SB 1 Eligibility Criteria and Conditions for Incentives

Photovoltaic Component and Installation Standards

Smita Gupta
Buildings and Appliances Office

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SB 1 Assignments to Energy Commission

- Establish Eligibility Criteria - PRC 25782(a)
  - Design, Installation and Electrical Output Standards or Incentives
- Establish Conditions for Ratepayer Incentives
- Set Rating Standards for Equipment, Components and Systems – PRC 25782(c)

Component Standards

Modules

Inverters

Meters

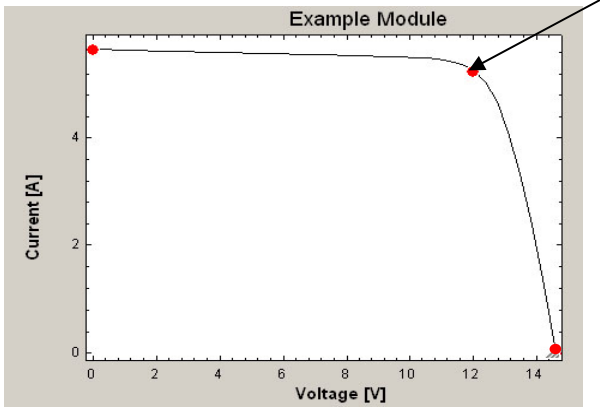
PV Module eligibility criteria

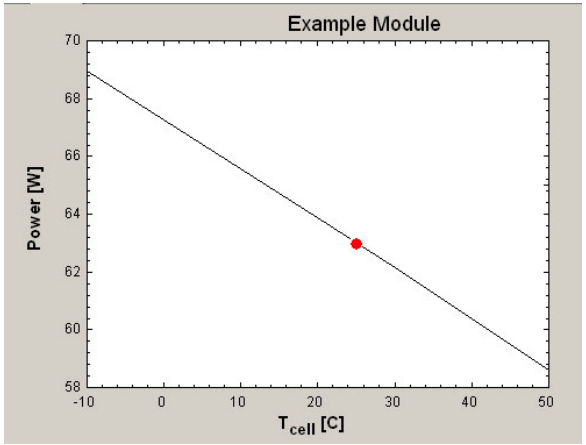
- Detailed performance values
  - Name plate power rating - inadequate indicator of performance (STC or PTC)
  - Cell manufacturing technology development focusing on properties not captured by name plate rating
- International test standards
- Independent, accredited laboratory for testing
  - Currently self reported for UL listing purposes

Module Performance Characteristics

- I-V curve (at STC and low irradiation)
  - I_{mp}, V_{mp}, I_{sc}, V_{oc}
- Normal Operating Cell Temperature (NOCT)
  - Rack mounted and BIPV
- Temperature Coefficients
  - Power – γ_{Pmp} (%/K)
  - Current – α_{Isc} (amps/K)
  - Voltage – β_{Voc} (volts/K)

Maximum Power – name plate rating





PV Modules

NSHP eligibility requirements

- Modules should be certified to UL 1703 by a Nationally Recognized Testing Laboratory (NRTL) to ensure safety and reliability
- Detailed performance data
  - IEC 61215 or 61646 (subsections relevant to performance)
  - International Laboratory Accreditation Cooperation (ILAC) accredited laboratory
- The NOCT for roof integrated BIPV products should be determined using the specification as described in the NSHP Guidebook Appendix 3

Inverters

CEC exisiting protocol - no change

- Inverters should be certified to UL 1741 safety standards by a Nationally Recognized Testing Laboratory (NRTL).
- Performance data tested in accordance with "*Performance Test Protocol for Evaluating Inverters Used in Grid-Connected Photovoltaic Systems*" by a NRTL
  - Maximum Continuous Output Power
  - Conversion Efficiency at various voltage and power conditions
  - Tare Losses

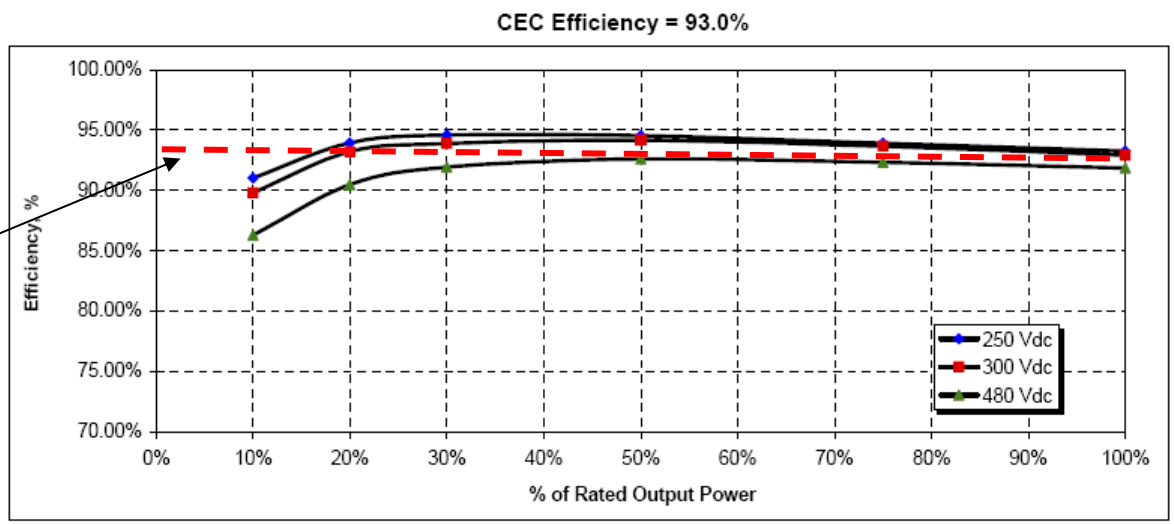
Inverter performance

- Use of performance curves rather than single weighted efficiency

Rated Maximum Continuous Output Power: 2.5 kW Night Tare Loss: 0.318 W

Vmin: 250 Vdc Vnom: 300 Vdc Vmax: 480 Vdc

		Power Level (%; kW)						
		10%	20%	30%	50%	75%	100%	
Input Voltage (Vdc)		0.25	0.50	0.75	1.25	1.88	2.50	Wtd
Vmin	250	91.03%	93.93%	94.57%	94.53%	93.90%	93.26%	93.97%
Vnom	300	89.79%	93.21%	93.89%	94.15%	93.66%	92.89%	93.57%
Vmax	480	86.28%	90.48%	91.91%	92.59%	92.33%	91.84%	91.98%



Performance impact of single efficiency number

Meters

CSI Metering sub-committe

- ± 2 percent accuracy for all PBI applicants tested according to all applicable ANSI C-12 testing protocols by independent test laboratories
- ± 5 percent accuracy meters (primarily inverter integrated) allowed for expected performance incentive applicants (test protocol under development)
- Communication port for performance monitoring and reporting service (PMRS)
- Display and storing of instantaneous and cumulative performance data

Installation Standards

Calculation methodology

Shading

Peak Load

Field verification

Installer

Incentivizing Performance

- Over time – Performance Based Incentives (PBI)
  - All systems over 50 kW (2008) and 30 kW (2010)
  - Require TOU and PMRS

based on CSI PBI deployment schedule

- Up front – Expected Performance Based Incentives
  - Calculation methodology to account for performance
  - Shading avoidance or accounting
  - Addressing Peak load
  - Field Verification
  - Installer (certification of system)

based on NSHP methodology

Factors that affect performance

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

Equipment characteristics and other factors that affect performance

- PV Modules
  - Current-Voltage (I-V) curve (at STC and low irradiation)
  - Normal Operating Cell Temperature (NOCT)
  - Temperature coefficients
- Inverter
  - Performance efficiency curves for the range of voltage and power conditions applicable
  - Night time tare loss
  - Maximum Power Point Tracking (MPPT)
- System level factors
  - Dirt and dust
  - Wiring mismatch
  - Equipment mismatch (inverter and module, power and voltage mismatches)

Calculation methodology/tool recommendation

- Address system installation and equipment characteristics that affect performance
  - Incentivize high performing systems rather than name plate capacity
  - Address all cell and equipment technologies (such as: crystalline Si, a-Si, rack mounted, BIPV)
  - Address all installation types (such as: fixed, one and 2 axis tracking, concentrating solar)
- Generate Hourly results
  - Address peak load
  - Address hourly shading
- Generate Field Verification Table
  - Verify spot performance based on measured ambient conditions (temperature and incident solar radiation)

EPBB – EPBI comparison

	EPBB-CSI	EPBI-NSHP
Module characteristics	Nameplate capacity rating - PTC	Actual tested detailed performance values, I_{sc}, V_{oc}, I_{mp}, V_{mp}, NOCT, temperature coefficients
Module type	Adjusted PTC for BIPV	BIPV and rack mounted modules addressed in detail with respect to operating temperature
Inverter	Single weighted efficiency number	Performance curve for range of operation conditions
Calculator generated Field Verification of Performance	Not addressed	A table specific to each proposed system is generated to verify performance against ambient temperature and incident radiation.

	EPBB-CSI	EPBI-NSHP
Design Factor		
Design Factor	Capped at 1	No cap, incentive rewards systems better than reference
Calculation Engine	PVWatts2 - monthly estimate of performance used only in the determination of Design Factor	Five parameter model enhanced with inverter model and customized for CA - hourly simulation of performance
Module Characteristics	Defaulted by PVWatts, same for proposed and reference (NOCT, temp coeff)	Actual tested performance values of proposed modules compared to reference modules, to incentivize high performing designs
Inverter	Weighted efficiency Allowed under sizing up to 25%	Performance curve over range of operating conditions. Voltage and power matched with array production hourly and capped to maximum capacity
Mounting height	Not addressed	Mounting height above ground scales the impact of wind on the operation temperature for the hour
Peak load	Summer months (May - Oct)	Hourly weighting of performance using TDV for each hour of the year
Hourly Calculations		

		EPBB-CSI	EPBI-NSHP	
Location and Weather data	Design Factor	PVWatts defaulted selection of weather based on location. Addressed in Geographic Correction reference Orange, CA	Location data based on 16 climate zones (Title 24), Hourly weather data (solar radiation, temperature, wind) reference San Jose, CA	Hourly Calculations
Azimuth		Design Correction 180-270 proposed –no advantage; 45-180 compared to 180 south; 270-45 compared to 270 west	Proposed azimuth simulated in hourly calculations, azimuth of reference system is always 180 south	
Tilt		Design Correction and compared with optimal tilt	Proposed tilt simulated in hourly calculations, tilt for the reference system is fixed at 5:12 roof pitch (22.6 deg)	
Shading		2:1 minimal shading criteria. Percentage solar available monthly	2:1 minimal shading criteria. Hourly estimation based on solar altitude obstructed in each azimuth direction.	
Future shade		Not addressed	Assumptions of mature tree heights for shading purposes and potential structures that could shade in the future accounted for	

Shading

based on NSHP methodology

Review recommendations of the CSI Shading sub-committee

- Emphasis on avoiding shade
  - Minimal shade criteria – 2:1 distance to height ratio
- Simple methodology to determine unavoidable shading
  - Height and distance measurement
  - Optional elevation angle measurement (use of instrumentation)
- Account for existing and future potential shade
  - Trees (mature height for species)
  - Other (known/planned) structures on roof or neighboring
- Measurement and verification methodology specified with tolerance

Peak Load

based on NSHP methodology

- Weighting of hourly results to encourage systems that perform higher on peak
- TDV weighting factors for every hour

Field Verification

based on NSHP Field Verification Protocol

- Third party (eg - HERS raters for new homes)
- Protocol to include:
  - Equipment verification
  - Installation characteristics verification
  - Performance verification
  - Shading verification
- Sampling approach
- Tolerance in measurements

Installer

combination of CSI and NSHP

- Qualified installers
  - valid A, B, C-10 or C-46 contractor license
- Installer certification of installation
  - Components
  - Installation characteristics
  - Performance
  - Shading analysis
- NABCEP certification encouraged though not required

Questions and comments?