

## **Technical Bulletin: NYSERDA Solar Photovoltaic System Labeling Guidelines**

July 2013

Revised March 2014

### **Scope and Purpose**

This document was prepared as part of NYSERDA's ongoing quality assurance (QA) for the solar photovoltaic (PV) non-competitive incentive program, currently funded under PON 2112.

As part of this QA program, Cadmus has performed approximately 800 inspections on PV systems installed in New York State since January 1<sup>st</sup>, 2012. Many of these inspections have found issues related to incorrect, incomplete, or missing labels on installed equipment. The National Electrical Code® (NEC), OSHA and ANSI provide guidelines for required labels. However, these guidelines are not necessarily organized in an easy to use manner and make it difficult for system installers to get a clear picture of what is required labeling for PV systems.

The purpose of this document is to provide participating installers and other stakeholders with a summary of the required labels for the most common PV system configurations. While specific installations may have different labeling requirements, the labels included in this bulletin represent those required for PV systems under NYSERDA's QA program.

Please note that this bulletin references both the 2008 and 2011 editions of the NEC. The 2011 NEC will be adopted as part of the statewide building code updated expected to occur this summer.

### **Document Organization**

This bulletin includes the following sections:

- **Label Construction and Color**
- **Label descriptions and NEC references**
  - Arc-Flash Hazard Warning: NEC 110.16
  - Directory/Identification of Power Sources: 705.10, 225.37 & 230.2(E)
  - Conductor Identification & Grouping: 690.4(B)&(F) (\*New to 2011 NEC\*), 200.6
  - Ground Fault Indication: 690.5(C)
  - Identification of PV Disconnects: 690.14(C)(2)
  - Terminals Energized on Line & Load Sides of Disconnect in Open Position: 690.17
  - DC PV Source & Output Circuits Inside a Building: 690.31(E)(3)&(4) (\*New to 2011 NEC\*)
  - Ungrounded PV Systems: 690.35(F)

- DC Photovoltaic Power Source: 690.53
- Identification of PV System Interconnection: 690.54
- Batteries: 690.55
- Identification of Power Sources: 690.56(B)
- Point of Connection Identification: 690.64(B)(4) (\*relocated to Article 705.12(D)(4) in 2011 NEC\*)
- Identification and warning of additional power source at the panel board: 690.64(B)(7) (\*relocated to Article 705.12(D)(7) in 2011 NEC\*)
- **Common Labeling Mistakes to Avoid**
- **Example Label Location Diagrams**
  - Residential Supply Side Connected PV System
  - Commercial Supply Side Connected PV System
  - Residential Load Side Connected PV System
  - Commercial Load Side Connected PV System
  - Residential Micro-Inverter PV System
  - Commercial Micro-Inverter PV System

## Label Construction and Color

All labeling used outdoors must be engraved metal, durable vinyl labeling compliant with UL 969, or UV stabilized engraved plastic. Even “UV resistant” 2 mil labels, such as those available from Kroy and others, are generally rated for 5-7 years of outdoor exposure-far less than the expected 25 year life of the PV system. Values written in marker on outdoor labels are not acceptable, as the marking will wear off with exposure to sunlight and weather. Labels used indoors may be made of durable vinyl or paper and values may be written in using marker or pen-but must be legible.

It is a violation of an enclosure’s UL listing (and NEC 110.3(B) to cover any existing manufacturer applied labels with installation specific labels, so this should be avoided. Additionally, it is highly recommended that the installer attach a label or magnet with the company name and contact information at the inverter.

Label colors are chosen per OSHA 29 CFR 1910.145 direction that the requirements of ANSI Z53.1-1967 & Z535 be used. Current code allows for warning signs being red with white lettering or the ANSI & OSHA required orange with black lettering. Informational signage is yellow with black lettering. There are no minimum font size requirements for wording of the labeling unless otherwise noted in the references below. To avoid future confusion on color requirements for PV signage, the 2014 NEC will adopt ANSI Z535 sign requirements exclusively.

## Label Descriptions and NEC References

There are various articles in the NEC that require labeling for PV systems. Many of the specific requirements are found in Article 690, Solar Photovoltaic Systems. Additional requirements are found in Article 110: Requirements for Electrical Installation; Article 200: Use and Identification of Grounded Conductors; Article 225: Outside Branch Circuits and Feeders; Article 230:

Services; and Article 705: Interconnected Electric Power Production Sources. Requirements comply with NEC 2008 & NEC 2011.

## Arc-Flash Hazard Warning

### 110.16 Flash Protection

Electrical equipment- such as switchboards, panel boards, industrial control panels, meter socket enclosures, and motor control centers- that is in other than dwelling occupancies and is likely to require examination, adjustment, servicing, or maintenance while energized shall be field marked to warn qualified persons of potential electric arc flash hazards. The marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

❖ *Cadmus Note: may apply to commercial installations*



Figure 1

## Directory: Identification of Power Sources

A directory identifying the solar system and other power sources on site should be placed at service equipment and state the location of system disconnecting means if not at the same location. The NEC stipulates this requirement in the following articles:

### 705.10 Directory

A permanent plaque or directory, denoting all electric power sources on or in the premises, shall be installed at each service equipment location and at locations of all electric power production sources capable of being interconnected.

### 225.37 Identification

Where a building or structure has any combination of feeders, branch circuits, or services passing through it or supplying it, a permanent plaque or directory shall be installed at each feeder and branch-circuit disconnect location denoting all other services, feeders, or branch circuits supplying that building or structure or passing through that building or structure and the area served by each.

### 230.2(E) Identification

Where a building or structure is supplied by more than one service, or any combination of branch circuits, feeders, and services, a permanent plaque or directory shall be installed at each service disconnect location denoting all other services, feeders, and branch circuits supplying that building or structure and the area served by each. See 225.37.

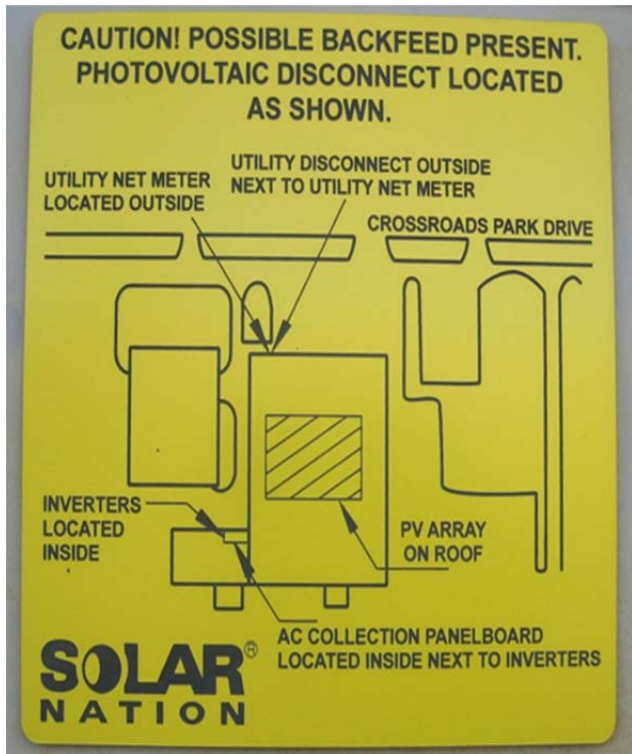


Figure 2



Figure 3

## Conductor Identification & Grouping

### 690.4(B) Identification and Grouping (\*New to 2011 NEC\*)

PV system conductors shall be identified and grouped as required by 690.4(B)(1) through (4). The means of identification shall be permitted by separate color coding, marking tape, tagging, or other approved means.

1. **PV Source Circuits.** PV source circuits shall be identified at all points of termination, connection, and splices.
2. **PV Output and Inverter Circuits.** The conductors of PV output circuits and inverter input and output circuits shall be identified at all points of termination, connection, and splices.

3. **Conductors of Multiple Systems.** Where the conductors of more than one PV system occupy the same junction box, raceway, or equipment, the conductors of each system shall be identified at all termination, connection, and splice points. *Exception: Where the identification of the conductors is evident by spacing or arrangement, further identification is not required.*
4. **Grouping.** Where the conductors of more than one PV system occupy the same junction box or raceway with a removable cover(s), the ac and dc conductors of each system shall be grouped separately by wire ties or similar means at least once, and then shall be grouped at intervals not to exceed 1.8 m (6 feet). *Exception: The requirement for grouping shall not apply if the circuit enters from a cable or raceway unique to the circuit that makes the grouping obvious.*

### **690.4(F) Circuit Routing.**

PV source and PV output conductors, in and out of conduit, and inside of a building or structure, shall be routed along building structural members such as beams, rafters, trusses, and columns where the location of those structural members can be determined by observation. Where circuits are imbedded in built-up, laminate, or membrane roofing materials in roof areas not covered by PV modules and associated equipment, the location of circuits shall be clearly marked.

### **200.6 Means of Identifying Grounded Conductors**

**(A) Sizes 6 AWG or Smaller.** An insulated grounded conductor 6 AWG or smaller shall be identified by one of the following means:

1. A continuous white outer finish.
2. A continuous gray outer finish.
3. Three continuous white stripes along the conductor's entire length on other than green insulation.
4. Wires that have their outer covering finished to show a white or gray color but have colored tracer threads in the braid identifying the source of manufacture shall be considered as meeting the provisions of this section.

**(B) Sizes 4 or Larger.** An insulated grounded conductor 4 AWG or larger shall be identified by one of the following means:

1. A continuous white outer finish.
2. A continuous gray outer finish.
3. Three continuous white stripes along the conductor's entire length on other than green insulation.
4. At the time of installation, by a distinctive white or gray marking at its terminations. This marking shall encircle the conductor or insulation.



Figure 4

## Ground Fault Indication

### 690.5(C) Labels and Markings

A warning label shall appear on the utility-interactive inverter or be applied by the installer near the ground-fault indicator at a visible location, stating the following:

WARNING  
ELECTRIC SHOCK HAZARD IF A GROUND FAULT IS INDICATED, NORMALLY  
GROUNDED CONDUCTORS MAY BE UNGROUNDED AND ENERGIZED

When the photovoltaic system also has batteries, the same warning is to be applied by the installer in a visible location at the battery bank.

*Labeling addressing 690.5(C) – 690.14(C)(2) – 690.17 – 690.53*





Figure 5

## Identification of PV Disconnects

### 690.14(C)(2) Marking

Each photovoltaic system disconnecting means shall be permanently marked to identify it as a photovoltaic system disconnect.

- ❖ *Cadmus Note: This requirement applies to both AC and DC disconnects. The International Fire Code (IFC) recommends labels that identify the main service disconnect or critical disconnects with reflective, red and white labels (IFC 605.11).*

## Terminals Energized on Line & Load Sides of Disconnect in Open Position

### 690.17 Switch or Circuit Breaker

Where all terminals of the disconnecting means may be energized in the open position, a warning sign shall be mounted on or adjacent to the disconnecting means. The sign shall be clearly legible and have the following words or equivalent:

WARNING  
ELECTRIC SHOCK HAZARD. DO NOT TOUCH TERMINALS.  
TERMINALS ON BOTH THE LINE AND LOAD SIDES MAY BE ENERGIZED  
IN THE OPEN POSITION.



Figure 6

## DC PV Source & Output Circuits Inside a Building (\*New to 2011 NEC\*)

### 690.31(E)(3) Marking or Labeling Required

The following wiring methods and enclosures that contain PV power source conductors shall be marked with the wording “Photovoltaic Power Source” by means of permanently affixed labels or other approved permanent marking:

1. Exposed raceways, cable trays, and other wiring methods
2. Covers or enclosures of pull boxes and junction boxes
3. Conduit bodies in which any of the available conduit opening are unused

### 690.31(E)(4) Marking and Labeling Methods and Locations

The labels or markings shall be visible after installation. Photovoltaic power circuit labels shall appear on every section of the wiring system that is separated by enclosures, walls, partitions, ceilings, or floors. Spacing between labels or markings, or between a label and a marking, shall not be more than 3 m (10 feet). Labels required by this section shall be suitable for the environment where they are installed.

- ❖ *Cadmus Note: The International Fire Code (IFC) has specific requirements for this label: that these labels must have reflective properties so that they are clearly visible in the beam of a flashlight. The IFC is specifying that the markings must be detectable from a distance, which denotes that the minimum text height is 3/8” using white lettering on a red background. Finally, the IFC recommends that the marker meets the adhesive label specification of UL969.*





Figure 7



Figure 8

## Ungrounded PV Systems

### 690.35(F) Ungrounded PV Power Systems

The photovoltaic power source shall be labeled with the following warning at each junction box, combiner box, disconnect, and device where energized, ungrounded circuits may be exposed during service:

WARNING  
ELECTRIC SHOCK HAZARD. THE DC CONDUCTORS  
OF THIS PHOTOVOLTAIC SYSTEM ARE  
UNGROUNDING AND MAY BE ENERGIZED.

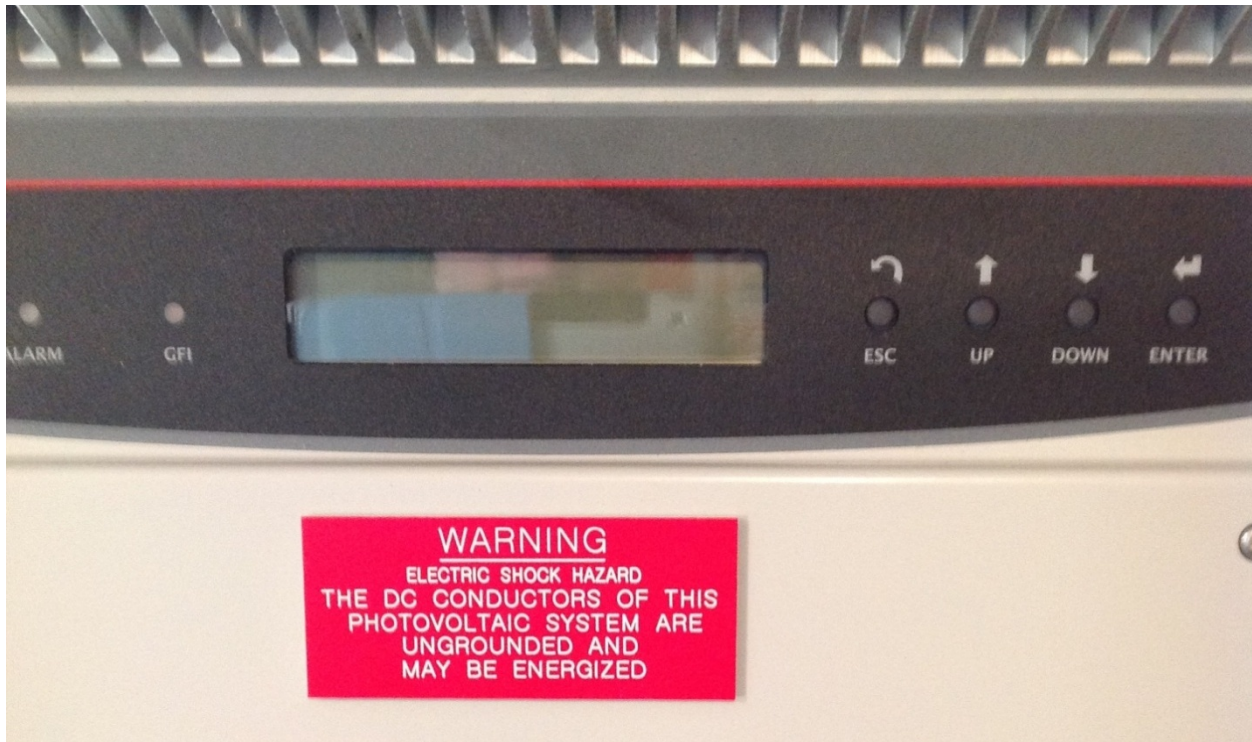


Figure 9

## DC Photovoltaic Power Source

### 690.53 Direct-Current Photovoltaic Power Source

A permanent label for the direct-current photovoltaic power source indicating items (1) through (5) provided by the installer at the photovoltaic disconnecting means:

1. Rated maximum power-point current
2. Rated maximum power-point voltage
3. Maximum system voltage  
Informational Note to (3): See 690.7(A) for maximum photovoltaic system voltage.
4. Short-circuit current  
Informational Note to (4): See 690.8(A) for calculation of maximum circuit current.
5. Maximum rated output current of the charge controller (if installed) Informational Note: Reflecting systems used for irradiance enhancement may result in increased levels of output current and power.



Figure 10



Figure 11

## Identification of PV System Interconnection

### 690.54 Interactive System Point of Interconnection

All interactive system(s) points of interconnection with other sources shall be marked at an accessible location at the disconnecting means as a power source and with the rated ac output current and the nominal operating ac voltage.

*Well-labeled point of interconnection, including wording for 690.64(B)(7).*



Figure 12





Figure 13



Figure 14



Figure 15



Figure 16

## Batteries

### 690.55 PV Systems Employing Energy Storage

Photovoltaic power systems employing energy storage shall also be marked with the maximum operating voltage, including any equalization voltage and the polarity of the grounded circuit conductor.

❖ *Cadmus Note: also refer to 690.5(C)*

## Identification of Power Sources

### 690.56 Identification of Power Sources

(A) Facilities with Stand-Alone Systems. Any structure or building with a photovoltaic power system that is not connected to a utility service source and is a stand-alone system shall have a permanent plaque or directory installed on the exterior of the building or structure at a readily visible location acceptable to the authority having jurisdiction. The plaque or directory shall indicate the location of system disconnecting means and that the structure contains a stand-alone electrical power system.

❖ *Cadmus Note: (A) will not apply to NYSERDA funded systems*

(B) Facilities with Utility Services and PV Systems. Buildings or structures with both utility service and a photovoltaic system shall have a permanent plaque or directory providing the location of the service disconnecting means and the photovoltaic system disconnecting means if not located at the same location. *Refer to figure 2.*

## Point of Connection Identification

### 690.64(B)(4) Marking (\*Article 705.12(D)(4) in 2011 NEC\*)

Equipment containing overcurrent devices in circuits supplying power to a busbar or conductor supplied from multiple sources shall be marked to indicate the presence of all sources.

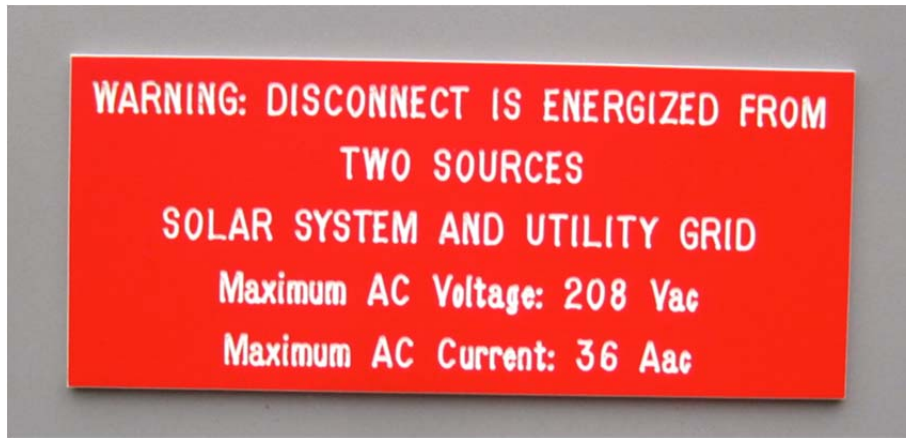


Figure 17

*Well-labeled device*

*Device needing additional labeling*



Figure 18



Figure 19

### Identification and warning of additional power source at the panel board

#### 690.64(B)(7) Inverter Output Connection (\*Article 705.12(D)(7) in 2011 NEC\*)

A permanent warning label shall be applied to the distribution equipment with the following or equivalent marking:



WARNING  
INVERTER OUTPUT CONNECTION  
DO NOT RELOCATE THIS OVERCURRENT DEVICE

*Well-labeled point of interconnection:*



Figure 20

### Common Labeling Mistakes to Avoid

*Do not cover manufacturer's labeling with other labels.*



Figure 21

Figure 22

Make sure labels are permanent and suitable for use in the environment to which it will be exposed. In this example, these light duty adhesive labels will not withstand 20+ years of wind, sun and rain.



Figure 23

Maximum System DC voltage is not 600VDC, it must be calculated per 690.7(A)

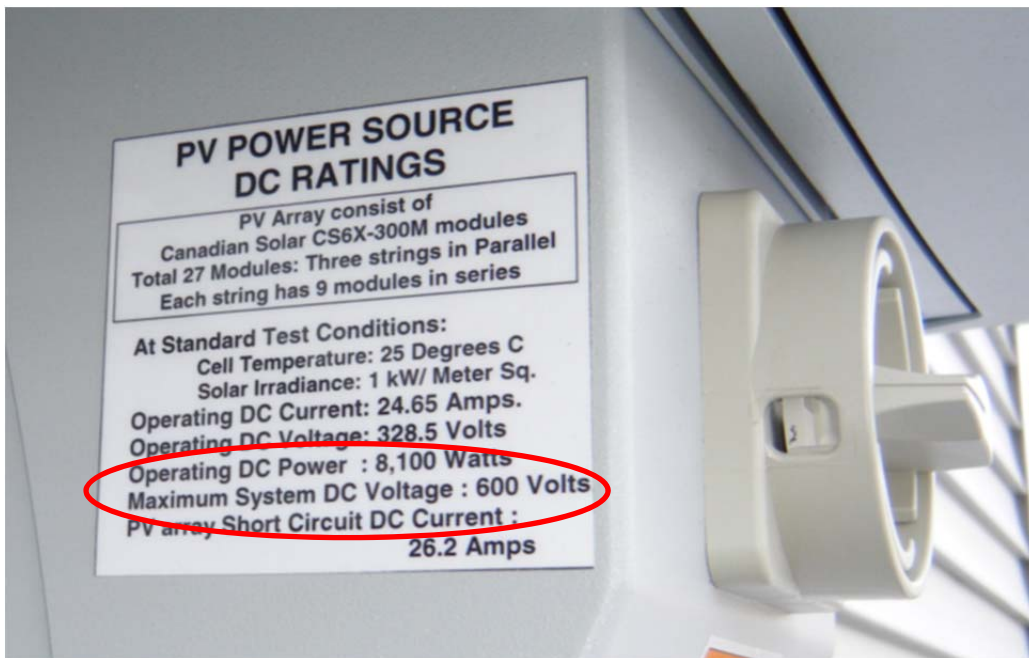


Figure 24

## Label Not of Permanent Construction



Figure 25

### Example Labels and Location Diagrams

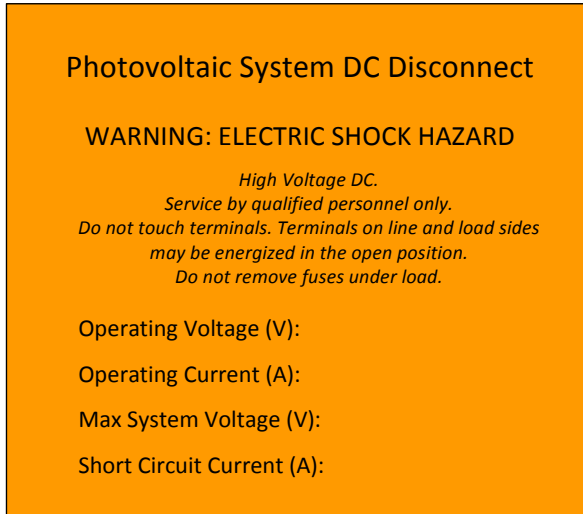
The following pages provide example NEC-compliant labels and recommended labeling locations for several typical PV system configurations. The example labels on the following pages are numbered to correspond with the example label location diagrams in the following section. We have provided examples of labeling requirements for several typical system configurations. While the use of these labels on NYSERDA-funded PV projects is encouraged; final selection, preparation, and placement of labels in compliance with the NEC and other relevant codes is the responsibility of the installer.

- Example Label Location Diagrams
  - Residential Supply Side Connected PV System
  - Commercial Supply Side Connected PV System
  - Residential Load Side Connected PV System
  - Commercial Load Side Connected PV System
  - Residential Micro-Inverter PV System
  - Commercial Micro-Inverter PV System

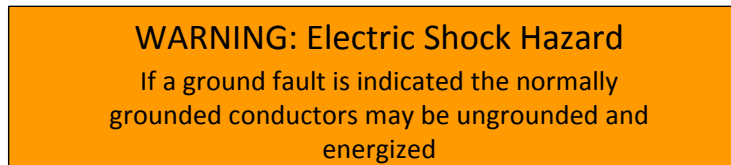


- ❖ All labeling used outdoors must be engraved metal or UV stabilized engraved plastic. Values written in marker on outdoor labels are not acceptable.
- ❖ Labels used indoors may be made of durable vinyl or paper.
- ❖ Do not cover any existing manufacturer applied labels with installation specific labels.
- ❖ Label colors chosen per OSHA 29 CFR 1910.145 direction that ANSI Z53.1-1967 & Z535 be used.
- ❖ Requirements comply with NEC 2008 & NEC 2011.
- ❖ Additionally, it is highly recommended that the installer attach a label or magnet with the company name and contact information at the inverter.

Label #1  
690.14(C)(2)  
690.17  
690.53



Label #2  
690.5(C)



Label #3  
690.64(B)(7)





Label #4  
690.14(C)  
690.17  
690.54  
690.56(B)

**Photovoltaic AC Disconnect**

Equipment is energized from two sources:  
PV System and Utility Grid.

Electric Shock Hazard  
Do not touch terminals.

Terminals on the Line and Load sides may be energized in the open position.

AC Operating Current (A):

AC Operating Voltage (V):

Label #5  
690.54  
690.64(B)4

**WARNING: Equipment is energized from two sources: Utility Grid & Photovoltaic System**

AC Operating Current (A):

AC Operating Voltage (V):

Label #6  
705.10  
690.56(B)  
225.37  
230.2(E)

**Building Supplied by Utility Grid and Photovoltaic System**

PV System Disconnect Located



Label #7  
690.54

**Solar AC Combining Panel**

**WARNING:**  
Panel is energized from two sources:  
Utility Grid and PV System

Dedicated Equipment – DO NOT ADD LOADS!

AC Operating Current (A):

AC Operating Voltage (V):

Label #8  
690.56(B)  
230.2(E)

**Service Disconnect**

#  of

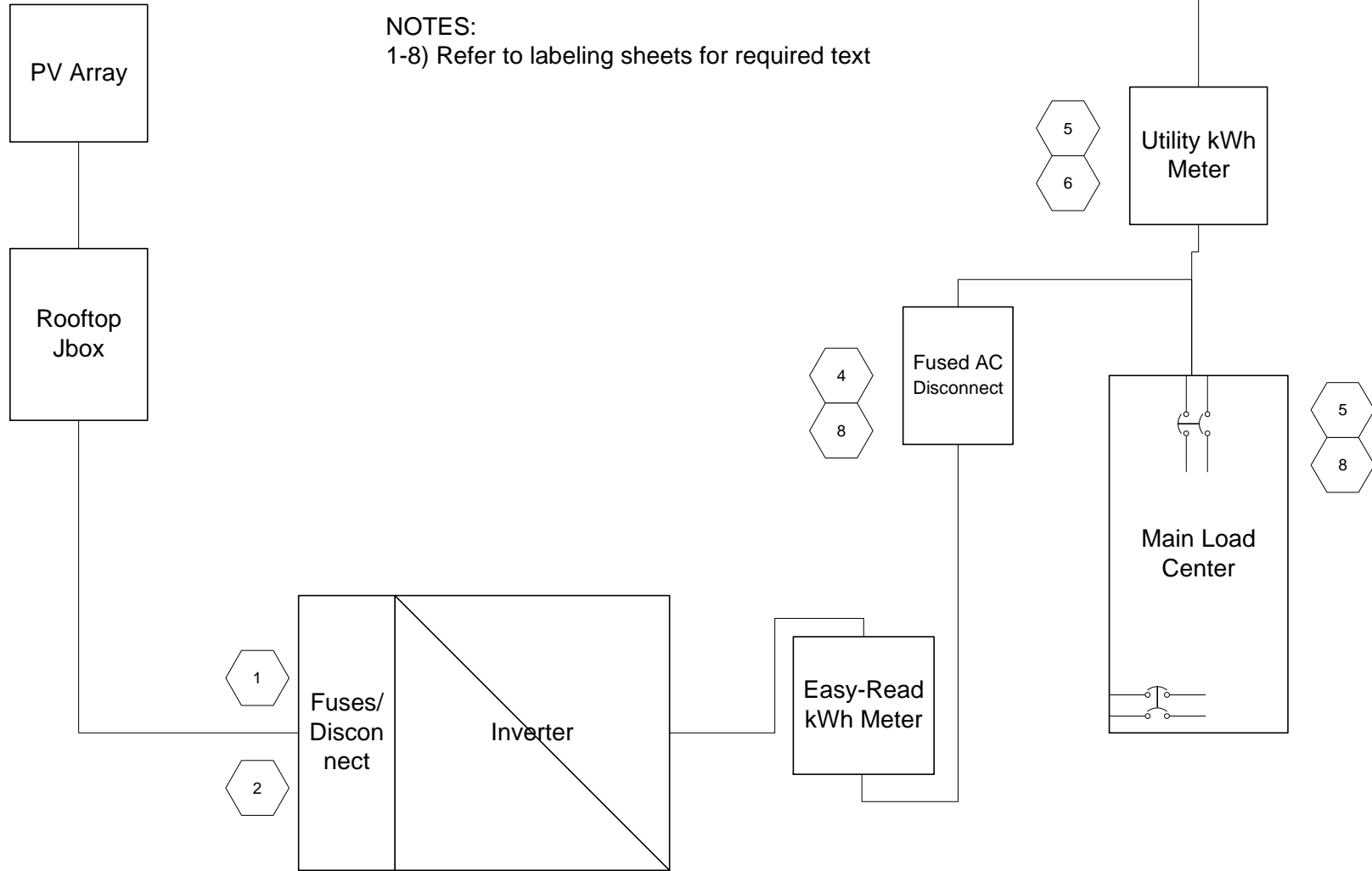
Other Disconnects Located:

# 1 of 2 and 2 of 2 where utility is 1 and solar is 2, etc.  
Description of other disco location.



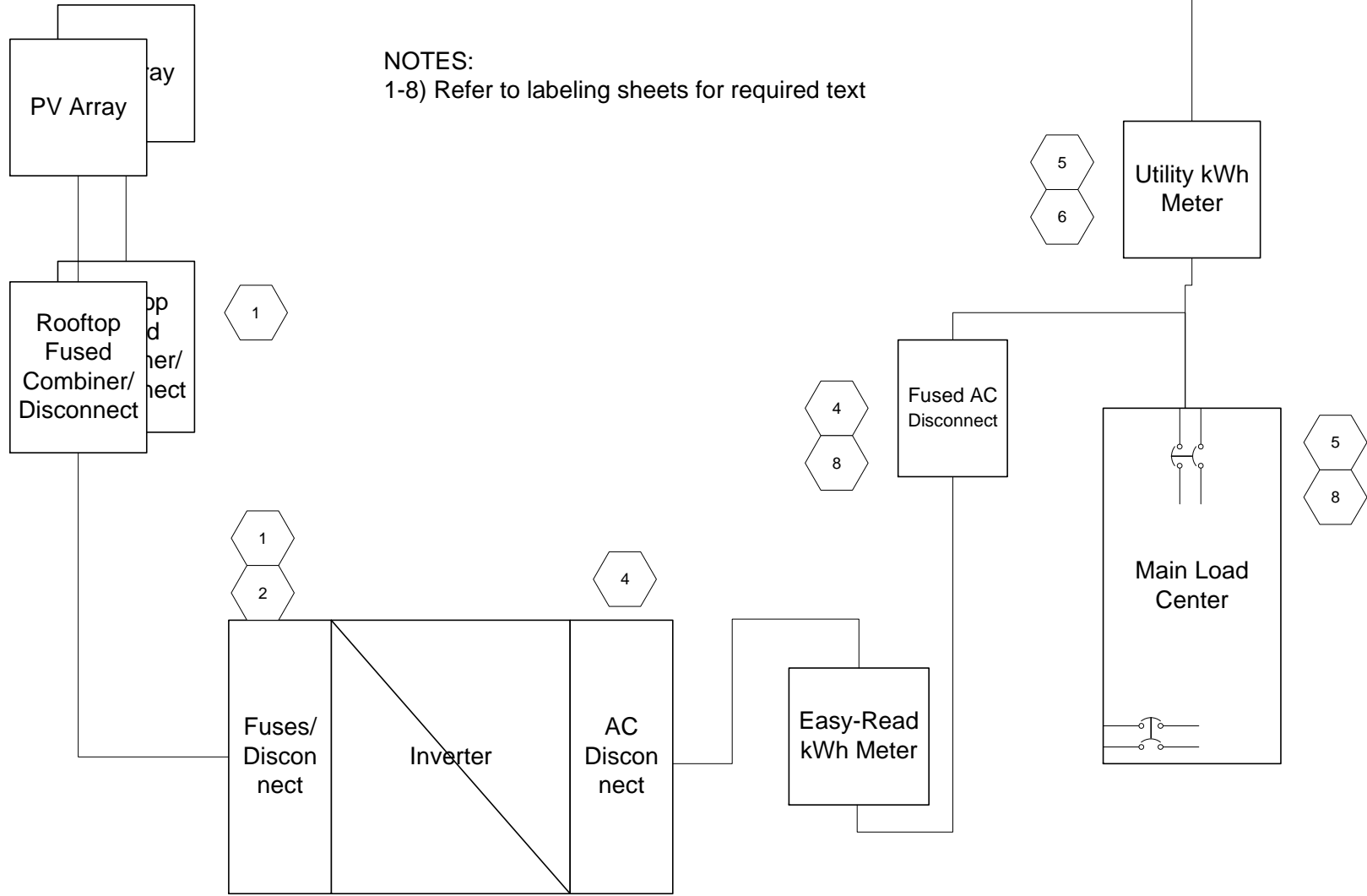
### Recommended Labeling Points: Residential Solar PV System – Supply Side Connection

NOTES:  
1-8) Refer to labeling sheets for required text

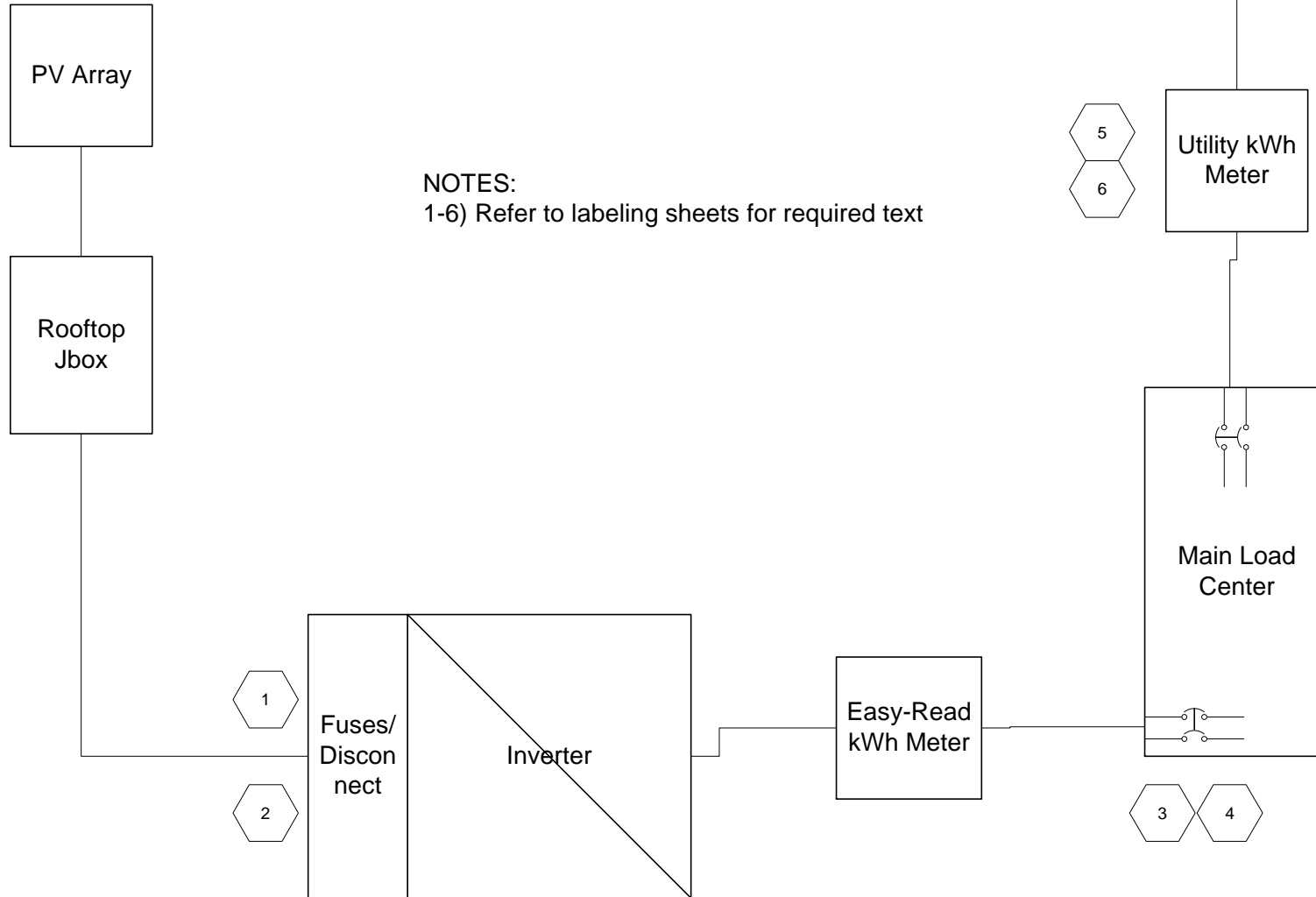


### Recommended Labeling Points: Commercial Solar PV System – Supply Side Connection

NOTES:  
 1-8) Refer to labeling sheets for required text

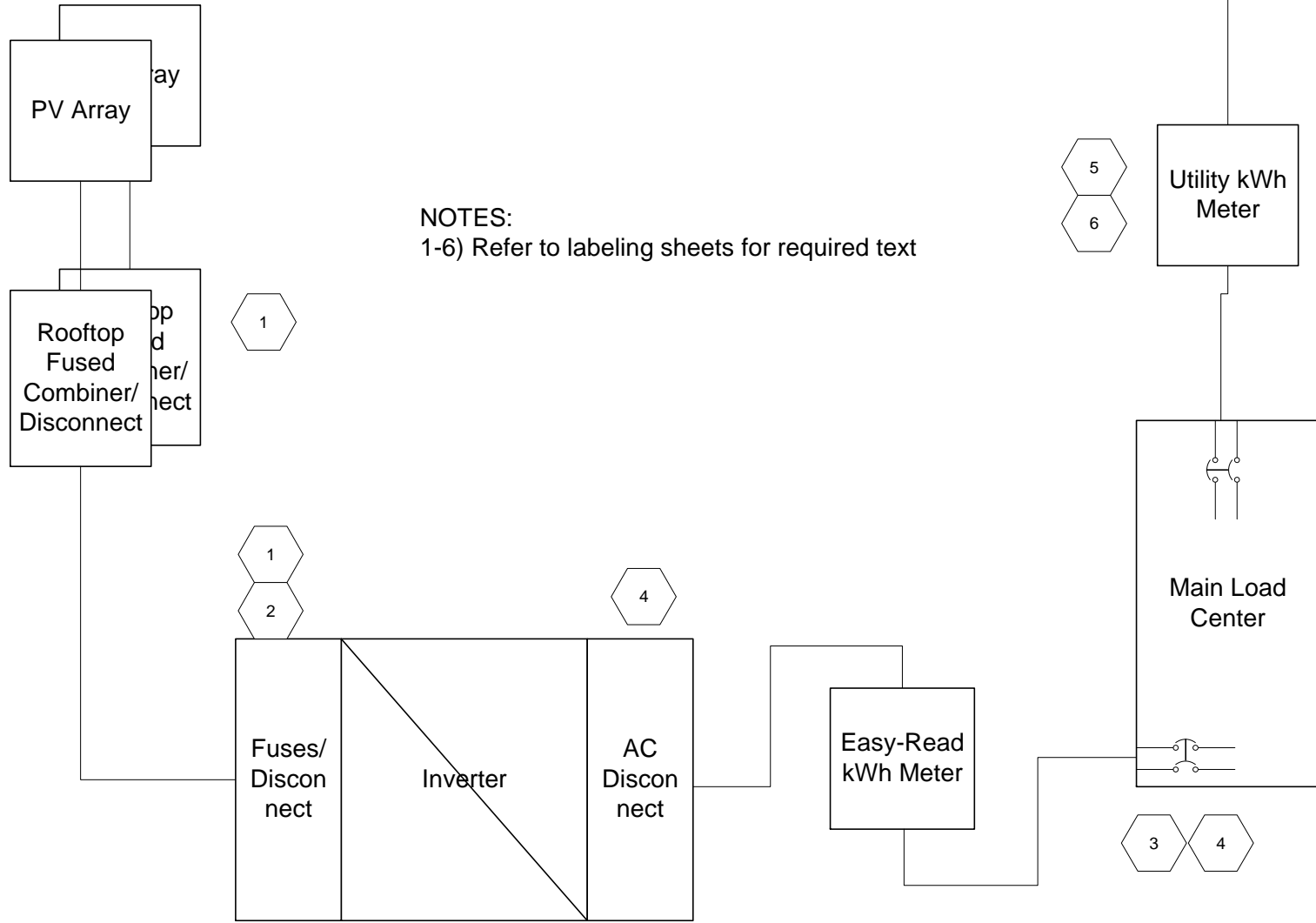


### Recommended Labeling Points: Residential Solar PV System



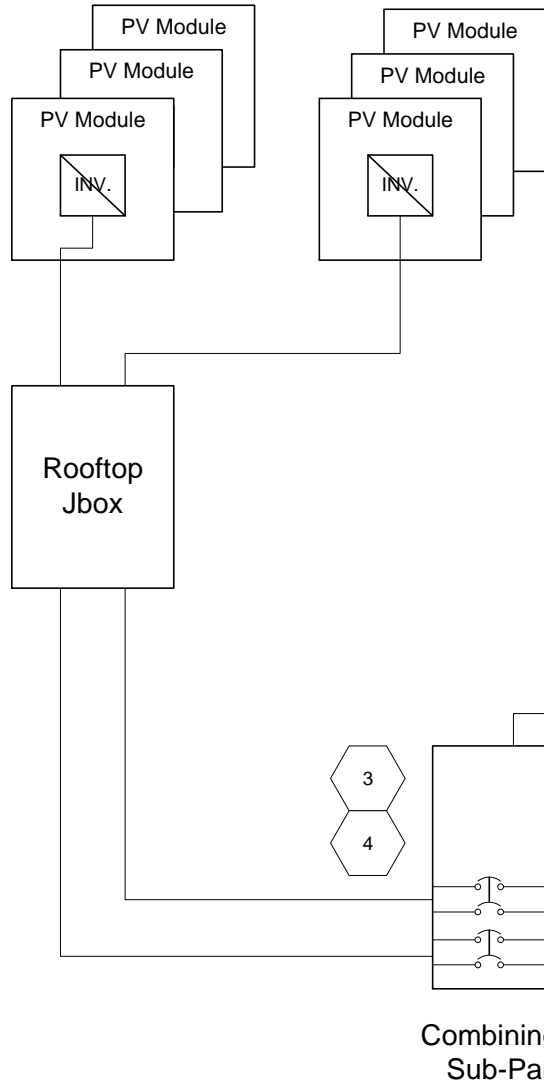
NOTES:  
1-6) Refer to labeling sheets for required text

### Recommended Labeling Points: Commercial Solar PV System

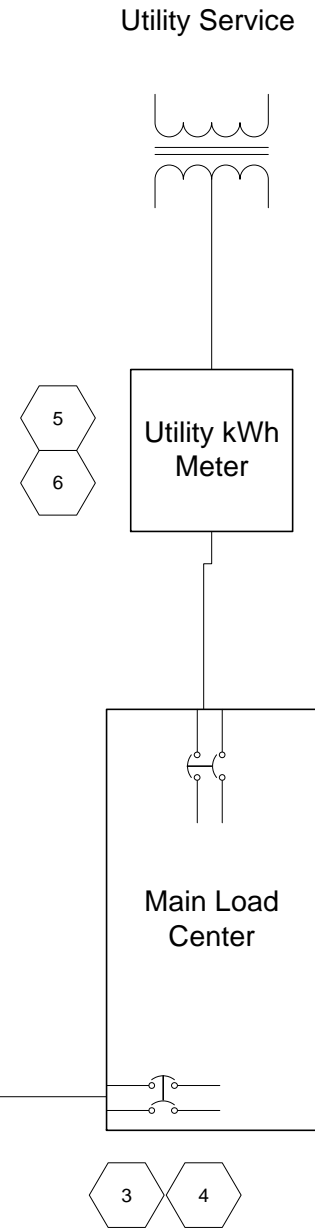


NOTES:  
1-6) Refer to labeling sheets for required text

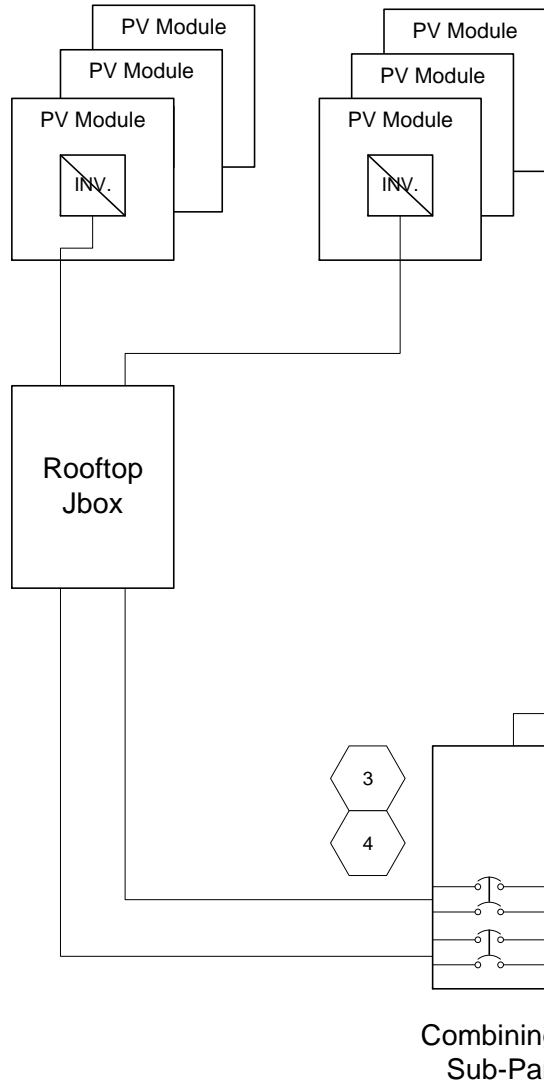
### Recommended Labeling Points: Residential Solar PV System - microinverters



NOTES:  
3-7) Refer to labeling sheets for required text



### Recommended Labeling Points: Commercial Solar PV System - microinverters



NOTES:  
3-7) Refer to labeling sheets for required text

Utility Service

