



# RESIDENTIAL PHOTOVOLTAIC SYSTEMS (PV)

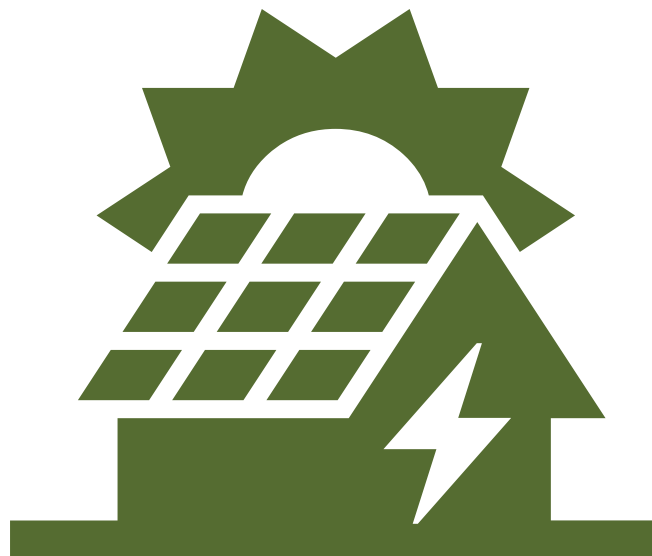
**APPLICABLE CODES:** 2019 CBC, CRC, CEC, CFC, CPAU's Rule 27 (EUSERC 501) and PAMC

## INTRODUCTION

The purpose of this guideline is to assist permit applicants in the permitting and inspection process for residential PV systems. Our goal is to provide you with the quickest turnaround time possible, consistent review and inspections. The information provided in this document is general in nature and intended as a guide. Each project is unique and additional requirements may be required as deemed appropriate. All plans, forms and documents are to be submitted electronically through our Palo Alto Online Permitting System (OPS). Please see our **ONLINE PERMITTING SYSTEM (OPS) WEBSITE** for instructions on how to submit your application. For project scope that includes electrical service upgrade, ESS and/or EVCS components, refer to their respective guidelines for additional information.

### LAUNCH OF SOLAR APP+

*As an alternative to the traditional submittal and plan review process, qualifying projects may submit through Solar APP+. A qualifying project in Palo Alto would be a stand-alone roof-mounted photovoltaic system that meets current Solar APP+ PV eligibility criteria and does not include an electrical service upgrade or battery storage.*



# SUBMITTAL INFORMATION

This information will help prepare you for a successful permit submission.

## APPLICABLE FORMS/DOCUMENTATION

These documents are also on our Online Permitting System (OPS) website.

- [BUILDING PERMIT APPLICATION](#)
- [CPAU PHOTOVOLTAIC ELECTRIC LOAD SHEET](#)
- [RESIDENTIAL ELECTRIC LOAD CALCULATOR](#)
- [CPAU SIGNED & APPROVED INTERCONNECTION AGREEMENT\\*](#)

### **\*Informational Note:**

*Applying for and obtaining pre-approval for a City of Palo Alto Utilities (CPAU) Interconnection Agreement is a crucial pre-requisite to applying for an energy storage building permit. The approved interconnection agreement must be signed by the property owner. To learn how to apply, check out the [Electric Utilities Pre-Approval for ESS/PV Instructions](#).*

*The Interconnection Agreement must be refiled if there is an existing alternative power source and you are adding capacity or additional sources.*



## GENERAL REQUIREMENTS

- Plan shall be printable at 11"x 17" minimum and a maximum of 30"x 42"
- Text shall be a minimum size 10 Font, 0.12" or 1/8"
- Specify the following information on the Cover Sheet:
  - Applicable Codes
  - Occupancy Type of Existing Structure
  - Type of Existing Roofing Material
  - Identify if residence is sprinklered when PV coverage exceed 33 percent of total roof plan area. (CFC 1204.2.1.2, 1204.2.1.3 and CRC R325.3)

- Capacity of System in kW-AC (Kilowatts – Alternating Current)
- Type of PV System (Roof-Mounted Photovoltaic Panels, Building-Integrated Photovoltaic System or Ground-Mounted Photovoltaic System)
- Existing Roofing Fire Classification

### Provide Project Professional Design Documents (CBC 107 and CRC R106):

- Site Plan/Roof Plan
  - Show location of existing main panel and meter. Include size of panel (AMPS)
  - Identify location of proposed PV panels and location and size of any existing PV, ESS or EVCS.
  - Identify location of proposed related equipment, including panelboards and standalone disconnects.
  - Indicate layout of existing roof penetrations, such as vents, chimneys, skylights, etc.
  - Show property line setback distances to the proposed equipment when equipment is not attached to the structure.
- Elevation Plans, if structure or equipment is in flood plain when equipment is installed outside.
  - Lowest part of equipment must be installed 1 foot above Base Flood Elevation (BFE).
- Structural Attachment Details
- Structural Calculation, such as ballast system, standing seam roofs, or any tilt-up system, etc., as applicable
- Waterproofing Details
- Three-line Electrical Diagram
- Residential Electrical Load Calculation
- Signage and Labeling Plan, indicating means of rapid shutdown.
- Manufacturer's Equipment Specification Sheets and Installation Instructions

***All equipment shall be listed by a Nationally Recognized Testing Laboratory (NRTL) either individually or as a complete, self-contained system according to a recognized standard. (CEC 110.3 and CRC R324.3.1)***

# PLAN REVIEW INFORMATION

This information will help provide an understanding of what our city's plan review staff will generally look for.

## BUILDING

### Type of Photovoltaic System

- Roof-Mounted Photovoltaic System (CRC R324.4)
- Building-Integrated Photovoltaic System (CRC 324.5)
- Ground-Mounted Photovoltaic System (CRC R324.7)

### Fire Classification of solar panels/roofs are to have at least the same rating as the roof fire classifications required by CRC R902. (CRC R324.4.2 and R324.5.2)

### Means of Access and Clearances

- Roof Access, Pathways and Setback at Ridge (CRC R324.6, CFC 1204.2)
- Working Clearances at Equipment (CEC 110.26)
- Vegetation including trees, which impact working clearances, shall be removed or relocated.

### Manufacturer's Equipment Specification Sheets and Installation Instructions, such as:

***All equipment shall be identified and listed for the application. (CEC 110.3 and 690.4(B))***

- PV panels shall be listed and labeled for residential use in accordance with UL 1703. (CEC 110.3, 690.4(B) and CRC R324.3.1)
- Inverter
- Transformer or Autotransformer
- Transfer Switch(es)
- Converter
- Combiner
- Interconnecting Cables and Connectors
- Recombiner
- Charge Controller

### Structural Attachment Details

### Structural Calculation considering roof and wind loads if required (CRC R324.4.1)

- Use manufacturer's stamped span tables, including wind load
- PE-stamped plans and calculations

### Waterproofing Details (CRC 324.4.3)

### Three-line Electrical Diagram

- Wiring Method/Materials/Sizes (CEC 110.8 and 300)
- Identify AC and DC Photovoltaic wiring locations

- Photovoltaic DC circuits that are routed inside a building shall be contained in a metal raceway. (CEC 690.31(G))
- Method of Interconnection (CEC 705)
- Systems connected to the utility grid shall use inverters listed for utility interaction (CEC 705.6)
- Overcurrent Protection (CEC 705.30 and 690.9)
- Grounding and Bonding for the PV and ESS (if installed), including the ground return path. (CEC 250)

### Disconnecting Means (CEC 690 Part III)

- Interconnection Disconnect (CEC 705.21, 705.22 and 110.25)
- Disconnect Directory/Labeling (CEC 690 Part III, 705.10, 706.11, 110.22 (A) and CFC 1204.5)

## FIRE & BUILDING'S CODE REQUIREMENT SUMMARY FOR INTERCONNECTION & EQUIPMENT DISCONNECT(S)

These disconnects are required, plainly indicating whether open or closed, lockable in the open (off) position, within sight of the alternative power source, such as PV or group of ESS. The manufacturer of a system may have in their design, a disconnect function integrated in an inverter, which might satisfy one or both disconnect requirements. All equipment must be listed for its intended use.

### Signs, Placards, Directories and Markings (CEC 690 Part III, CFC 1204.5)

- Field-Applied Hazard Markings ANSI Z535.4-2011 – Product Safety Signs and Labels (CEC 110.21 (B))
- Type and Location
  - Rapid Shutdown Type (CFC 1204.5.1)
  - Diagram (CFC 1204.5.1.1)
  - Location (CFC 1204.5.1.2)
  - Point of Interconnection (CEC 705.12)
  - Interconnected Power Production Sources Directory (CEC 705.10)

***See Illustrations 2, 3A, 3B, 3C and Signs and Labels Table for Clarification/Guidance***

### Equipment subject to physical damage shall be protected by approved means. (CEC 110.27(B))

***See Illustration 1 for Clarification/Guidance – Similar to ESS***

## CPAU ELECTRICAL ENGINEERING

- ❑ **A knife/blade type, lockable (Rule 27) disconnect is required to be within 10' and within sight of the main service panel.** (Utilities Rules and Regulation 27(D)(1) (d)). This disconnect shall be installed between the main service and the alternative energy source interconnection point. If not capable of being installed within sight, a phenolic directory indicating location is required.

## UTILITIES' REQUIREMENT SUMMARY FOR (RULE 27) DISCONNECT EXPLANATION

An AC disconnect (Referred to as Rule 27 Disconnect), of the knife/blade type, lockable in the open (off) position, is required within 10 ft and within sight of the main service panel. It must plainly indicate whether open or closed. The manufacturer's term for this is 'safety switch.' This requirement by Utilities is intended to prevent back feed during servicing of their side of the meter. This is to assure Utilities personnel that they will not be affected by energy output from other sources. Note: If this disconnect is also within 10 feet and within sight of the equipment or alternative power source, it might also fulfill the Building and Fire code requirement for an alternative power source or equipment disconnect.

- ❑ **All electrical equipment clearance requirements to gas meter are to be as specified in Utilities Standard Detail SR-CN-0-1009 of the Electric Service Requirements and Gas Standard Detail GD-02A of Water, Gas, Wastewater Utility Standards.**

Conduit without couplings is allowed to pass through the "Restricted Area" at a height of more than 6 feet.

*See Illustration 4 for Clarification/Guidance*

## PLANNING

- ❑ **If a new separate structure is needed for the installation of a photovoltaic system, Planning approval will be required.**

## FIRE

- ❑ **Access and Pathways (CFC 1204.2)**  
**Exception: Occupancy Group U (CFC 1204.2 Ex 1)**  
**Exception: Flat Roofs 2:12 or less (CFC 1204.2.1 Ex 2)**
  - Pathways to Ridge (CFC 1204.2.1.1)
  - Setbacks at Ridge (CFC 1204.2.1.2)
  - Emergency Escape and Rescue Openings (CFC 1204.2.2)  
Smoke Detection needs to comply with CRC R314 and CPMC 16.06.200.
- ❑ **Smoke Detection needs to comply with CRC R314 and CPMC 16.06.200.**

# INSPECTION INFORMATION

This information will help provide an understanding of what our city's inspection staff will generally look for.

## PRIOR TO INSPECTION

- Approved plans, permit, and installation instructions shall be available on site at time of inspection.
- Major changes, such as size and scope of system, change in equipment or relocation of equipment that would affect wire and conduit size shall be submitted to the city for review and approval prior to inspection. A minor change, such as moving equipment yet remaining in the general area or placing a solar panel in a different location on the roof would not require resubmission.
- De-energize relevant electrical panels prior to removing the dead-front. Notify tenant/owner/occupant prior to de-energizing. All equipment shall be open and ready for inspection.
- The installer shall check the existing electrical panel for unsafe conditions. If existing panel is found to be unsafe, it may be necessary to make repairs or replace equipment. This work may require change in scope of the permit and a revision.
- Torque specifications are to be determined and provided for any electrical termination, such as circuit breakers, equipment grounds, neutrals, and feeders. (CEC 110.3 (B) and 110.14 (D))
- We recommend that the electrical contractor be on site with the following tools: (CEC 100.3(B) and CEC 110.14(D))
  - Torque wrenches with in-lbs. or ft-lbs., as appropriate
  - Torque screwdriver (with a range of up to 50 in-lb.)
  - Slip-joint pliers to secure lugs in place when applying the proper torque
- Contractor to torque all connections per the manufacturer's listings prior to inspection. The inspector will witness a spot check. If all terminations are found to be torqued properly, nothing further will be required. If loose connections are found, all connections will be required to be torqued in the presence of the inspector. (CEC 110.3 (B) and 110.14 (D))

## INSPECTION

- Required Inspections (to be scheduled at the same time)**
    - 703 – PHOTOVOLTAIC / FINAL
    - 280 – TRAVEL TIME WEST OF 280 (Use in addition to required inspections for projects west of 280)
  - Working Spaces About Electrical Equipment (CEC 110.26)**
    - Minimum 36 inches in depth, 30 inches in width, and 6 feet-6 inches in height.
    - Vegetation, including trees, which impact working clearances, shall be relocated.
  - Equipment subject to physical damage shall be protected by approved methods. (CEC 110.27, CRC R327.8 and CFC 1206.11.7)**
- See Illustration 1 for Clarification/Guidance*
- Grounding will be verified in accordance with CEC 250.52(5) and CEC 250.53(A)(3)**
  - Equipment grounding shall be as required by the manufacturer. (CEC 110.3(B))**
  - Circuit breakers shall be listed as compatible with the panel they are installed in. (CEC 110.3 (B))**
  - Circuits shall be legibly identified for its specific purpose or use. (CEC 110.22(A) and CEC 408.4(A))**
  - Disconnects for Alternative Power Source and Equipment**
    - Interconnection (CEC 705.21, 705.22, 110.25 and 705.6)
    - Equipment disconnecting means shall be provided within sight of the electrical equipment. (CEC 705.22 and 110.25)
    - Utility (Rule 27) AC disconnect(s) shall be located within sight and within 10 feet of main electrical service. They shall be configured with visible-blades and lockable. (CPAU Electrical Engineering Interconnection Requirement, Rule 27)
  - Wiring Methods (CEC 690 Part IV)**
    - Guarding or installed in MC or raceway for systems over 30 volts (CEC 690.31 (A))
    - Separation of AC and DC conductors (CEC 690.31(B))
    - Identification of circuit conductors at all accessible points (CEC 690.31(B)(1))
    - DC Circuits run inside of building to be contained in metal raceways (CEC 690.31(G))

- Flexible, fine-stranded cables (CEC 690.31(H) and 110.14)
- Access to all junction boxes (CEC 690.34)

**Conductor Size (CEC 310)**

**Derating of more than three current-carrying conductors in conduit exceeding 24 inches in length. (CEC 310.15(B)(3))**

**Conduit Fill (CEC Chapter 9)**

**Signs, Placards, Directories and Markings (CFC 1204.5)**

- Field-Applied Hazard Markings ANSI Z535.4-2011 – Product Safety Signs and Labels (CEC 110.21 (B))  
***This jurisdiction has interpreted the weather-resistant to the use of painted metal or engraved plastic laminate.***
- Type and Location
- Rapid Shutdown Type (CFC 1204.5.1)
- Location (CFC 1204.5.1.2)
- Point of Interconnection (CEC 705.12)
- Interconnected Power Production Sources Directory (CEC 705.10, CFC 1204.5.1.1)

*See Illustrations 2, 3A, 3B, and 3C and Signs and Labels Table for Clarification/Guidance*



**Equipment subject to physical damage shall be protected by approved means. (CEC 110.27(B))**

*See Illustration 1 for Clarification/Guidance – Similar to ESS*

**Listed Smoke Alarms within the structure per CRC R314.8.**

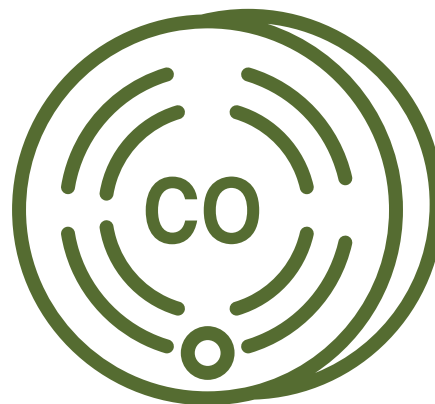
- PAMC 16.06.200- R314.1 Smoke detection and notification.

Listed single- and multiple-station smoke alarms complying with UL 217 shall be installed in accordance with the California Fire Code Sections 907.2.11.1 through 907.2.11.5 and manufacturer’s installation and use instructions.

Smoke alarms and smoke detectors shall be in compliance with this code or subject to the provisions of the Health and Safety Code, they shall also be listed and approved for rapid response to smoldering synthetic materials. All smoke alarms or detectors shall be of the photoelectric type or shall have equivalent detection capabilities in compliance with UL 217.

Exception: A combination photoelectric/ionization smoke alarm or detector may be used if located no closer than 20 feet to a kitchen, bathroom, fireplace or woodburning stove.

**Listed Carbon Monoxide Alarms if the residence has fuel-fired appliances and/or an attached garage with an adjoining opening. (R315.2)**



# ILLUSTRATIONS/TABLE

## Illustration 1: Vehicular Protection Example

Compliments of Cobalt Power Systems Inc.

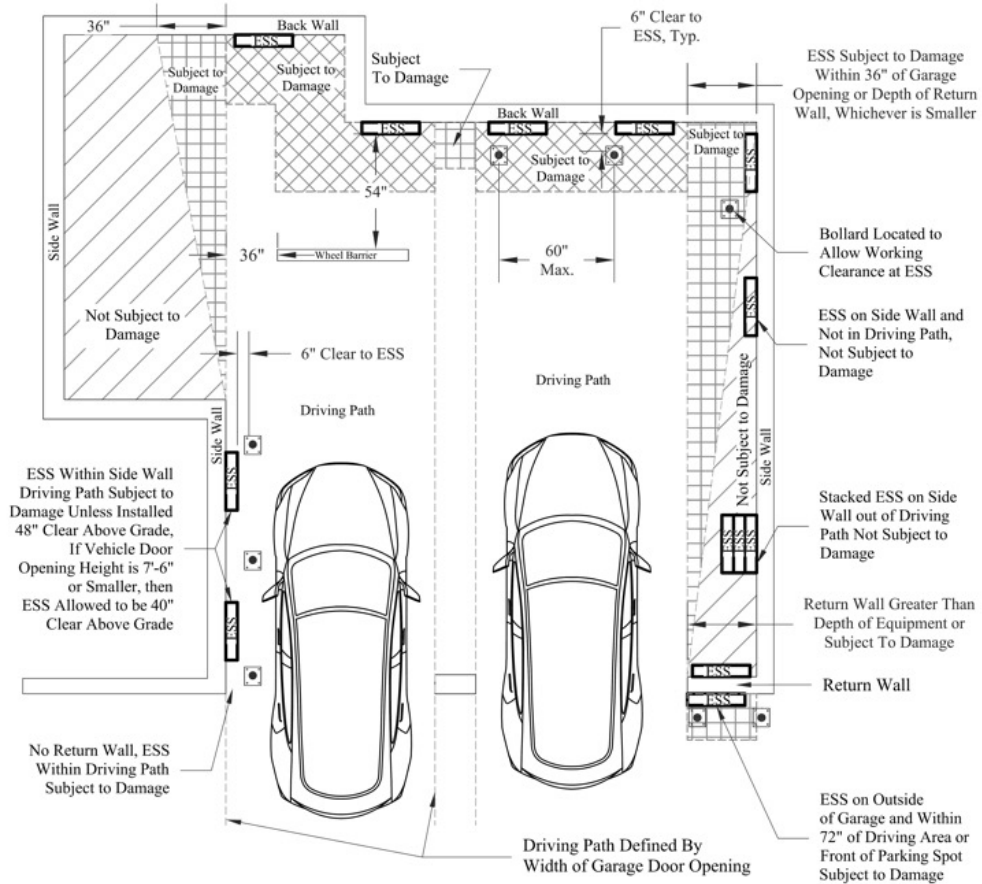
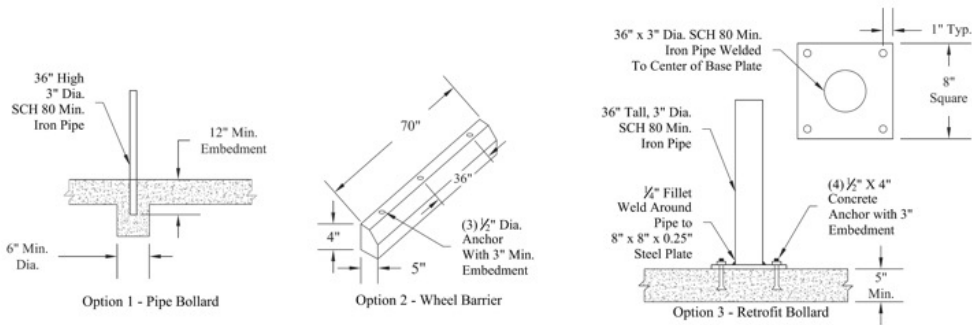







Image Courtesy of: Cobalt Power Systems



**SIGNS AND LABELS TABLE**

Labels shall be phenolic where exposed to sunlight. Labels required on conduit shall be permanent, weather resistant, and suitable for the environment. Labels shall be red background with white lettering. The following labels must be provided:

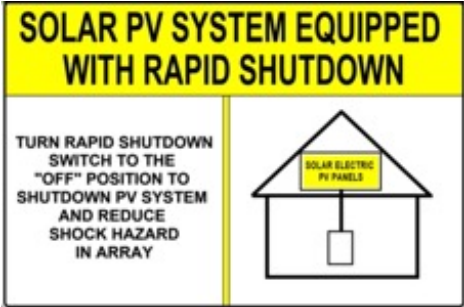
CEC Article (s)	Location of Label	Label Verbiage
705.10	Each Service Equipment Locations	 <p><b>WARNING:</b> EQUIPMENT FED BY MULTIPLE SOURCES LOCATION OF DISCONNECTING MEANS</p> <p>LAYOUT OR DESCRIPTION PROVIDED HERE</p> <p><i>See Illustrations 2, 3A, 3B, and 3C for Clarification/ Guidance on the Layout and Description</i></p>
690.13(B)	Photovoltaic AC System Disconnect	 <p><b>PV SYSTEM DISCONNECT</b></p>  <p><b>WARNING:</b> ELECTRIC SHOCK HAZARD TERMINALS ON LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION</p>
690.53	Photovoltaic DC Equipment Disconnect	 <p><b>PHOTOVOLTAIC DC DISCONNECT</b></p>  <p>MAXIMUM VOLTAGE (V<sub>mp</sub>) <input type="text"/></p> <p>MAXIMUM CURRENT (I<sub>mp</sub>) <input type="text"/></p> <p><b>Informational Note:</b> <i>This text must be included if this equipment is installed:</i></p> <p><i>“Maximum rated output current of the charge controller or DC-to-DC converter”</i></p>

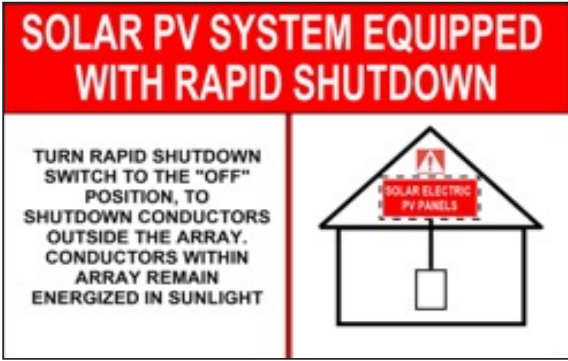
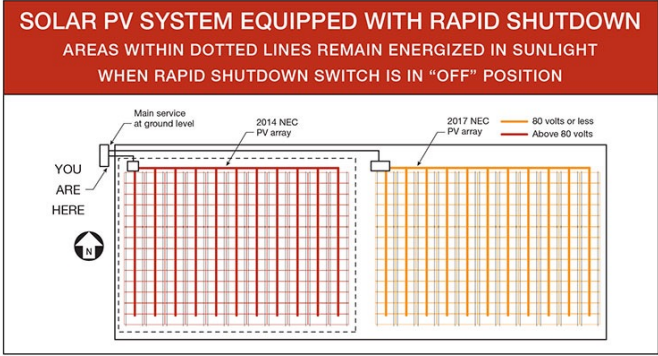


**SIGNS AND LABELS TABLE**

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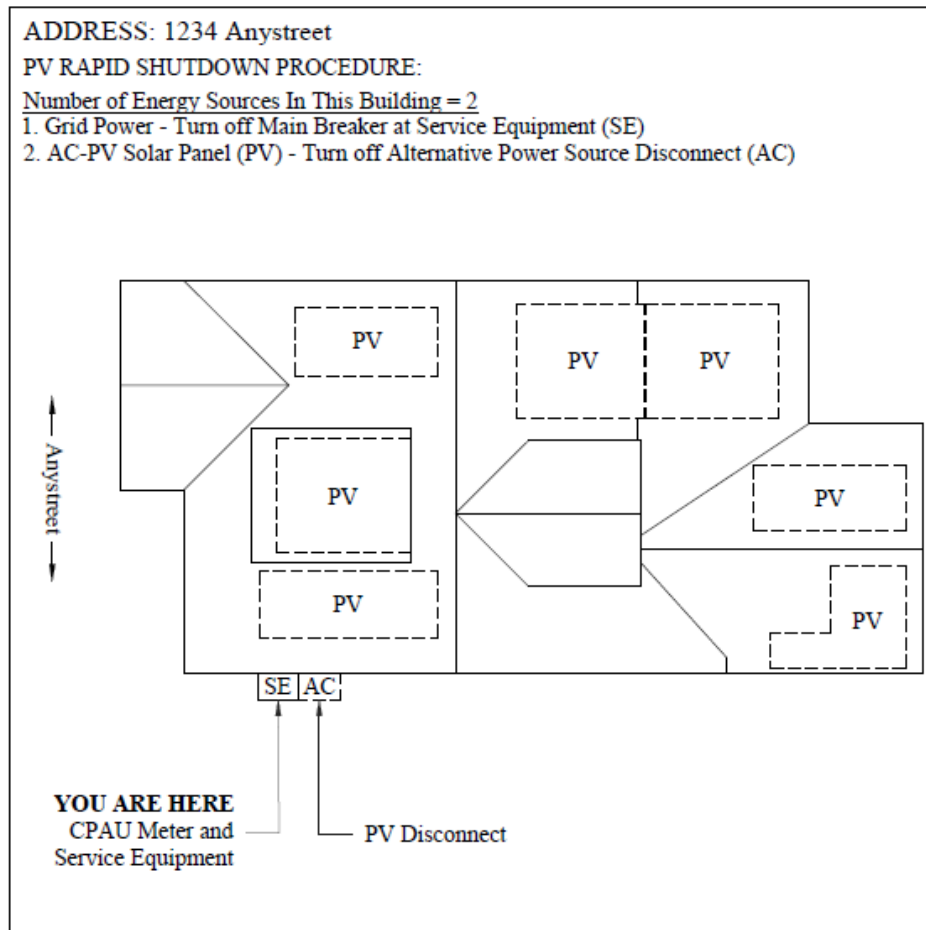
CEC Article (s)	Location of Label	Label Verbiage
690.54	Interactive Points of Interconnection	“RATED AC OUTPUT CURRENT <u>XXX</u> AMPS NORMAL OPERATING AC VOLTAGE <u>XXX</u> VOLTS”
705.12(B)(2)(3)(b)	Power Source Back Fed Output Breaker AKA: Inverter Output Breaker	<div style="border: 1px solid black; background-color: #c00000; color: white; padding: 5px; text-align: center;"> <b>WARNING:</b> DUAL POWER SOURCE SECOND SOURCE IS PV SYSTEM         </div> <div style="border: 1px solid black; background-color: #c00000; color: white; padding: 5px; text-align: center;"> <b>WARNING:</b> POWER SOURCE OUTPUT CONNECTION DO NOT RELOCATE THIS OVERCURRENT DEVICE         </div>
705.12(B)(2)(3)(c)	Interactive System Point of Interconnection  <b><u>Informational Note:</u></b> <i>Install this signage only if the interconnection is directly tapped into the busbar.</i>	<div style="border: 1px solid black; background-color: #c00000; color: white; padding: 5px; text-align: center;"> <b>WARNING:</b> DUAL POWER SOURCE SECOND SOURCE IS PV SYSTEM         </div> <div style="border: 1px solid black; background-color: #c00000; color: white; padding: 5px; text-align: center;"> <b>WARNING:</b> THIS EQUIPMENT FED BY MULTIPLE SOURCES TOTAL RATING OF ALL OVERCURRENT DEVICES EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE SHALL NOT EXCEED AMPACITY OF BUSBAR         </div>
690.31(G)(3) 690.31(G)(4)	DC Conduits, Raceways, Enclosures  <b><u>Informational Notes:</u></b> <i>1. Mark Every 10', At Turns, Above/Below Penetrations 2. 3/8" Minimum Text Size</i>	<div style="border: 1px solid black; background-color: #c00000; color: white; padding: 5px; text-align: center;"> <b>WARNING:</b> PHOTOVOLTAIC POWER SOURCE         </div>

CEC Article (s)	Location of Label	Label Verbiage
	<p><i>Electric Service</i></p> <p><b><u>Informational Note:</u></b>  <i>Only install if a de-rated main breaker is installed.</i></p>	<p>“MAXIMUM MAIN BREAKER SIZE: XXX AMPS”</p>
<p>Utility Department Requirement</p>	<p>Electrical Service</p> <p><b><u>Informational Note:</u></b>  <i>Only install when a supply side tap is utilized.</i></p>	<p>CAUTION! SUPPLY SIDE TAP.            OPEN AND LOCK AC PHOTOVOLTAIC DISCONNECT BEFORE REMOVING METER</p>
<p>690.56 (B)            690.56(C)(1)(a)            705.12            110.21(B)</p>	<p>Service Equipment and at Photovoltaic System Disconnects that Shutdown <b>ARRAY AND THE CONDUCTORS LEAVING THE ARRAY</b></p> <p><b><u>Informational Note:</u></b>  <i>Label shall be installed within 3 feet of service equipment.</i></p>	

CEC Article (s)	Location of Label	Label Verbiage
<p>690.56 (B) 690.56(C)(1)(b) 705.12 110.21(B)</p>	<p>Service Equipment and at Photovoltaic System Disconnects that Shutdown the <b>CONDUCTORS LEAVING THE ARRAY ONLY</b></p> <p><b>Informational Notes:</b></p> <ol style="list-style-type: none"> <li><i>This is legacy signage for systems installed under previous rapid shutdown codes.</i></li> <li><i>Label shall be installed within 3 feet of service equipment.</i></li> </ol>	
<p>690.56(C)(2)</p>	<p>Service Equipment and at Photovoltaic System Disconnects Where Both Type of Rapid Shutdown Are Utilized</p> <p><b>Informational Notes:</b></p> <ol style="list-style-type: none"> <li><i>This is legacy signage for systems installed under previous rapid shutdown codes.</i></li> <li><i>Illustration shown is conceptual.</i></li> <li><i>Label shall be installed within 3 feet of service equipment.</i></li> <li><i>Three colors shown for illustrational purposes only. Two colors (white on red) is acceptable.</i></li> </ol>	
<p>690.56(C)(3)</p>	<p>Rapid Shutdown Switch</p> <p><b>Informational Notes:</b></p> <ol style="list-style-type: none"> <li><i>3/8" Minimum Text Size</i></li> <li><i>Label shall be installed within 3 feet of service equipment.</i></li> </ol>	<p>"RAPID SHUTDOWN SWITCH FOR SOLAR PV SYSTEM"</p>

**Illustration 2: Directory Example with One Common Interconnection Disconnect**

Compliments of Cobalt Power Systems Inc.



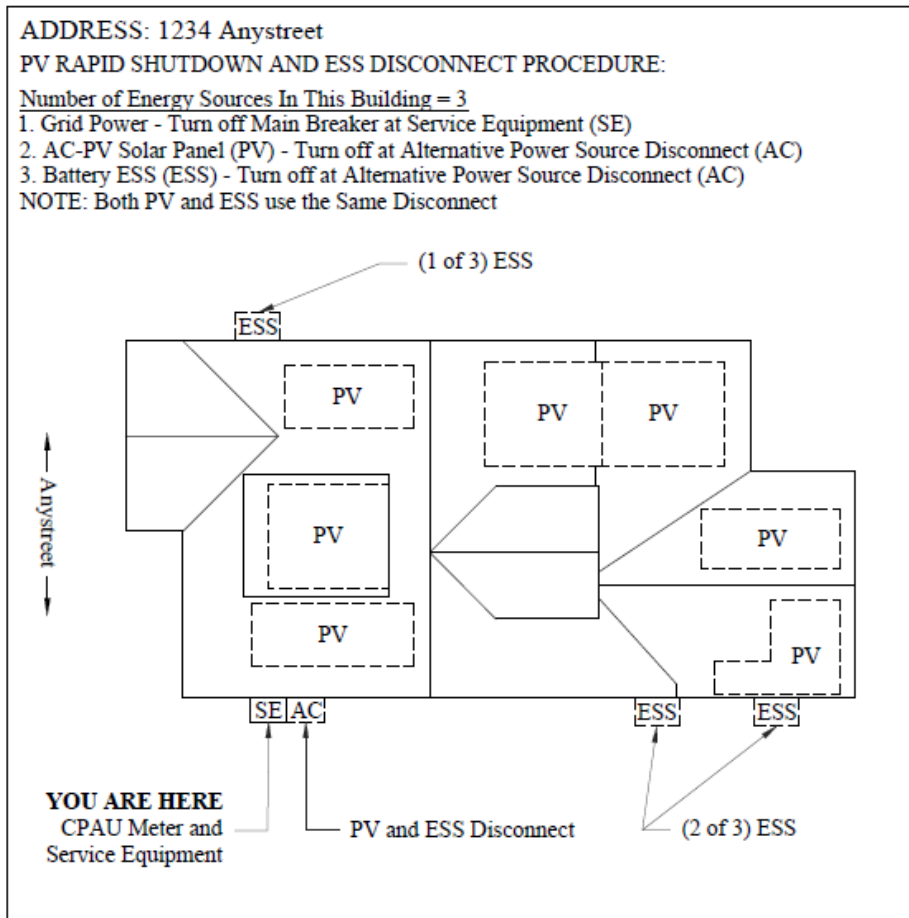
## NOTES:

1. This Example does not Necessarily Represent Required Equipment Disconnect Locations.
2. Utility Department (Rule 27) Disconnect Should Not be Indicated Unless it Serves as an Alternative Power Source Disconnect.
3. Recommended Directory Placard Size = 7" x 7"
4. UV Resistant Red Plastic Material with White Lettering at  $\frac{1}{8}$ " (0.12") Text Height

**Illustration 3A: Directory Example with One Common Interconnection Disconnect for all Alternative Power Sources**

Note that 'YOU ARE HERE' is at the Main Service Panel and Rapid Shutdown

Compliments of Cobalt Power Systems Inc.



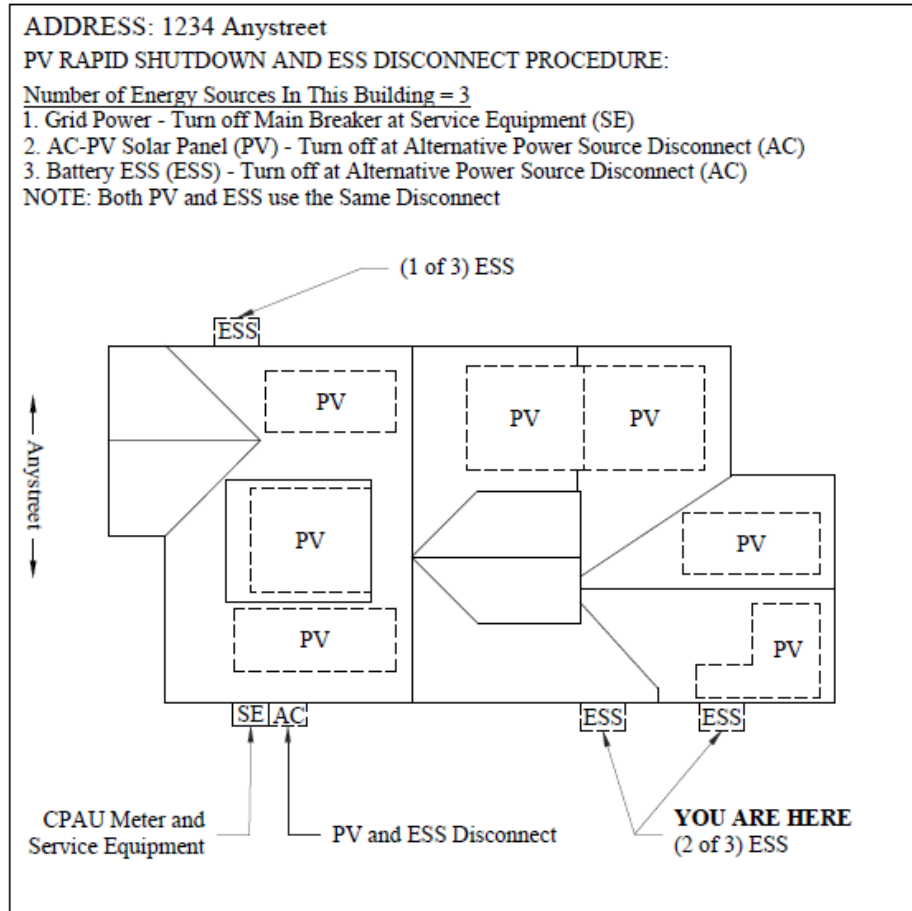
**NOTES:**

1. This Example does not Necessarily Represent Required Equipment Disconnect Locations.
2. Utility Department (Rule 27) Disconnect Should Not be Indicated Unless it Serves as an Alternative Power Source Disconnect.
3. Recommended Directory Placard Size = 7" x 7"
4. UV Resistant Red Plastic Material with White Lettering at 1/8" (0.12") Text Height

**Illustration 3B: Directory Example with One Common Interconnection Disconnect for all Alternative Power Sources**

Note that 'YOU ARE HERE' is at two of the three ESS Location

Compliments of Cobalt Power Systems Inc.



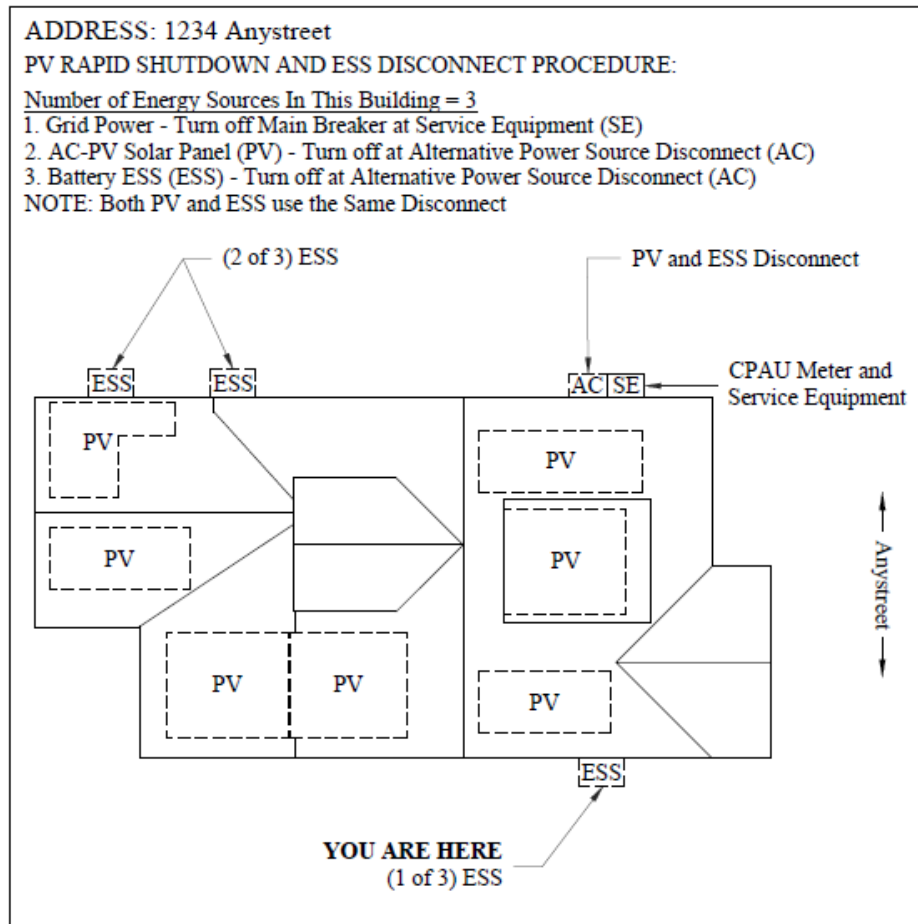
NOTES:

1. This Example does not Necessarily Represent Required Equipment Disconnect Locations.
2. Utility Department (Rule 27) Disconnect Should Not be Indicated Unless it Serves as an Alternative Power Source Disconnect.
3. Recommended Directory Placard Size = 7" x 7"
4. UV Resistant Red Plastic Material with White Lettering at 1/8" (0.12") Text Height

**Illustration 3C: Directory Example with One Common Interconnection Disconnect for all Alternative Power Sources**

Note that 'YOU ARE HERE' is at one of the ESS, opposite side of Main Service Panel and Rapid Shutdown

Compliments of Cobalt Power Systems Inc.

**NOTES:**

1. This Example does not Necessarily Represent Required Equipment Disconnect Locations.
2. Utility Department (Rule 27) Disconnect Should Not be Indicated Unless it Serves as an Alternative Power Source Disconnect.
3. Recommended Directory Placard Size = 7" x 7"
4. UV Resistant Red Plastic Material with White Lettering at  $\frac{1}{8}$ " (0.12") Text Height

**Illustration 4: Utilities Standard Detail SR-CN-0-1009**

Extracted from Utilities Department Electric Service Requirements

Additional reference: Gas Standard Detail GD-02A of Water, Gas, Wastewater Utility Standards

