation details. The Compliance Software must perform both pre-processing of the inputs and post-processing of the inputs to determine annual TDV output of the system.

The CEC software module also contains databases with performance data for both PV modules and inverters. The Compliance Software passes the PV module name and inverter name to the CEC software module, which matches the module and inverter names passed in the input file to names in its internal database. The location and source of data is shown in the table below.

Table RB-1 – Data Location for PV Simulation Runs

Data	Location	Source
PV Module Name	Both	CEC Database
PV Performance Data	CEC Software Module	CEC Database
Inverter Name	Both	CEC Database
Inverter Efficiency Data	CEC Software Module	CEC Database
City Latitude and Longitude Data	Compliance Software	2008 Joint Appendix 2
Representative City Data for CEC Climate Zones	Compliance Software	2008 Joint Appendix 2
Time Dependent Valuation Multipliers	Compliance Software	http://www.energy.ca.gov/title24/2008standards/documents/E3/index.html
TDV Retail Rate Adjustment Adders	Compliance Software	http://www.energy.ca.gov/title24/2008standards/documents/E3/index.html

The PV calculation process consists of the following steps:

1. The Compliance Software (CS) accepts required inputs for PV module and inverter information, and site-specific details such as tilt, azimuth, mounting height and offset and location information.
2. The Compliance Software accepts optional inputs describing shading objects, which include trees, adjacent buildings, and roof obstructions.
3. The Compliance Software follows preprocessing rules to determine the climate zone and other inputs.
4. The Compliance Software writes a text input file (described later in this document).
5. The Compliance Software runs an executable command and designates the names of two output files (in comma-separated value format) to be used for post-processing.
6. The Compliance Software performs post processing to apply TDV valuation and shading rules to determine annual module TDV production.

Additional information related to the New Solar Homes Partnership can be found in the New Solar Homes Partnership guidebook.

RB3. Model Required Inputs

PV and inverter performance data is stored in libraries along with the CEC calculation engine. The Compliance Software accepts several user inputs and passes them to the calculation engine through a text input file. The Compliance Software also shall assume fixed values for several of the inputs.

RB3.1 User Inputs

The Compliance Software shall allow for the following user inputs:

1. PV Module Name – the name must match a listed name in the CEC database. A list of module names is available in a text file, PVDROPDOWN.TXT which is provided along with the calculator and periodically updated to include new modules as they become eligible. The text file also contains a flag for each module that indicates whether or not the module is a building-integrated module. Each entry in the text file has the format:

'Module ABC,Y'

In this example, "Module ABC" is the name of the PV module and "Y" indicates that it is building integrated.

2. Inverter Name – the inverter make and model, which must match an inverter name in the CEC database. A list of inverters in the CEC database is also available in a text file, INVERTERDROPDOWN.TXT which is provided along with the calculator and periodically updated.

3. City – the ACM shall allow selection of a City based on cities listed in JA2 of the 2008 Standards. The city selection determines the climate zone weather file that is used as an input for the calculation engine.

4. Number of series modules in each string – the number of PV modules connected in series in each string.

5. Number of strings in parallel – the number of strings of PV modules that are connected in parallel.

6. Installation Option – the Compliance Software shall allow the user to choose an installation option from the following choices: California Flexible Installation, Detailed Input.

a) For the *California Flexible Installation* option, the tilt shall be fixed at 22.6 degrees (5:12 tilt) and azimuth shall be fixed at 170 degrees in the background as inputs for the simulation runs. But this implies that the user is allowed greater flexibility in actual installation with range of azimuth from (150 degrees to 270 degrees) and tilt from 4:12 to 7:12. This option also assumes the wind factor is set at 0.61 (at 22 feet or greater). For this option, shading is required to be minimal.

b) For the *detailed input* option, the Compliance Software shall allow user inputs for tilt, azimuth and mounting height. This option can allow for entry of user defined detailed shading input.

7. Mounting standoff distance – the ACM shall allow the following entries for standoff for PV modules that are not building integrated:

Roof mounted (min 3.5 in. from roof)

Roof mounted (2.5 in. to 3.5 in. from roof)

Roof mounted (1.5 in. to 2.5 in. from roof)

Roof mounted (0.5 in. to 1.5 in. from roof)

Roof mounted (within 0.5 in. from roof)

Roof mounted (Ground / rack mounted)

For modules that are building integrated, the compliance software shall not allow a user selection for standoff height.

8. Tilt – the tilt in degrees of the PV array. The Compliance Software can allow this input defined as a rise over run pitch, but would need to convert to degrees for creating the input file (e.g. 5:12 pitch would be 22.6 deg).

9. Azimuth – the azimuth of the PV array in degrees (180 is South, 0 is North, 90 is East and 270 is West).

RB3.2 Fixed Inputs

The PV calculator engine requires several additional inputs that are "hardcoded" to the input file. For the annual simulation run, the input file requires the following inputs:

1. RowStart – the starting hour of the simulation. Value is "1" to indicate the first hour of the year.

2. RowEnd – the ending hour of the simulation. Value is "8760" to indicate the last hour of the year.

3. Tracking – tracking option, defaults to 1 for fixed (no tracking).

4. eta_MPPT – maximum power point tracking efficiency. Value is fixed at "0.88" to account for losses due to dirt and mismatched wiring.

For the FVT simulation run, the input file requires the following entries:

1. Month – this is fixed at "3" (for March) as representative of typical solar angles.

2. RowStart – fixed at "1".

3. RowEnd – fixed at "37" (for 37 rows in the field verification output table).

4. eta_MPPT – this value is fixed at "0.792" to account for losses due to dirt, mismatched wiring and an additional tolerance for capturing field verification related measurements.

5. Tracking$ - fixed at " 'Fixed' " (no tracking).

RB3.3 Multiple Orientations Arrays

A system may have arrays in multiple orientations connected to the same inverter. In this case, a separate hourly simulation run is performed for arrays in each orientation, and the hourly results can be summed to determine the total annual TDV Output. But separate field verification tables are required for each orientation and solar irradiance must be measured separately in a plane parallel to each orientation array that has a different azimuth and tilt. The expected output AC power is determined separately for each condition and the sum is used for field verification purposes.

RB4. Shading

Shading can significantly affect the output of a PV system. The Compliance Software shall assume that if any part of the array is shaded, PV production will drop to zero. An array will meet the "minimal shading" criterion if anything higher than the PV array is located a distance from the array at least two times the height difference. When an array does not meet this criteria, it will be considered shaded and production will drop to zero.

Mature tree heights are defined as follows: small trees are assumed to be 20 feet in height, medium trees 35 feet in height and large trees 50 feet in height. The Reference Residential Appendix R9 contains reference to information on classification of tree species into the three categories for input and field verification purposes.

Utility poles are an exception to the 'no shading' criterion provided they are located at least 30 feet from the array. The shading analysis must also consider the expected mature height of any nearby trees. Shading does not disqualify homeowner from receiving PV incentives, as electricity production is only ignored during hours of the year when shading occurs.

If the Detailed Input with Shading input is selected, the Compliance Software shall allow the user to define and describe a number of shading obstructions. A sample interface accepting such inputs is shown below.

Figure RB-1 – Sample Shading Interface

Orientation	Obstruction Type	Height of Shading Obstruction	Horizontal Distance to Shading Obstruction	Shading Angle
SE (Azimuth >123.75 to 146.25)	Medium Tree (existing - mature)		15	
WSW (Azimuth >236.25 to 258.75)	**Neighboring Structure (Enter Distance and Height)**	15	10	
WNW (Azimuth >281.25 to 305)	On Roof Obstruction (Enter Distance and Height)	10	10	
S (Azimuth >168.75 to 191.25)	Neighboring Structure (Measured Angle)			32.0

For each shading obstruction, the following information is required:

1. Azimuth. The azimuth of the obstruction relative to the module shall be selected from a list of direction segments. Each direction segment spans an azimuth range of 22.5 degrees, except for WNW and

ENE directions, since the azimuth angles between 305 degrees and 55 degrees are exempt from shading obstruction input.

For each shading obstruction, the user should choose from the following direction segments:

ENE (Azimuth >55 to 78.75)

E (Azimuth >78.75 to 101.25)

ESE (Azimuth >101.25 to 123.75)

SE (Azimuth >123.75 to 146.25)

SSE (Azimuth >146.25 to 168.75)

S (Azimuth >168.75 to 191.25)

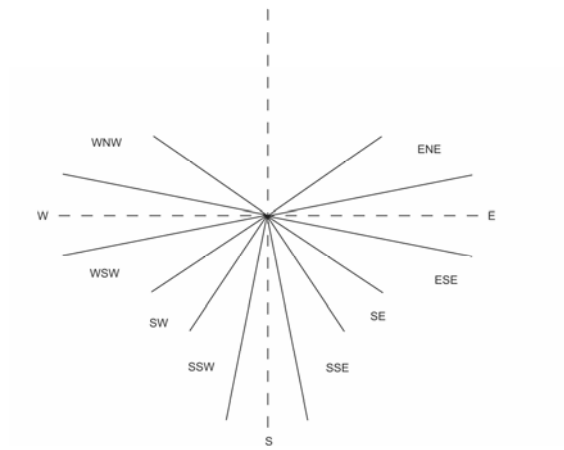
SSW (Azimuth >191.25 to 213.75)

SW (Azimuth >213.75 to 236.25)

WSW (Azimuth >236.25 to 258.75)

W (Azimuth >258.75 to 281.25)

WNW (Azimuth >281.25 to 305)



2. Obstruction Type – the user chooses the obstruction type from the following:

Table RB-2 – Obstruction Types for Shading Calculation

Obstruction Type	**Required Inputs**
Small Tree (existing - mature)	Distance from Obstruction
Small Tree (existing - not mature)	Distance from Obstruction
Small Tree (planned)	Distance from obstruction
Medium Tree (existing - mature)	Distance from Obstruction
Medium Tree (existing - not mature)	Distance from Obstruction
Medium Tree (planned)	Distance from Obstruction
Large Tree (existing - mature)	Distance from Obstruction
Large Tree (existing - not mature)	Distance from Obstruction
Large Tree (planned)	Distance from Obstruction
On Roof Obstruction (Enter Distance and Height)	Distance from Obstruction, Height of Obstruction
On Roof Obstruction (Measured Angle)	Altitude Angle
Neighboring Structure (Enter Distance and Height)	Distance from Obstruction, Height of Obstruction
Neighboring Structure (Measured Angle)	Altitude Angle

The ***distance from obstruction*** is the horizontal distance to the obstruction from the closest edge of the module with worst shading impact.

The ***height of obstruction*** is the vertical height of the obstruction. For on-roof obstructions, the height is measured relative to the mounting height of the array; for neighboring structures, the height is measured relative to the ground.

The ***altitude angle*** is the angle from the worst shaded point on the PV array to the highest point on the shading obstruction in each direction segment. The greatest altitude angle for a given direction segment determines the shading angle.

The Compliance Software shall determine the greatest shading angle for each of the 11 direction segments, and uses this angle to adjust hourly system production. The Compliance Software shall assume that there is minimal shading for any direction segment that has a shading angle equal or less than 26.5 degrees (corresponding to a distance to height ratio of 2:1). If this minimal shading criterion is met, shading effects shall be ignored for the corresponding direction segment.

The CEC PV engine produces hourly output that includes solar altitude angle and solar azimuth. Whenever the solar azimuth for the current hour is within a direction segment and the solar altitude angle is less than the shading angle, the electricity production of the system (in W) is assumed to be zero (0) for that hour.

RB5. Input Processing

The Compliance Software must perform processing of some user inputs prior to writing the input file.

1. **Determine CEC climate zone from city entry.** In order for PV production to be calculated, a city in California must first be chosen. The city location will correspond with 1 of 16 climate zones, each having a unique weather file. These weather files, as defined in Joint Appendix 2, will provide data necessary to perform the production calculation, such as radiation on a horizontal surface, beam normal radiation, diffuse radiation, and ambient temperature for each hour of the year.

2. **Determine normal operating cell temperature (NOCT) adjustment** (DELTANOCT in input file) from mounting standoff height according to the table below[2].

Table RB-3 – NOCT Adjustment from Mounting Standoff

Mounting Standoff Height	Input for NOCT adjustment
Roof mounted (Ground / rack mounted)	DELTANOCT=0
Roof mounted (min 3.5 in. from roof)	DELTANOCT=0
Roof mounted (2.5 in. to 3.5 in. from roof)	DELTANOCT=2
Roof mounted (1.5 in. to 2.5 in. from roof)	DELTANOCT=6
Roof mounted (0.5 in. to 1.5 in. from roof)	DELTANOCT=11
Roof mounted (within 0.5 in. from roof)	DELTANOCT=18

3. **Determination of wind adjustment factor** from mounting height (one-story or two-story):

The user may select the mounting height of the array, which is the height of the lowest point of the array relative to the ground. The user may choose between *one-story*, *two-story*, or a user-defined height. The mounting height is used to determine the wind adjustment factor, and is used for shading calculations. The wind adjustment factor is defined by the following rule: for a mounting height below 22 feet or for a one-story building, the wind adjustment factor is 0.51. For a mounting height at 22 feet or above or for a two-story building, the wind adjustment factor is 0.61.

4. **Determination of latitude and longitude** for annual run: the latitude and longitude for the annual simulation are the latitude and longitude of the reference city in the city's climate zone. Representative cities are shown in the table below. For instance, in climate zone 4, the reference city is Sunnyvale, so latitude and longitude data from this city are used in the run. For the FVT run, the latitude and longitude of the reference city in the city's climate zone are used in the simulation.

[2] Data interpolated from Fuentes, M., "A Simplified Thermal Model of Flat-plate Photovoltaic Arrays," Sandia, 1987.

Table RB-4 – Reference City Data by Climate Zone

Zone	City	Latitude	Longitude
1	Arcata	40.8	124.2
2	Santa Rosa	38.4	122.7
3	Oakland AP	37.7	122.2
4	Sunnyvale	37.4	122.4
5	Santa Maria AP	34.9	120.4
6	Los Angeles AP	33.9	118.5
7	San Diego AP	32.7	117.2
8	El Toro MCAS	33.6	117.7
9	Burbank AP	34.2	118.4
10	Riverside FS 3	33.9	117.2
11	Red Bluff AP	40.2	122.2
12	Sacramento AP	38.5	121.5
13	Fresno AP	36.8	119.7
14	China Lake	35.7	117.7
15	El Centro	32.8	115.6
16	Mount Shasta	41.3	122.3

RB6. CECPV Input File

A sample input file to the CECPV Calculator is shown below, with comments after each entry prefaced by "//". The input file is to be written in text format.

```
//This inputfile is run with the Title 24 PV EES Application
Load #1                        // Fixed command to EXE
PVModule$='Example Module,Y'   // Module Name – must match list in PVDROPDOWN.TXT
LatitudeX=37.3                 // Latitude of City (same value as Latitude)
LongitudeX=122                 // Longitude of City (same value as Longitude)
City$='San Jose'               // City Name –determines the CZ based on JA2 Table
2.2
Zone=4                         // CEC Climate Zone – ACM shall determine from city
Latitude=37.4                  // Latitude defaulted from reference city in CZ
Longitude=122.4                // Longitude defaulted from reference city in CZ
slope=22.6                     // Tilt of the collector, in degrees
N_Parallel=1                   // Number of strings connected in parallel
N_series=48                    // Number of PV modules in each series string
RowStart=1                     // Starting hour of simulation-fixed for annual run
RowEnd=8760                    // Ending hour of simulation-fixed for annual run
CEC_inverter$='SMA America      SWR2500U (240V)' // Inverter name
AZ_CEC=180                     // Solar azimuth
eta_MPPT=0.88                  // Placeholder for MPPT of inverter, but used as
overall derating factor accounting for dirt, dust and mismatched wiring in a
system for now, and fixed at 0.88
FFV_wind=0.51                  // Wind adjustment factor – 0.51 for one-story,
0.61 for two-story
Output$='CECPV_output.csv'     // Name of output file
DELTANOCT=0                    // NOCT adjustment based on cell mounting height
Tracking=1                     // Tracking option - fixed
Solve                          // Fixed command to EXE
//The following entries are required for generation of a field verification table
Load #2                        // Fixed command to EXE
Month=3                        // Fixed representative month for calculation
```

```
PVModule$='Example Module,Y'  // Module name
City$='San Jose'              // City name - determines CZ from JA2 Table 2-2
Zone=4                        // CEC climate zone for city
Latitude=37.4                 // Latitude of actual city from JA2
Longitude=121.9               // Longitude of actual city from JA2
slope=22.6                    // Tilt
N_Parallel=1                  // Number of strings connected in parallel
N_series=48                   // Number of PV modules in series string
RowStart=1                    // Fixed entry
RowEnd=37                     // Fixed entry – number of rows in output table
CEC_inverter$='SMA America     SWR2500U (240V)' // Inverter name
AZ_CEC=180                    // Solar azimuth
eta_MPPT=0.792                // maximum power point tracking efficiency - fixed
FFV_wind=0.51                 // wind adjustment factor
Output$='FVT.csv'             // Output file name
DELTANOCT=0                   // NOCT adjustment based on mounting option
Tracking$='Fixed'             // Tracking option – fixed
solveTable 'FVT'              // Fixed command to EXE
Quit                          // Fixed command to EXE
```

RB7. Execute Simulation

After the input file is written, the Compliance Software runs the engine executable as a background process. Execution of the command follows the following format:

c:\ Software\CECPV.exe c:\Software\CECPV.emf

The input file name is specified as an argument in the command line. This input file name contains the file names for the two output files that are generated from the simulation run. This command runs the PV simulation engine in the background. Note that the simulation may take as long as 90 seconds to run, depending upon the performance of the system.

RB8. Post-Process Results

RB8.1 PV Calculation Engine Output Files

The engine produces two output files: an hourly table of electricity production, and a field verification table, each in comma-separated value (.csv) format. The hourly electricity production table has the following data:

Table RB-5 – PV Engine Output File Details

Column	Field	Units	Notes
A	hr of year	--	Hour of year (1-8760)
B	month	--	Month for the current hour
C	day	--	Day for the current hour
D	T_amb	°C	Ambient (outdoor) temperature from weather file
E	I_T	W/m^2	Horizontal Incident Solar Radiation from weather file
F	T_c	°C	Cell Temperature
G	I_mp	A	Maximum power point current for the current hour
H	V_mp	V	Maximum power point voltage for the current hour
I	eta_mp	Unitless	Conversion efficiency of solar to DC power
J	eta_inverter	Unitless	Inverter Efficiency for the current hour
K	P_del	Watts	AC Power delivered
L	gamma_s	Degrees	Solar azimuth angle
M	alpha_s	Degrees	Solar altitude angle
N	hr of Day	--	Hour of day (1-24)

The data that is used for post-processing is the power delivered (column K) and the solar azimuth and altitude angles (columns L and M). The power delivered is the AC power for the current hour of the simulation. If the system is not shaded for that hour, the power is added to the annual total. The solar azimuth and altitude angles are used with the shading angle for each orientation, determined from pre-processing of shading inputs, to determine whether or not the system is shaded.

RB8.2 TDV Calculation

The state of California places greater value on electricity during periods of higher demand as defined in Joint Appendix 3. This time-dependent valuation of energy will be considered in calculating PV production by assigning a TDV multiplier to electricity production for each hour of the year.

The Compliance Software sums the hourly system AC production, excluding electricity production for all hours when the solar azimuth falls within a direction segment whose shading angle is greater than the solar altitude angle for that hour. Output is expressed in Wh; the hourly output is multiplied by a TDV multiplier, and then summed to determine annual TDV output. The TDV multiplier used in this calculation excludes a retail rate adjustment adder that is used in compliance calculations. This retail rate adjustment, which is constant for a given climate zone, is subtracted from the TDV multiplier to determine the TDV multiplier for the PV performance calculation. A listing of TDV values may be found at: http://www.energy.ca.gov/title24/2008standards/documents/E3/index.html

Table RB-6 – Retail Rate Adder

Climate Zone	Retail Rate Adder (kBtu/kWh)
1	3.12
2	3.21
3	3.45
4	3.34
5	3.34
6	3.24
7	6.19
8	3.23
9	3.17
10	3.11
11	3.07
12	3.17
13	3.42
14	3.10
15	3.09
16	3.02

RB8.3 Field Verification Table

The engine also produces an output file with a field verification table, which lists expected system AC power output (in W) for different solar irradiance levels and ambient temperatures. This table is used for field verification purposes to verify proper installation and operation of the PV system. The table shows expected PV system output for solar irradiance levels in 25 W/m^2 increments and for ambient temperatures in 5°F increments. Table RB-7 shows a sample of the output.

Table RB-7 - Example of Field Verification Table

(W/m²)	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

RB9. Reports

The New Solar Homes Partnership (NSHP) compliance option related to PV production requires three reports. The Certificate of Compliance form, CF-1R-PV, reports the inputs describing the system and the annual TDV production from the system. Refer to the Reference Residential Appendix RA9 for the field verification protocol which is used by HERS raters and system installers.

Forms CF-4R-PV and CF-6R-PV must also be completed to qualify for NSHP compliance option.

The Residential Compliance Manual provides additional information on the forms required to claim credit for residential PV production.