Checklist for Residential Roof Mount Photovoltaic/Solar Systems Submittals

**DESIGN CRITERIA:**

- Seismic Zone D or provide analysis and calculation from California Registered Engineer
- Basic velocity 110 mph, 3 second gust, exposure B or provide wind speed calculations from California Registered Engineer
- 2016 editions of the California Residential Code (CRC) and the California Electrical Code (CEC) Article 690
- Climate Zone 11
- PG & E Greenbook Requirements

**DRAWING CRITERIA:**

- Drawing sizes shall be a minimum of 11” x 17” inches and all pages shall be the same size. Plans must be clear and legible; non-legible plans will not be accepted. Scale shall be ¼” inch per foot for structural and architectural; 1” inch = 20 feet for site plans.
- Plans must be wet-signed by the preparer on each page. Architects/Engineers must affix their seal and wet-sign (cover sheet of supporting documents to be wet-signed).
- Two complete stapled plan sets

**PLANS PREPARED BY:**

- California Registered Architect, California Registered Engineer, Owner, Licensed General, Electrical, Solar Contractor
- Structural Plans Included – Stamped and Signed (original) by a California Registered Engineer

**CONTENTS OF PACKET:**

- Photovoltaic Checklist (2 pages – complete and submit with permit) **Note: all forms must be signed or initialed (as indicated) by the appropriately authorized party.**
- Sample One-Line Diagram for PV System including derating load calculations
- Sample Site Diagram
- Solar Panel Dead Weight Loading Calculation (complete and submit with permit)
- Verification of Wire Size for PV System Calculation form (complete and submit with permit)
- CEC Table 310.15 (B)(16) included for reference
- PV Roof Clearance drawing
- PG&E Greenbook Figure 2-19 (Minimum Meter Set Clearance Requirements)

If you have any questions regarding your PV system permit, please call the building department at (916) 625-5120
Residential Photovoltaic Checklist

Based on the 2016 California Residential Code (CRC) and the 2016 California Electrical Code (CEC) Article 690

Residential PV system shall be installed in accordance with the current adopted edition of the (CRC) and CEC Article 690 and any other applicable articles or codes adopted by the jurisdiction.

☐ Simple plot plan showing:
   - Lot lines
   - Structure locations
   - Main service panel location
   - PV module array configuration shown on a roof layout (or lot if ground mounted system)
   - % of coverage of roof area (If more than 50% a review by the fire department is required)
   - Distance from ridge to array(s) - (minimum of 3’ required by CRC)
   - Distance from valley/hip to array(s) - (minimum of 18” by CRC)
   - PV equipment locations, Solar arrays, DC combiner boxes, conduit and conductor location, Inverter, AC combiner box, AC disconnect

☐ Roof Information (for roof mounted systems):
   - Type of roof structure and slope. If rafters, provide size and spacing of existing roof framing members.
   - Existing roofing material

☐ PV Equipment Manufacturer’s Specifications: Provide cut sheets on all components including but not limited to those shown below; including make, model, listing, size, weight, etc. Highlight project specific information on the cut sheets.
   - PV modules UL 1703 listed (R907.5)
   - Inverter with GFCI & AFCI protection
   - Mounting System (if using substitution parts to any listed/certified system, or mixing components of different mounting systems, additional engineering shall be required addressing the withdrawal and lateral capacities).
   - Disconnects
   - Combiner Box (if used) AC and DC Combiner boxes.

☐ Inverter:
   - Model number
   - Integrated disconnect – Equipped with rapid shutdown.
   - A visible external A/C disconnect within 5’ of the main service panel.

☐ Mounting System for Panel Installation: Highlight project specific information on the cut sheets
   - Indicate the style, diameter, length of embedment of bolts into framing members and location of attachments.
   - Indicate number of bolts per panel.
   - Provide mounting details and certified engineering or listed mounting installation.
   - Complete “Solar Panel Dead Weight Loading Calculation” form.
   - If ground mounted, provide details for the foundation.

Residential PV Checklist

Initials:________
Photovoltaic Modules:
- Open-circuit voltage (Voc) from listed cut sheet
- Maximum system voltage from listed cut sheet
- Short-circuit current (Isc) from listed cut sheet
- Maximum fuse rating from listed cut sheet
- Maximum power- panel wattage from listed cut sheet

Electrical Schematic:
- System inter-tie with utility company or stand alone
- Indicate the system KW rating
- Indicate if the system has battery backup
- Single line drawing of electrical installation which includes:
  - Array
  - PV power source short circuit rating
  - Conductor size and type
  - Conductor locations and runs
  - Equipment bonding points and sizes – Per *CEC 250.122
  - Inverter location
  - AC & DC disconnect locations – Per *CEC 690.13
  - Batteries; number, size and locations (if applicable)
  - Point of connect to existing main electrical service panel
  - Size and number of electrical service meters – Per *CEC 705.12 (D)(2) exception
  - Location of required signage
  - Complete attached ‘verification of wire sizes’ sheet
  - Provide Rapid Shutdown of PV per 690.12

Proper Signage and Labeling:
- Signage (see attached)

Indicate system type below and show location of each required sign on one line diagram (see electrical):
- SINGLE PV ARRAY SYSTEM
- PV ARRAY SYSTEM W/ BATTERY BACKUP
- MULTIPLE PV ARRAY SYSTEMS

*CEC 690.17 - Switch or Circuit Breaker. The disconnecting means for ungrounded conductors shall consist of a manually operable switch (es) or circuit breaker(s) complying with all of the following requirements:

1. Located where readily accessible
2. Externally operable without exposing the operator to contact with live parts
3. Plainly indicating whether in the open or closed position
4. Having an interrupting rating sufficient for the nominal circuit voltage and the current that is available at the line terminals of the equipment.

*CEC 250.122 – Size of Equipment Grounding Conductors. Copper, aluminum, or copper-clad aluminum equipment grounding conductors of the wire type shall not be smaller than shown in Table 250.122 but shall not be required to be larger than the circuit conductors supplying the equipment.

*CEC 690.46 – Grounding for AC/DC Systems. #6, in conduit or protected from damage

*CEC 690.13 (E) – Grouping. The photovoltaic system disconnecting means shall be grouped with other disconnecting means for the system to comply with 690.14(C)(4). A Photovoltaic disconnecting means shall not be required at the photovoltaic module or array location.

*CEC 705.12 (D)(2) exception - Load Side. A photovoltaic power source shall be permitted to be connected to the load side of the service disconnecting means of the other source(s) at any distribution equipment on the premises, provided that (exception) the sum of the ampere ratings of the overcurrent devices shall not exceed 120% of the rating of the bus bar or conductor.

Initials:_______
1. PV array contains two parallel strings of 10, 140-Watt Modules in series (20 modules)
2. PV array wiring to combiner is #10 AWG USE-2 with factory-installed MC connectors to interface with modules.
3. PV array combiner/junction box provides transition from array wiring to conduit wiring.
4. PV power source disconnect (unfused) rated at 30-amps, 600 Vdc, NEMA 3R rainproof.
5. Ground Fault Protection provided in Inverter.
6. Inverter is SB250UL model rated at 2.5 kW AC output and is rated to provide 10.4 amps at 240-Volts at 40 °C.
7. Inverter is Listed to UL-1741 “Utility-Interactive”
8. Inverter output disconnect rated at 30-amps, 240 Vac, NEMA 3R (Req. by PG&E)
9. 100-Amp Main Service Panel with 15-Amp Two-Pole circuit breaker for point of connection (not to exceed 120% of busbar rating – CEC 690.64 (B) (2) exp)
10. Equipment grounding conductors on AC and DC side sized according to CEC 250.122
11. Negative pole of PV array referenced to ground at the Inverter.
12. All plan pages shall be signed by the party responsible for the design
13. Rapid Shutdown

Notes:

COMPANY NAME:
Project Address:

Title: Sample One-Line Diagram for PV System

Drawn By: Date:

Checked By: DWG NO. EX-1

Scale: NTS

Material:

Related Dwg: EX-2
SOLAR PANEL DEAD WEIGHT LOADING CALCULATION

System:
Solar panel consists of ____________ solar modules
Mounting system has ____________ points of connection with the roof

Panel Weight Calculation:
Solar Module Weight = ____________ lbs.
Mounting System Weight = ____________ lbs.
Total Panel Weight = ((# of modules) x (module wt.)) + (mounting system wt.)
= (______ x _______) + ________ = ________ lbs.

Point Load Calculation:
Point Load = (total panel wt. )
____________________________ = ______________ = ____________ (lbs.)
(# of points of connection) _________

Distributed Load Calculation:
Solar Module Area = length” x width” = _________ x ________ = __________ ft2
____________________________ = _____________________________
144 144
Total Solar Module Area = (# of modules) x (solar mod. area)
= _________ x ____________ = __________ ft2

Inter-module Spacing = ___________ in.
Total Spacing Area =
(# spaces bet. modules) x (inter-mod spacing) x (panel length or width) = _______ x _______ x ________ = _______ ft2

Total Panel Area = (total solar modular area) + (total spacing area)
= _________ + _________ = __________ ft2

Distributed Load = (total panel wt.)
____________________________ = ______________ = __________ lbs./ft2
(total panel area ) ____________

The point loading and distributed loading should be below building department requirements for structural analysis. Distributed loading - Max. 5 lbs/ft2

Residential PV Dead Weight Loading Calculation form

Initials: _______
Verification of Wire Sizes for PV System Calculation Form

Checking the wire size from the modules to the inverter (D/C):

Total PV System Rating: \(=\) (Module wattage off cut sheet) \(x\) (# of modules in array)
\[= \text{__________} \times \text{__________} = \text{__________} \text{Watts}\]

Max. PV System Voltage: \(=\) (Voc (v) off cut sheet) \(x\) (# of modules) \(x\) CEC Factor
\[= \text{__________} \times \text{__________} \times 1.13 = \text{__________} \text{Volts}\]

Max. Circuit Current: \(=\) CEC Factor \(x\) (Total system wattage/ total system voltage)
\[= 1.25 \times \text{__________} / \text{__________} = \text{__________} \text{Amps}\]

Using CEC Table 310.15(B)(16): In temperature column copper, 75° C, find the amperage allowed, then read over the size column for the minimum wire size. Minimum wire size from Table 310.15(B)(16) # ________

Checking the wire size from the inverter to the service panel (A/C):

Max Inverter AC Power Output: \(=\) (Max AC Output off cut sheet)
\[= \text{__________} \text{Watts}\]

Max Service Voltage: \(=\) (110/240 V)
\[= \text{__________} \text{Volts}\]

Max Circuit Current: \(=\) CEC Factor \(x\) (max inverter AC Power Output / 240)
\[= 1.25 \times \text{__________} / \text{__________} = \text{__________} \text{Amps}\]

Using CEC Table 310.15(B)(16): In temperature column copper, 75° C, find the amperage allowed, then read over the size column for the minimum wire size. Minimum wire size from Table 310.15(B)(16) # ________

Note: The smaller the wire size number, the larger the wire thickness.

Initials: ________
### ARTICLE 310 - CONDUCTORS FOR GENERAL WIRING

Table 310.15(B)(16) (formerly Table 310.16) Allowable Ampacities of Insulated Conductors Rated Up to and Including 2000 Volts, 60°C Through 90°C (140°F Through 194°F), Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)*

<table>
<thead>
<tr>
<th>Size AWG or kcmil</th>
<th>Temperature Rating of Conductor [See Table 310.14(A.)]</th>
<th>Size AWG or kcmil</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60°C (140°F)</td>
<td>75°C (167°F)</td>
</tr>
<tr>
<td>Types TW, UF</td>
<td>Types RHW, THHW, THW, THWN, XHHW, USE, ZW</td>
<td>Types TBS, SA, SIS, FEPE, FEPEB, Mi, RHH, RHW-2, Thiil, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2</td>
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</table>

*Refer to 310.15(B)(2) for the ampacity correction factors where the ambient temperature is other than 30°C (86°F).

**Refer to 240.4(D) for conductor overcurrent protection limitations.

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2016 California Electrical Code    70-161       Residential PV Table 310.15(B)(16)
REQUIRED LABELS FOR RESIDENTIAL SOLAR ELECTRIC (PV) SYSTEMS
(SEE DRAWING PV-1)

• LABELS SHALL BE MADE OF RED PLASTIC MATERIAL WITH ENGRAVED WHITE LETTERS.
• LETTERS SHALL BE A MINIMUM 3/8” IN SIZE.
• THE LABELS SHALL BE PERMANENTLY ATTACHED TO THE APPROPRIATE PANEL.
• AC & DC CONDUIT, RACEWAY, ENCLOSURES, CABLE ASSEMBLIES AND JUNCTION BOXES SHALL BE RED BACKGROUND MATERIAL WITH WHITE LETTERING MADE OF DURABLE ADHESIVE, REFLECTIVE, WEATHER RESISTANT MATERIAL SUITABLE FOR THE ENVIRONMENT PER UL 969; TO ALERT FIRE SERVICE TO AVOID CUTTING THEM OFF.

**WARNING!**
DUAL POWER SUPPLY
SOLAR ELECTRIC SYSTEM

THIS TAG TO BE ATTACHED TO METER PANEL

**WARNING!**
DUAL POWER SUPPLY
SOLAR ELECTRIC SYSTEM
DISCONNECT

THIS TAG TO BE ATTACHED TO PV DISCONNECT DEVICE

**CAUTION:**
SOLAR ELECTRIC CIRCUIT

THIS TAG TO BE ATTACHED TO AC AND DC CIRCUIT EQUIPMENT

DRAWING PV-1
REQUIRED LABELS FOR RESIDENTIAL SOLAR ELECTRIC (PV) SYSTEMS WITH BATTERY BACK-UP

(SEE DRAWING PV-2)

- Labels shall be made of red plastic material with engraved white letters.
- Letters shall be a minimum 3/8” in size.
- The labels shall be permanently attached to the appropriate panel.
- AC & DC conduit, raceway, enclosures, cable assemblies and junction boxes shall be red background material with white lettering made of durable adhesive, reflective, weather resistant material suitable for the environment per UL 969; to alert fire service to avoid cutting them off.

**WARNING!**
**DUAL POWER SUPPLY SOLAR ELECTRIC SYSTEM**
**CRITICAL LOAD MUST BE DISCONNECTED SEPARATELY**

This tag to be attached to meter panel

**WARNING!**
**DUAL POWER SUPPLY SOLAR ELECTRIC SYSTEM**
**DISCONNECT**

This tag to be attached to PV disconnect device

**CAUTION:**
**SOLAR ELECTRIC CIRCUIT**

This tag to be attached to AC and DC circuit equipment

**CRITICAL LOAD DISCONNECT**

This tag to be attached to battery bank disconnect

DRAWING PV-2
REQUIRED LABELS FOR RESIDENTIAL MULTI - SOLAR ELECTRIC (PV) SYSTEMS
(SEE DRAWING PV-3)

- LABELS SHALL BE MADE OF RED PLASTIC MATERIAL WITH ENGRAVED WHITE LETTERS.
- LETTERS SHALL BE A MINIMUM 3/8” IN SIZE.
- THE LABELS SHALL BE PERMANENTLY ATTACHED TO THE APPROPRIATE PANEL.
- AC & DC CONDUIT, RACEWAY, ENCLOSURES, CABLE ASSEMBLIES AND JUNCTION BOXES SHALL BE RED BACKGROUND MATERIAL WITH WHITE LETTERING MADE OF DURABLE ADHESIVE, REFLECTIVE, WEATHER RESISTANT MATERIAL SUITABLE FOR THE ENVIRONMENT PER UL 969; TO ALERT FIRE SERVICE TO AVOID CUTTING THEM OFF.

WARNING!
DUAL POWER SUPPLY
2 - SOLAR ELECTRIC SYSTEMS
2 - DISCONNECT DEVICES

THIS TAG TO BE ATTACHED TO METER PANEL

WARNING!
DUAL POWER SUPPLY
SOLAR ELECTRIC SYSTEM DISCONNECT 1

WARNING!
DUAL POWER SUPPLY
SOLAR ELECTRIC SYSTEM DISCONNECT 2

THIS TAG TO BE ATTACHED TO PV DISCONNECT DEVICES

CAUTION:
SOLAR ELECTRIC CIRCUIT

THIS TAG TO BE ATTACHED TO AC AND DC CIRCUIT EQUIPMENT

DRAWING PVT-3
Residential Photovoltaic

*Provide a 3' clear access pathway from the eave to the ridge on each roof slope where panels are located.

0° clearance required when adjacent has no panel.

3' min.

18' min. when panels on adjacent side of the roof.
Minimum Meter Set Clearance Requirements

- Figure 2-19, “Electric and Gas Meter Set Separation Dimensions and Clearance,” below; Figure 2-20, “Gas Meter Set Clearance From Building Openings,” on Page 2-32; and figure 2-21, “Gas Regulator Set Clearance Requirement From Sources of Ignition,” on Page 2-33, all represent various metering facilities' clearance requirements. If applicants install enclosures on their premises, the enclosures must meet the specifications provided in these illustrations.

![Diagram of meter set clearance requirements](image)

Notes in Reference to Figure 2-19.

1. Electric meter panel locations are subject to utility approval and must comply with the applicable code requirements. PG&E does not have specific requirements for the distance from the electric panel to the outside building corner. See Section 5, “Electric Metering: General,” for properly locating the electric meters. See Subsection 5.4.4, “Working Space,” on Page 5-11, for electric meter working space.

2. Applicants must not install any electrical devices or equipment, including wires, cables, metering enclosures, telecommunication enclosures, bond wires, clamps, or ground rods within the shaded area around the gas meter. The 36-inch distance can be reduced to 18 inches for electrical devices or equipment certified for NEC Class I, Division 2 locations.

3. Place the gas service riser 6 inches to 9 inches from the finished wall. The completed customer houseline at the service delivery point must extend a minimum of 4 to 6 inches from the finished wall where the meter is to be set, and must be 26 inches above the finished grade. See Figure 2-14 on Page 2-26, Figure 2-15 on Page 2-27, and Subsection 2.5 on Page 2-42.

4. The minimum dimensions and clearances in figure 2-19 are good for gas meters up to the 1,000 class. See Figure 2-15 on Pages 2-26 and 2-27 for illustrations of clear and level working space in front of the gas meter.