

**ORDINANCE 572-AC**

**AN ORDINANCE OF THE CITY COUNCIL OF THE CITY OF NEEDLES  
AMENDING THE NEEDLES MUNICIPAL CODE (NMC)  
SECTION 96.00 "USES PERMITTED", 96.01 "TABLE OF PERMISSIBLE  
USES, ADDING SECTION 99.09.04 "RENEWABLE ENERGY  
FACILITIES (REF)**

**WHEREAS**, Assembly Bill 2188 (Chapter 521, Statutes 2014) requires California cities to adopt an ordinance creating a streamlined permitting process for small residential rooftop solar energy systems; and

**WHEREAS**, the City of Needles wishes to advance the use of solar energy by all of its citizens, businesses and industries; and

**WHEREAS**, the City of Needles recognizes that rooftop solar energy provides reliable energy and pricing for its residents; large scale solar projects create local jobs and economic opportunity; and

**WHEREAS**, a public hearing notice for the Needles Planning Commission meeting was published in the Needles Desert Star on September 16, 2015; and

**WHEREAS**, on October 7, 2015, the Needles Planning Commission held a duly noticed and advertised public hearing to receive oral and written testimony relative to the amendment of the Needles Municipal Code (NMC), and following the conclusion adopted its Resolution No. 10-07-2015-1 PC, recommending that the City Council of the City of Needles make such amendment to the Needles Municipal Code (NMC); and

**WHEREAS**, a public hearing notice for the Needles City Council meeting was published in the Needles Desert Star on September 9, 2015; 10 days prior to said meeting; and

**WHEREAS**, on October 27, 2015, the Needles City Council held a duly noticed and advertised public hearing to receive oral and written testimony relative to the amendment to the Needles Municipal Code (NMC); and

**WHEREAS**, the Needles City Council has sufficiently considered all testimony and any documentary evidence presented to them in order to make the following determination:

**SECTION 1.** The City Council HEREBY FINDS AND DETERMINES that this activity is not subject to the California Environmental Quality Act ("CEQA") pursuant to CEQA Section §§ 15060 (c)(2), the activity will not result in a direct or reasonable foreseeable indirect physical change in the environment

**SECTION 2.** The City Council HEREBY FINDS AND DETERMINES that facts do exist to approve an amendment to the Needles Municipal Code (NMC).



# CITY OF NEEDLES

817 Third Street • Needles, California 92363  
(760) 326-2113 • FAX (760) 326-6765  
[www.cityofneedles.com](http://www.cityofneedles.com)

Mayor Edward Paget, M.D.  
Vice Mayor Jeff Williams  
Councilmember Tony Frazier  
Councilmember Tom Darcy  
Councilmember Shawn Gudmundson  
Councilmember Louise Evans  
Councilmember Robert Richardson, M.D.  
City Manager Rick Daniels

October 26, 2015

Re: Correction to Proposed Permissible Use Table as Reflected in Ordinance #572, page 2

The Permissible Use Table Section 24.20 "utility scale" REP utilizing any technology requiring a PPA should be Subsection "24.30", not "24.20".

(a) Energy Project (REP) as follows:

| 24.00 | RENEWABLE ENERGY PROJECT (REP)                                                                       | R1 | R1 | R2 | R3 | CR   | C1 | C2 | C3 | M1 | M2 | P  |
|-------|------------------------------------------------------------------------------------------------------|----|----|----|----|------|----|----|----|----|----|----|
| 24.10 | residential rooftop or ground mounted on-site use only less than 10 kw photovoltaic or 30 kw thermal | BP | BP | BP | BP | BP/Z | Z  | Z  | Z  | Z  | Z  | Z  |
| 24.20 | REP on-site only utilizing any technology no PPA required                                            | S  | S  | S  | S  | S    | S  | S  | S  | S  | S  | S  |
| 24.20 | utility scale REP utilizing any technology requiring a PPA                                           |    |    |    |    | C*   | C* | C* | C* | C* | C* | C* |
| 30    |                                                                                                      |    |    |    |    |      |    |    |    |    |    |    |
| *     | See Section "9(A)" Public Benefit Program                                                            |    |    |    |    |      |    |    |    |    |    |    |

Dan Williams  
Bldg. Official

**SECTION 3.** The City Council HEREBY APPROVES Ordinance 572-AC for an amendment to the Needles Municipal Code (NMC) as follows:

- (a) Amend Section 96.00 Uses Permitted, adding under the section "Symbol Meaning", as follows:

"BP = Permitted Use with building permit for residential rooftop or ground mounted solar projects less than 10 kw solar voltaic or 30 kw thermal

- (b) Amend Section 96.01 Table of Permissible Uses, adding Subsection 24.00 "Renewable Energy Project (REP)" as follows:

| 24.00            | <b>RENEWABLE ENERGY PROJECT (REP)</b>                                                                | <b>R1</b> | <b>R1</b> | <b>R2</b> | <b>R3</b> | <b>CR</b> | <b>C1</b> | <b>C2</b> | <b>C3</b> | <b>M1</b> | <b>M2</b> | <b>P</b> |
|------------------|------------------------------------------------------------------------------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|
|                  |                                                                                                      |           |           |           |           |           |           |           |           |           |           |          |
| 24.10            | residential rooftop or ground mounted on-site use only less than 10 kw photovoltaic or 30 kw thermal | BP        | BP        | BP        | BP        | BP/Z      | Z         | Z         | Z         | Z         | Z         | Z        |
|                  |                                                                                                      |           |           |           |           |           |           |           |           |           |           |          |
| 24.20            | REP on-site only utilizing any technology no PPA required                                            | S         | S         | S         | S         | S         | S         | S         | S         | S         | S         | S        |
| <del>24.20</del> | <del>utility scale REP utilizing any technology requiring a PPA</del>                                |           |           |           |           | C*        | C*        | C*        | C*        | C*        | C*        | C*       |
|                  |                                                                                                      |           |           |           |           |           |           |           |           |           |           |          |
| *                | See Section "9(A)" Public Benefit Program                                                            |           |           |           |           |           |           |           |           |           |           |          |
|                  |                                                                                                      |           |           |           |           |           |           |           |           |           |           |          |

- (c) Add Section 99.09.04 "Renewable Energy Projects (REP)"

**(1) Permitted Uses**

- Renewable Energy Projects (REP) shall be allowed in accordance with the City Code Section 96.01 "Permissible Use Table", unless otherwise exempted by state or federal law.
- Other hybrid or emerging renewable energy technologies, which in the opinion of the review authority are of a similar and compatible nature to those uses described in this section.

**(2) Definitions**

- "Electronic submittal" means the utilization of one or more of the following:
  - e-mail,
  - the internet,
  - Facsimile.
- "Small residential rooftop solar energy system" means all of the following:
  - A solar energy system that is no larger than 10 kilowatts alternating current nameplate rating or 30 kilowatts thermal.
  - A solar energy system that conforms to all applicable state fire, structural, electrical, and other building codes as adopted or

amended by the City and paragraph (iii) of subdivision (c) of Section 714 of the Civil Code, as such section or subdivision may be amended, renumbered, or redesignated from time to time.

- 3) A solar energy system that is installed on a single or duplex family dwelling.
- 4) A solar panel or module array that does not exceed the maximum legal building height as defined by the authority having jurisdiction.
- c) "Applicant" is the Landowner, developer, facility owner, and/or operator with legal control of the project, including heirs, successors and assigns, who have filed an application for development of a Solar Energy Facility under this Ordinance.
- d) "Parcel" means all land within a legally established parcel.
- e) "Practicable" means it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes.
- f) "Landowner" means the persons or entities possessing legal title to the Parcel(s) upon which a REP is located.
- g) "Protected Lands" means, for the purpose of this chapter only, lands containing resources that are protected or regulated by established regulatory standards of local, state, and federal agencies, conservation easements or other contractual instruments in such a way that prohibits or limits development of those lands.
- h) "Review Authority" means applicable-city land use decision-making body as determined by local ordinance and appeal procedures.
- i) "Solar Energy Project (SEP)" means a Solar Electric System that satisfies the parameters identified in the Ordinance...
- j) "Solar Electric System (SES)" means the components and subsystems that, in combination, convert solar energy into electric or thermal energy suitable for use, and may include other appurtenant structures and facilities. The term includes, but is not limited to, photovoltaic power systems, solar thermal systems, and solar hot water systems.
- k) "Uses Allowed" means one of the following:
  - (1) A REP designed primarily for serving on-site needs or a use that is related to the Primary Use of the property.
  - (2) A REP designed and installed to provide on-site energy demand for any legally established use of the property.
  - (3) A REP that uses over 50% of the Parcel(s) and is devoted to solar electric power generation primarily for use off-site.
  - (4) A REP that provides up to 125% of on-site electricity (or hot water) demand and generally less than 50% of the building site area, or 15-25% of the Parcel land area.
  - (5) A REP that is not the Primary Use of the property and uses less than 50% of the Parcel(s).

- (6) Other hybrid or emerging renewable energy technologies, which in the opinion of the review authority are of a similar and compatible nature to those uses described in this section.

### **(3) Permit Requirements**

#### **(a) Small residential rooftop energy system**

##### **1) Application package includes:**

- a) Exhibit "A" - Checklist for Expedited Solar Residential Rooftop Project
- b) Exhibit "B-1" - Standard Plan-Simplified Central/String Inverter System
- c) Exhibit "B-2" - Standard Plan-Simplified Micro inverter and ACM System
- d) Exhibit "C" - Structural Criteria for Rooftop Solar Structural Requirements
- e) Exhibit "D" - building permit application with interconnection agreement application (Photovoltaic guidelines/ Needles Rebate Program)

##### **2) Application Submittal for permit**

Will be accepted by the City via email, internet, or facsimile

##### **3) Review Process and permit issuance**

- a) Building official to review and confirm application is complete and administratively approve the application and issue all required permits or authorizations. Incomplete applications will be returned with written notification from building official identifying application deficiencies.

Such approval does not authorize an applicant to connect the small residential rooftop energy system to the local utility provider's electricity grid. The applicant is responsible for obtaining such approval or permission from the local utility provider.

##### **4) Inspection**

Only one inspection shall be required, which shall be done in a timely manner. If a small residential rooftop solar energy system fails inspection, a subsequent inspection is authorized; however the subsequent inspection need not conform to the requirements of this subsection.

#### **(b) All other REP Projects**

##### **1) Permits required**

The type of land use permit required for REFs are shown in the Permissible Use Table under Section 24.00

##### **2) Application Package includes:**

- a) Conditional Use Permit Application
- b) CEQA Checklist
- c) Interconnection Agreement Application

3) Permits

- a) Nothing in this chapter modifies the minimum building standards required to construct a REP, consistent with applicable building and fire codes. The REP components and all accessory equipment shall comply with the most recently adopted Building Code as determined by the Building Official and Fire Code as determined by the Fire Official.
- b) The Permits shall include review by local permitting departments including, but not limited to, the local Fire Authority, for Health and Safety Requirements.

(4) General Requirements

(a) Setbacks.

The following setbacks from the Parcel line to the closest part of the REP shall be established as shown in the Table below. Fencing, roads and landscaping may occur within the setback.

| Parcel Line Setback Table                                                                                                                                                                                            |                              |      |      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|------|------|
| Zoning District                                                                                                                                                                                                      |                              |      |      |
|                                                                                                                                                                                                                      | Front                        | Rear | Side |
|                                                                                                                                                                                                                      |                              |      |      |
| Commercial                                                                                                                                                                                                           | 30'                          | 30'  | 30'  |
| Industrial                                                                                                                                                                                                           | 30'                          | 30'  | 30'  |
| Residential*                                                                                                                                                                                                         | Per Zoning for that District |      |      |
| * Complies with required front yard setbacks, or otherwise does not impair sight distance for safe access to or from the property or other properties in the vicinity as determined by ministerial zoning clearance. |                              |      |      |

(b) Grading, Access and Parking

- (1) Renewable energy projects shall be sited to maintain natural grades and use existing roads for access to the extent practical. Construction of new roads shall be avoided as much as possible. Natural grades shall be restored and re-vegetated for temporary access roads, construction staging areas, or field office sites used during construction. The operator shall maintain an all-weather access road for maintenance and emergency vehicles.

(c) Soil Stabilization, Erosion Control and Ground Water Management –

- (1) To the extent feasible and compatible with the climate and pre-project landscaping of the property the site shall be restored with native vegetation. The re-vegetation plans shall be reviewed and approved by the City. All areas occupied by the facility that are not utilized for access to operate and maintain the installation shall be covered with gravel or other soil stabilization or other methods approved by the City. Use of chemical soil stabilization will require ongoing maintenance as required by the City.
- (2) The renewable energy facility must have a storm water management plan/permit showing existing and proposed grading and drainage demonstrating no net increase in runoff.
- (3) Erosion and Sediment Control Plan, if applicable, approved prior to beginning grading or construction. The plan must include best management practices for erosion control during and after construction, and permanent drainage and erosion control measures to prevent damage to local roads or adjacent areas, and to minimize sediment and storm water run-off into waterways, agricultural lands and habitat areas.
- (4) Prior to issuing a final Building Permit, an as-built grading and drainage plan, prepared by a licensed professional surveyor or other approved qualified professional shall be submitted to the reviewing agency's engineer for review and approval. The plan shall show that the as-built conditions are substantially the same as those shown on the approved grading and drainage plan.
- (5) A maintenance plan shall be submitted for the continuing maintenance of the REP, which may include, but not be limited to, planned maintenance of soil stabilization, equipment maintenance, and plans for cleaning of solar panels if required.

(d) Aesthetics

The operator of the renewable energy facility shall maintain the facility including all required landscaping in compliance with the approved design plans, and shall keep the facility free from weeds, dust, trash and debris.

(e) Air Quality

During site preparation, grading and construction, the renewable energy facility operator must implement best management practices to minimize dust and wind erosion, including regularly watering roads and construction staging areas as necessary, and minimizing vehicle idling and number of vehicle trips. Paved roads shall be swept as needed to remove any soil that has been carried onto them from the facility site.

(f) Air Safety

Renewable energy facilities shall be sited and operated to avoid hazards to air navigation. The renewable energy facility shall comply with any conditions

imposed by Federal, State, County, and City agencies.

(g) Biological Resources

The protection of high value biological resources is an important consideration. REP projects shall not be located on lands which support listed, candidate or other fully protected species, species of special concern, or species protected under the Native Plant Protection Act; Environmentally Sensitive Habitat Areas without CEQA. Applicant shall be responsible for all costs associated with the preparation of all documentation, studies, etc., as well as the costs associated with the City's use of a third party reviewer to ensure application completeness. Applicants are encouraged to coordinate with permitting agencies such as Dept. of Fish and Game and U.S. Fish and Wildlife Service during design stages.

(h) Cultural Resources

Renewable energy facilities shall be sited to avoid or mitigate impacts to significant cultural and historic resources, as well as sacred landscapes. Facilities requiring a use permit that result in ground disturbance shall require a cultural resources records search and, if necessary, a cultural resources field survey at the time of facility application. Consultation with Native American tribes shall be conducted as part of the environmental review process.

Grading plans for all renewable energy facilities shall include notes that require the contractor to halt work within the vicinity of any archeological, historical or cultural resources or artifacts that may be discovered during construction or operation. If cultural resources are discovered during construction, the operator shall notify the local agency and a qualified professional shall be retained at the applicant's expense to evaluate the find and determine any measures to mitigate impacts including avoidance, removal, preservation or recordation in accordance with California law. The operator shall implement any feasible mitigation measures as determined by the local agency. If human remains are discovered, the County Coroner must also be notified and consultation with the Native American Heritage Commission may be required to determine the most likely descendants.

(i) Fire Protection

The renewable energy facility shall be subject to Fire Safety Standards. The operator must implement a Fire Prevention Plan for construction and ongoing operations approved by the County Fire Marshall and local fire protection district. The plan shall include, but not be limited to: emergency vehicle access and turn-around at the facility site(s), addressing, vegetation management and fire break maintenance around structures.

(j) Proximity to Transmission Lines and Utility Notification

Upgrades to distribution or transmission facilities shall be identified and addressed as part of the CEQA review process. No building permit for a renewable energy facility shall be issued until evidence has been provided that the proposed interconnection is acceptable to the affected utility.

If new distribution, transmission, or substation facilities are required and the utility is an investor-owned utility, the California Public Utilities Commission (CPUC) may need to approve a Permit to construct or a Certificate of Public Convenience and Necessity. Coordination with the CPUC is essential prior to renewable energy facility approval.

(k) Security and Fencing

The site area for a renewable energy facility must be fenced or other appropriate measures to prevent unauthorized access and provide adequate signage. Wildlife friendly fencing shall be used where required. If needed, security lighting shall be operated by motion sensors. Access gates and equipment cabinets must be locked at all times.

(l) Signs

Temporary signs describing the facility, and providing contact information for the contractor and operator shall be placed during construction and must be removed prior to final inspection and operation. Signs for public or employee safety are required. No more than two signs relating the address and name of the operator/facility may be placed on-site, subject to design review. Outdoor displays, billboards or advertising signs of any kind either on- or off-site are prohibited.

(m) Off-Site Facilities

When the REP is located on more than one Parcel, there shall be proper easement agreements or other approved methods for the notification of all impacted parties.

(n) Septic System Avoidance – The REP shall not be located over a septic system, leach field area or identified reserve area unless approved by the Department of Environmental Health;

(o) Floodplain Avoidance – If located in a floodplain as designated by FEMA, or an area of known localized flooding, all panels, electrical wiring, automatic transfer switches, inverters, etc. shall be located above the base flood elevation; and, shall not otherwise create a fire or other safety hazard as determined by the Building Official.

(p) Visibility

- 1) If lighting is required, it shall be activated by motion sensors, fully shielded and downcast type where the light does not spill onto the adjacent Parcel or the night sky;
- 2) No display of advertising, except for reasonable identification of the panel, inverter or other equipment manufacturer, and the facility owner;

(q) Decommissioning and Restoration

- 1) A Decommissioning Plan shall be required and shall include the following:

An estimate prepared by a registered engineer describing the activities required to decommission the site and return it to its natural condition that existed before the installation along with an estimate to conduct the decommissioning activities.

The Owner/Applicant shall provide sufficient financial assurance to decommission the site. Allowable financial assurances include cash deposit, Letter of Credit or Performance Bond from an institution satisfactory to the City Manager.

- a) Removal of all aboveground and underground equipment, structures, fencing and foundations to a depth of three feet below grade. Underground equipment, structures and foundations located at least three feet below grade that do not constitute a hazard or interfere with the use of the land do not need to be removed.
- b) If applicable, removal of substations, overhead poles, above ground electricity transmission lines located on-site or within the public right of way if determined not to be usable to any other public or private utility.
- c) Removal of graveled areas and access roads.
- d) Regarding and placement of like-kind topsoil after removal of all structures and equipment.
- e) An Erosion Control Plan.
- f) Revegetation of disturbed areas with native seed mixes and plant species suitable to the area.
- g) The timeframe for completion of removal and decommissioning activities.
- h) An engineer's cost estimate for all aspects of the decommissioning plan, including use of prevailing wage rates, and credit for the salvage value of the panels and system materials.
- i) A statement signed by the owner or operator that they take full responsibility for reclaiming the site in accordance with the Decommissioning Plan and Use Permit approval upon cessation of use. See above. We want a financial assurance instrument.

The renewable energy facility operator is required to notify the City immediately upon termination or cessation of use or abandonment of the operation. The operator shall remove components of the facility when it becomes functionally obsolete or is no longer in use. The operator shall begin decommissioning and removal of all equipment, structures, footings/foundations, signs, fencing, and access roads within 90 days from the date the facility ceases operation, and shall return the site to an appropriate end-use within the timeframe specified in the Decommissioning Plan.

(r) Financial Assurance

At the time of issuance of the permit for the construction of the facility, the operator shall provide financial assurance in a form and amount acceptable to the local agency to secure the expense of decommissioning and removing all equipment, structures, fencing, and reclaiming the site and associated access or distribution lines in compliance with the approved reclamation plan.

(s) Workforce Development

The operator shall be encouraged to participate in the a regional occupational training program, or a similar program approved by the city, providing job training in renewable energy, and restoration and land stewardship, by providing an annual contribution to fund the program and providing access to the facility by teachers and students, for the term of the lease or facility use.

Submittal of a Local Hiring Plan is required prior to applying for a building permit for new construction valued at above \$TBD. The Plan shall set voluntary targets for local hiring, along with a protocol for sequencing local job recruitment activities prior to advertising outside the-City as determined by the City. The Plan shall also include annual monitoring and reporting requirements during construction

- (t) Abandonment – A REP that ceases to produce electricity on a continuous basis for twenty four (24) months shall be considered abandoned unless the Applicant or Landowner demonstrates by substantial evidence satisfactory to the City that there is no intent to abandon the facility. Applicants and/or Landowners are required to remove all equipment and facilities and restore the site to original condition upon abandonment.
  - 1) Facilities deemed by the City to be unsafe and facilities erected in violation of this section shall also be subject to this Section. The code enforcement officer or any other employee of the City shall have the right to request documentation and/or affidavits from the Applicant regarding the system's usage, and shall make a determination as to the date of abandonment or the date on which other violation(s) occurred.
  - 2) Upon a determination of abandonment or other violation(s), the City shall send a notice hereof to the Applicant and/or Landowner, indicating that the responsible party shall remove the REP and all associated facilities, and remediate the site to its approximate original condition within ninety (90) days of notice by the City, unless the City determines that the facilities must be removed in a shorter period to protect public safety. Alternatively, if the violation(s) can be addressed by means short of removing the REP and restoration of the site, the City may advise the Applicant and/or Landowner of such alternative means of resolving the violation(s).
  - 3) If the Applicant and/or Landowner do not comply, the City may remove the REP and restore the site and may thereafter (a) draw funds from any bond, security or financial assurance that may have been provided or (b) initiate judicial proceedings or take other steps authorized by law against the responsible parties to recover only those costs associated with the removal of structures deemed a public hazard.

**(5) Misc.**

**Public Benefit Program**

A streamlined permitting process utilizing a Special Use Permit in lieu of a Conditional Use Permit shall be used for any REF utility-scale sized project participating in the Public Benefit Program.

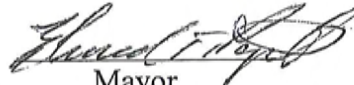
**SECTION 4.** This action shall become final and effective thirty (30) days after this decision by the City Council as provided by the Needles City Code.

**SECTION 5.** The City Clerk shall certify to the adoption of this Ordinance and shall transmit copies of the same to the applicant.

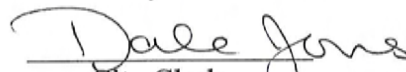
**NOW, THEREFORE, BE IT ORDAINED** that the City Council of the City of Needles, California, approve an amendment to the City Code.

**INTRODUCED AND READ** for the first time and ordered posted at a regular meeting of the City Council of the City of Needles, California, held on the 27th day of October, 2015, by the following roll call vote:

|          |                                                            |
|----------|------------------------------------------------------------|
| AYES:    | Councilmembers Gudmundson, Evans, Frazier, Williams, Darcy |
| NOES:    | None and Richardson                                        |
| ABSENT:  | None                                                       |
| ABSTAIN: | None                                                       |

  
Mayor

Attest:

  
City Clerk

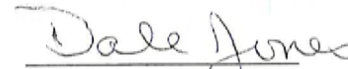
**PASSED, APPROVED AND ADOPTED** at a regular meeting of the City Council of the City of Needles, California, held on the 10th day of November, 2015.

|          |                                                      |
|----------|------------------------------------------------------|
| AYES:    | Councilmembers Gudmundson, Evans, Frazier, Williams, |
| NOES:    | None Darcy and Richardson                            |
| ABSENT:  | None                                                 |
| ABSTAIN: | None                                                 |

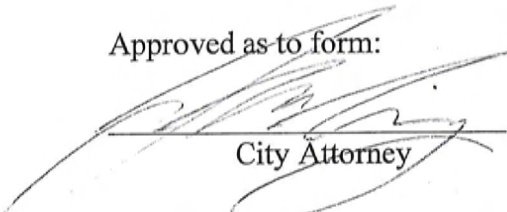
  
Mayor

(Seal)

Attest:

  
City Clerk

Approved as to form:

  
City Attorney



## Eligibility Checklist for Expedited Solar Photovoltaic Permitting for One- and Two-Family Dwellings

### GENERAL REQUIREMENTS

- |                                                                                          |                            |                            |
|------------------------------------------------------------------------------------------|----------------------------|----------------------------|
| A. System size is 10 kW AC CEC rating or less                                            | <input type="checkbox"/> Y | <input type="checkbox"/> N |
| B. The solar array is roof-mounted on one- or two-family dwelling or accessory structure | <input type="checkbox"/> Y | <input type="checkbox"/> N |
| C. The solar panel/module arrays will not exceed the maximum legal building height       | <input type="checkbox"/> Y | <input type="checkbox"/> N |
| D. Solar system is utility interactive and without battery storage                       | <input type="checkbox"/> Y | <input type="checkbox"/> N |
| E. Permit application is completed and attached                                          | <input type="checkbox"/> Y | <input type="checkbox"/> N |

### ELECTRICAL REQUIREMENTS

- |                                                                                                                                                                          |                            |                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|----------------------------|
| A. No more than four photovoltaic module strings are connected to each Maximum Power Point Tracking (MPPT) input where source circuit fusing is included in the inverter | <input type="checkbox"/> Y | <input type="checkbox"/> N |
| 1) No more than two strings per MPPT input where source circuit fusing is not included                                                                                   | <input type="checkbox"/> Y | <input type="checkbox"/> N |
| 2) Fuses (if needed) are rated to the series fuse rating of the PV module                                                                                                | <input type="checkbox"/> Y | <input type="checkbox"/> N |
| 3) No more than one noninverter-integrated DC combiner is utilized per inverter                                                                                          | <input type="checkbox"/> Y | <input type="checkbox"/> N |
| B. For central inverter systems: No more than two inverters are utilized                                                                                                 | <input type="checkbox"/> Y | <input type="checkbox"/> N |
| C. The PV system is interconnected to a single-phase AC service panel of nominal 120/220 Vac with a bus bar rating of 225 A or less                                      | <input type="checkbox"/> Y | <input type="checkbox"/> N |
| D. The PV system is connected to the load side of the utility distribution equipment                                                                                     | <input type="checkbox"/> Y | <input type="checkbox"/> N |
| E. A Solar PV Standard Plan and supporting documentation is completed and attached                                                                                       | <input type="checkbox"/> Y | <input type="checkbox"/> N |

### STRUCTURAL REQUIREMENTS

- |                                                                                           |                            |                            |
|-------------------------------------------------------------------------------------------|----------------------------|----------------------------|
| A. A completed Structural Criteria and supporting documentation is attached (if required) | <input type="checkbox"/> Y | <input type="checkbox"/> N |
|-------------------------------------------------------------------------------------------|----------------------------|----------------------------|

### FIRE SAFETY REQUIREMENTS

- |                                                                                                                                                                                            |                            |                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|----------------------------|
| A. Clear access pathways provided                                                                                                                                                          | <input type="checkbox"/> Y | <input type="checkbox"/> N |
| B. Fire classification solar system is provided                                                                                                                                            | <input type="checkbox"/> Y | <input type="checkbox"/> N |
| C. All required markings and labels are provided                                                                                                                                           | <input type="checkbox"/> Y | <input type="checkbox"/> N |
| D. A diagram of the roof layout of all panels, modules, clear access pathways and approximate locations of electrical disconnecting means and roof access points is completed and attached | <input type="checkbox"/> Y | <input type="checkbox"/> N |

#### Notes:

1. These criteria are intended for expedited solar permitting process.
2. If any items are checked NO, revise design to fit within Eligibility Checklist, otherwise permit application may go through standard process.



## Solar PV Standard Plan — Simplified Central/String Inverter Systems for One- and Two-Family Dwellings

**SCOPE:** Use this plan ONLY for utility-interactive central/string inverter systems not exceeding a system AC inverter output rating of 10kW on the roof of a one- or two-family dwelling or accessory structure. The photovoltaic system must interconnect to the load side of a single-phase AC service panel of nominal 120/240Vac with a bus bar rating of 225A or less. This plan is not intended for bipolar systems, hybrid systems or systems that utilize storage batteries, charge controllers, trackers, more than two inverters or more than one DC combiner (noninverter-integrated) per inverter. Systems must be in compliance with current California Building Standards Codes and local amendments of the authority having jurisdiction (AHJ). Other Articles of the California Electrical Code (CEC) shall apply as specified in 690.3.

**MANUFACTURER'S SPECIFICATION SHEETS MUST BE PROVIDED** for proposed inverter, modules, combiner/junction boxes and racking systems. Installation instructions for bonding and grounding equipment shall be provided, and local AHJs may require additional details. Listed and labeled equipment shall be installed and used in accordance with any instructions included in the listing or labeling (CEC 110.3). Equipment intended for use with PV system shall be identified and listed for the application (CEC 690.4[D]).

Job Address: \_\_\_\_\_ Permit #: \_\_\_\_\_

Contractor/ Engineer Name: \_\_\_\_\_ License # and Class: \_\_\_\_\_

Signature: \_\_\_\_\_ Date: \_\_\_\_\_ Phone Number: \_\_\_\_\_

Total # of Inverters installed: \_\_\_\_\_ (If more than one inverter, complete and attach the "Supplemental Calculation Sheets" and the "Load Center Calculations" if a new load center is to be used.)

Inverter 1 AC Output Power Rating: \_\_\_\_\_ Watts

Inverter 2 AC Output Power Rating (if applicable): \_\_\_\_\_ Watts

Combined Inverter Output Power Rating: \_\_\_\_\_ ≤ 10,000 Watts

Location Ambient Temperatures (Check box next to which lowest expected temperature is used):

- 1) ☐ Lowest expected ambient temperature for the location ( $T_L$ ) = Between -1 to -5 °C  
☐ Lowest expected ambient temperature for the location ( $T_L$ ) = Between -6 to -10 °C  
 Average ambient high temperature ( $T_H$ ) = 47 °C  
 Note: For a lower  $T_L$  or a higher  $T_H$ , use the Comprehensive Standard Plan

### DC Information:

|                                                                                    |                                                        |
|------------------------------------------------------------------------------------|--------------------------------------------------------|
| Module Manufacturer: _____ Model: _____                                            |                                                        |
| 2) Module $V_{oc}$ (from module nameplate): _____ Volts                            | 3) Module $I_{sc}$ (from module nameplate): _____ Amps |
| 4) Module DC output power under standard test conditions (STC) = _____ Watts (STC) |                                                        |

5) DC Module Layout

Identify each source circuit (string) for inverter 1 shown on the roof plan with a Tag (e.g. A,B,C,...)

Number of modules per source circuit for inverter 1

Identify, by tag, which source circuits on the roof are to be paralleled (If none, put N/A)

Combiner 1:

Combiner 2:

Total number of source circuits for inverter 1:

6) Are DC/DC Converters used? ☐ Yes ☐ No If No, skip to Step 7. If Yes enter info below.

DC/DC Converter Model #: \_\_\_\_\_

DC/DC Converter Max DC Input Voltage: \_\_\_\_\_ Volts

Max DC Output Current: \_\_\_\_\_ Amps

Max DC Output Current: \_\_\_\_\_ Volts

Max # of DC/DC Converters in an Input Circuit: \_\_\_\_\_

DC/DC Converter Max DC Input Power: \_\_\_\_\_ Watts

7) Maximum System DC Voltage — Use A1 or A2 for systems without DC/DC converters, and B1 or B2 with DC/DC Converters.

☐ A1. Module  $V_{oc}$  (STEP 2) = \_\_\_\_\_ x # in series (STEP 5) \_\_\_\_\_ x 1.12 (If  $-1 \leq T_i \leq -5^\circ\text{C}$ , STEP 1) = \_\_\_\_\_ V  
☐ A2. Module  $V_{oc}$  (STEP 2) = \_\_\_\_\_ x # in series (STEP 5) \_\_\_\_\_ x 1.14 (If  $-6 \leq T_i \leq -10^\circ\text{C}$ , STEP 1) = \_\_\_\_\_ V

Table 1. Maximum Number of PV Modules in Series Based on Module Rated  $V_m$  for 600 Vdc Rated Equipment (CEC 690.7)

|                                            |       |       |       |       |       |       |       |       |       |       |       |       |       |
|--------------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Max. Rated Module $V_{oc}$ (*1.12) (Volts) | 29.76 | 31.51 | 33.48 | 35.71 | 38.27 | 41.21 | 44.64 | 48.70 | 53.57 | 59.52 | 66.96 | 76.53 | 89.29 |
| Max. Rated Module $V_{oc}$ (*1.14) (Volts) | 29.24 | 30.96 | 32.89 | 35.09 | 37.59 | 40.49 | 43.86 | 47.85 | 52.63 | 58.48 | 65.79 | 75.19 | 87.72 |
| Max # of Modules for 600 Vdc               | 18    | 17    | 16    | 15    | 14    | 13    | 12    | 11    | 10    | 9     | 8     | 7     | 6     |

Use for DC/DC converters. The value calculated below must be less than DC/DC converter max DC input voltage (STEP 6).

☐ B1. Module  $V_{oc}$  (STEP 2) = \_\_\_\_\_ x # of modules per converter (STEP 6) \_\_\_\_\_ x 1.12 (If  $-1 \leq T_i \leq -5^\circ\text{C}$ , STEP 1) = \_\_\_\_\_ V  
☐ B2. Module  $V_{oc}$  (STEP 2) = \_\_\_\_\_ x # of modules per converter (STEP 6) \_\_\_\_\_ x 1.14 (If  $-6 \leq T_i \leq -10^\circ\text{C}$ , STEP 1) = \_\_\_\_\_ V

Table 2. Largest Module  $V_m$  for Single-Module DC/DC Converter Configurations (With 80 V/AFCI Cap) (CEC 690.7 and 690.11)

|                                                |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Max. Rated Module $V_{oc}$ (*1.12) (Volts)     | 30.4 | 33.0 | 35.7 | 38.4 | 41.1 | 43.8 | 46.4 | 49.1 | 51.8 | 54.5 | 57.1 | 59.8 | 62.5 | 65.2 | 67.9 | 70.5 |
| Max. Rated Module $V_{oc}$ (*1.14) (Volts)     | 29.8 | 32.5 | 35.1 | 37.7 | 40.4 | 43.0 | 45.6 | 48.2 | 50.9 | 53.5 | 56.1 | 58.8 | 61.4 | 64.0 | 66.7 | 69.3 |
| DC/DC Converter Max DC Input (Step #6) (Volts) | 34   | 37   | 40   | 43   | 46   | 49   | 52   | 55   | 58   | 61   | 64   | 67   | 70   | 73   | 76   | 79   |

8) Maximum System DC Voltage from DC/DC Converters to Inverter — Only required if Yes in Step 6

Maximum System DC Voltage = \_\_\_\_\_ Volts

9) Maximum Source Circuit Current

Is Module  $I_{sc}$  below 9.6 Amps (Step 3)? ☐ Yes ☐ No (If No, use Comprehensive Standard Plan)

**10) Sizing Source Circuit Conductors**

Source Circuit Conductor Size = Min. #10 AWG copper conductor, 90°C wet (USE-2, PV Wire, XHHW-2, THWN-2, RHW-2)

For up to 8 conductors in roof-mounted conduit exposed to sunlight at least 1/2" from the roof covering (CEC 310)  
Note: For over 8 conductors in the conduit or mounting height of lower than 1/2" from the roof, use Comprehensive Plan.

**11) Are PV source circuits combined prior to the inverter?** ☐ Yes ☐ No

If No, use Single Line Diagram 1 and proceed to Step 13.

If Yes, use Single Line Diagram 2 with Single Line Diagram 4 and proceed to Step 12.

Is source circuit OCPD required? ☐ Yes ☐ No

Source circuit OCPD size (if needed): 15 Amps

**12) Sizing PV Output Circuit Conductors — If a combiner box will NOT be used (Step 11),**  
Output Circuit Conductor Size = Min. #6 AWG copper conductor**13) Inverter DC Disconnect**

Does the inverter have an integrated DC disconnect? ☐ Yes ☐ No If Yes, proceed to step 14.

If No, the external DC disconnect to be installed is rated for \_\_\_\_\_ Amps (DC) and \_\_\_\_\_ Volts (DC)

**14) Inverter Information**

Manufacturer: \_\_\_\_\_ Model: \_\_\_\_\_

Max. Continuous AC Output Current Rating: \_\_\_\_\_ Amps

Integrated DC Arc-Fault Circuit Protection? ☐ Yes ☐ No (If No is selected, Comprehensive Standard Plan)

Grounded or Ungrounded System? ☐ Grounded ☐ Ungrounded

**AC Information:****15) Sizing Inverter Output Circuit Conductors and OCPD**

Inverter Output OCPD rating = \_\_\_\_\_ Amps (Table 3)

Inverter Output Circuit Conductor Size = \_\_\_\_\_ AWG (Table 3)

| Table 3. Minimum Inverter Output OCPD and Circuit Conductor Size |    |    |    |    |    |    |    |    |    |
|------------------------------------------------------------------|----|----|----|----|----|----|----|----|----|
| Inverter Continuous Output Current Rating (Amps) (Step 14)       | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 | 48 |
| Minimum OCPD Size (Amps)                                         | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 60 |
| Minimum Conductor Size (AWG, 75°C, Copper)                       | 14 | 12 | 10 | 10 | 8  | 8  | 6  | 6  | 6  |

Integrated DC Arc-Fault Circuit Protection? ☐ Yes ☐ No (If No is selected, Comprehensive Standard Plan)

Grounded or Ungrounded System? ☐ Grounded ☐ Ungrounded

**16) Point of Connection to Utility**

Only load side connections are permitted with this plan. Otherwise, use Comprehensive Standard Plan.

Is the PV OCPD positioned at the opposite end from input feeder location or main OCPD location? ☐ Yes ☐ No  
If Yes, circle the Max Combined PV System OCPD(s) at 120% value as determined from Step 15 (or Step S20), bus bar Rating, and Main OCPD as shown in Table 4.

If No, circle the Max Combined PV System OCPD(s) at 100% value as determined from Step 15 (or Step S20), bus bar Rating, and Main OCPD as shown in Table 4.

Per 705.12(D)(2): [Inverter output OCPD size [Step #15 or S20] + Main OCPD Size] ≤ [bus size x (100% or 120%)]

| Table 4: Maximum Combined Supply OCPDs Based on Bus Bar Rating (Amps) per CEC 705.12(D)(2) |     |     |     |     |     |     |     |     |     |
|--------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Bus Bar Rating                                                                             | 100 | 125 | 125 | 200 | 200 | 200 | 225 | 225 | 225 |
| Main OCPD                                                                                  | 100 | 100 | 125 | 150 | 175 | 200 | 175 | 200 | 225 |
| Max Combined PV System OCPD(s)<br>at 120% of Bus Bar Rating                                | 20  | 50  | 25  | 60* | 60* | 40  | 60* | 60* | 45  |
| Max Combined PV System OCPD(s)<br>at 100% Bus Bar Rating                                   | 0   | 25  | 0   | 50  | 25  | 0   | 50  | 25  | 0   |

\*This value has been lowered to 60 A from the calculated value to reflect 10 kW AC size maximum.

Reduction of the main breaker is not permitted with this plan. Otherwise, use Comprehensive Standard Plan.

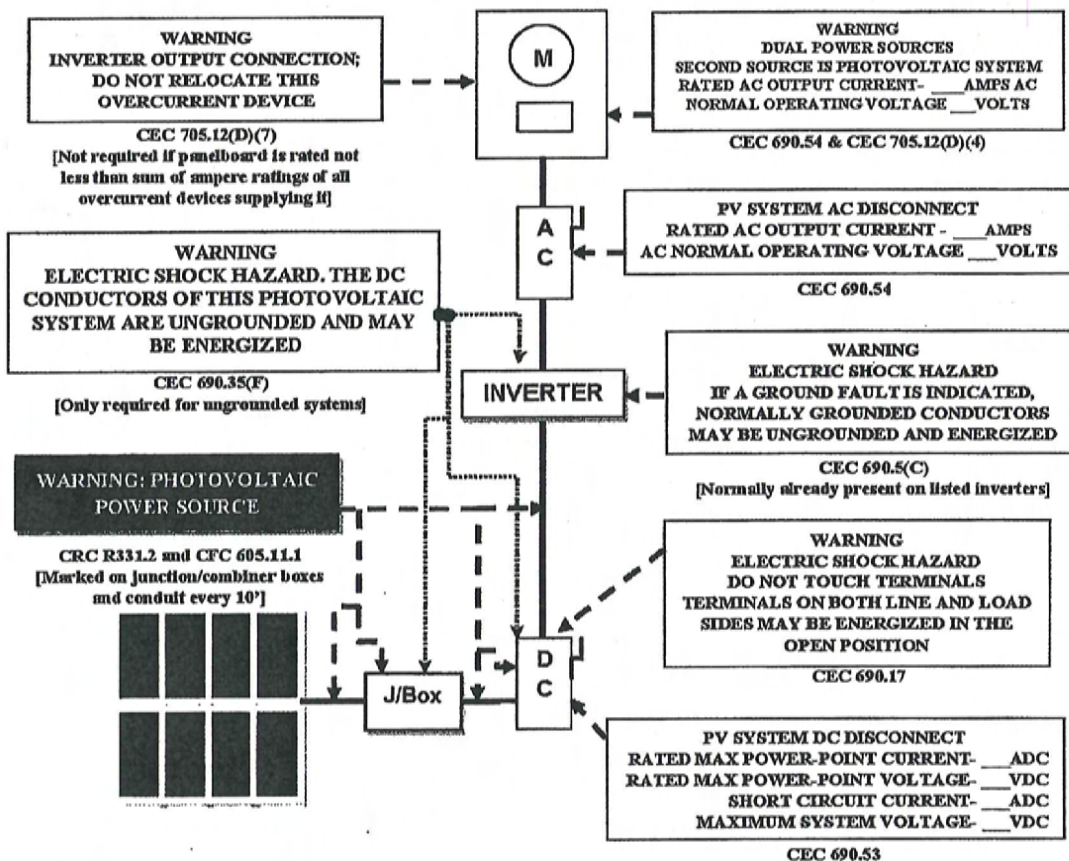
**17 & 18 & 19) Labels and Grounding and Bonding**

This content is covered by the labels on the next page and the Single Line Diagram(s). For background information, refer to the Comprehensive Standard Plan.

# Solar PV Standard Plan — Simplified Central/String Inverter Systems for One- and Two-Family Dwellings

## Markings

CEC Articles 690 and 705 and CRC Section R331 require the following labels or markings be installed at these components of the photovoltaic system:



### Code Abbreviations:

California Electrical Code (CEC)  
California Residential Code (CRC)  
California Fire Code (CFC)

Informational note: ANSI Z535.4 provides guidelines for the design of safety signs and labels for application to products. A phenolic plaque with contrasting colors between the text and background would meet the intent of the code for permanency. No type size is specified, but 20 point (3/8") should be considered the minimum.

CEC 705.12 requires a permanent plaque or directory denoting all electric power sources on or in the premises.

# Solar PV Standard Plan — Simplified Central/String Inverter Systems for One- and Two-Family Dwellings

| 1                                                                                                                                                                                                    | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|---|----|
| SINGLE-LINE DIAGRAM #1 — NO STRINGS COMBINED PRIOR TO INVERTER                                                                                                                                       |   |   |   |   |   |   |   |   |    |
| CHECK A BOX FOR WHETHER SYSTEM IS GROUNDED OR UNGROUNDED: <input type="checkbox"/> GROUNDED (INCLUDE GEC) <input type="checkbox"/> UNGROUNDED                                                        |   |   |   |   |   |   |   |   |    |
| FOR UNGROUNDED SYSTEMS:<br>- DC OCPD MUST DISCONNECT BOTH CONDUCTORS OF EACH SOURCE CIRCUIT<br>- UNGROUNDED CONDUCTORS MUST BE IDENTIFIED PER 210.5(C), WHITE-FINISHED CONDUCTORS ARE NOT PERMITTED. |   |   |   |   |   |   |   |   |    |
| * Consult with your local AHJ and/or Utility                                                                                                                                                         |   |   |   |   |   |   |   |   |    |

The diagram illustrates the electrical connections for a solar PV system. It shows four PV modules connected to a central inverter. The inverter's output is connected to a main service panel. The diagram includes labels A through 10, which correspond to the table below. A detailed inset shows the internal wiring of the inverter, including the DC input, AC output, and ground connections.

| 1                          | 2                            | 3              | 4                    | 5            | 6            | 7            | 8            | 9            | 10           |
|----------------------------|------------------------------|----------------|----------------------|--------------|--------------|--------------|--------------|--------------|--------------|
| CONDUCTOR/CONDUIT SCHEDULE |                              |                |                      |              |              |              |              |              |              |
| TYPE                       | DESCRIPTION AND CONDUIT TYPE | CONDUCTOR SIZE | NUMBER OF CONDUCTORS | CONDUIT TYPE | CONDUIT SIZE | CONDUIT TYPE | CONDUIT SIZE | CONDUIT TYPE | CONDUIT SIZE |
| A                          | 120V AC                      | 12             | 3                    | 12           | 3            | 12           | 3            | 12           | 3            |
| B                          | 240V AC                      | 12             | 3                    | 12           | 3            | 12           | 3            | 12           | 3            |
| C                          | 480V AC                      | 12             | 3                    | 12           | 3            | 12           | 3            | 12           | 3            |
| D                          | 600V AC                      | 12             | 3                    | 12           | 3            | 12           | 3            | 12           | 3            |
| E                          | 750V AC                      | 12             | 3                    | 12           | 3            | 12           | 3            | 12           | 3            |

ENTER "N/A" WHERE SUITABLE FOR WHEN NOT USING CONDUIT OR CABLE AS PERMITTED BY CODE

IF DC/DC CONVERTERS ARE USED, CHECK THE BOX BELOW THE CORRESPONDING CONFIGURATION:

PARALLEL DC/DC CONVERTERS ON ONE SOURCE CIRCUIT (FIXED UNIT VOLTAGE DC/DC CONVERTERS)

DC/DC CONVERTERS ARE ALL RUN IN SERIES (FIXED SOURCE CIRCUIT VOLTAGE DC/DC CONVERTERS)

# **Solar PV Standard Plan — Simplified** **Central/String Inverter Systems for One- and Two-Family Dwellings**

**A TAG DESCRIPTION**

|    |                                                                     |
|----|---------------------------------------------------------------------|
| 1  | SOLAR PV MODULE / STRING                                            |
| 2  | DC/DC CONVERTERS INSTALLED? YES / NO (IF YES, STEPS 8 & 9 REQUIRED) |
| 3  | SOURCE CIRCUIT JUNCTION BOX INSTALLED? YES / NO                     |
| 4  | COMBINER BOX (STEPS 11 & 12 REQUIRED)                               |
| 5  | SEPARATE DC DISCONNECT INSTALLED? YES / NO                          |
| 6  | INTERNAL INVERTER DC DISCONNECT? YES / NO                           |
| 7  | CENTRAL INVERTER                                                    |
| 8  | LOAD CENTER INSTALLED? YES / NO                                     |
| 9  | PV PRODUCTION METER INSTALLED? YES / NO                             |
| 10 | SEPARATE AC DISCONNECT INSTALLED? YES / NO                          |
| 11 | CONNECT TO INVERTER #2 (USE LINE DIAGRAM 4)                         |

\* Consult with your local AHJ and /or Utility

**SINGLE-LINE DIAGRAM #2 — COMBINING STRINGS PRIOR TO INVERTER**

CHECK A BOX FOR WHETHER SYSTEM IS GROUNDED OR UNGROUNDED:  
☐ GROUNDED (INCLUDE GEC)  
☐ UNGROUNDED

FOR UNGROUNDED SYSTEMS:  
 - DC OCPD MUST DISCONNECT BOTH CONDUCTORS OF EACH SOURCE CIRCUIT  
 - UNGROUNDED CONDUCTORS MUST BE IDENTIFIED PER 210.5(C), WHITE-FINISHED CONDUCTORS ARE NOT PERMITTED.

**COMBINER CONDUIT/CONDUIT SCHEDULE**

| CONDUIT TYPE | CONDUIT SIZE | NUMBER OF CONDUCTORS | CONDUIT TYPE | CONDUIT SIZE |
|--------------|--------------|----------------------|--------------|--------------|
| A1           | USE-2 D      | OR                   | PV-WIRE D    |              |
| B1           | REC/REC      |                      |              |              |
| C            | REC/REC      |                      |              |              |
| D            | REC/REC      |                      |              |              |
| E            | REC/REC      |                      |              |              |

**NON-COMBINED STRINGS CONDUIT/CONDUIT SCHEDULE (IF APPLICABLE)**

| CONDUIT TYPE | CONDUIT SIZE | NUMBER OF CONDUCTORS | CONDUIT TYPE | CONDUIT SIZE |
|--------------|--------------|----------------------|--------------|--------------|
| A2           | USE-2 D      | OR                   | PV-WIRE D    |              |
| B2           | REC/REC      |                      |              |              |
| C            | REC/REC      |                      |              |              |
| D            | REC/REC      |                      |              |              |
| E            | REC/REC      |                      |              |              |

ENTER "N/A" WHERE SUITABLE FOR WHEN NOT USING CONDUIT OR CABLE AS PERMITTED BY CODE

**IF DC/DC CONVERTERS ARE USED, THEY ARE RUN IN SERIES (FIXED SOURCE CIRCUIT VOLTAGE DC/DC CONVERTERS)**

**Solar PV Standard Plan — Simplified**  
**Central/String Inverter Systems for One- and Two-Family Dwellings**  
**Supplemental Calculation Sheets for Inverter #2**  
**(Only include if second inverter is used)**

DC Information:

|                                                                                                                                              |                                                     |                                                                                             |
|----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|---------------------------------------------------------------------------------------------|
| Module Manufacturer: _____                                                                                                                   |                                                     | Model: _____                                                                                |
| S2) Module $V_{oc}$ (from module nameplate): _____ Volts                                                                                     |                                                     | S3) Module $I_{sc}$ (from module nameplate): _____ Amps                                     |
| S4) Module DC output power under standard test conditions (STC) = _____ Watts (STC)                                                          |                                                     |                                                                                             |
| S5) DC Module Layout                                                                                                                         |                                                     |                                                                                             |
| Identify each source circuit (string) for inverter 1 shown on the roof plan with a Tag (e.g. A,B,C,...)                                      | Number of modules per source circuit for inverter 1 | Identify, by tag, which source circuits on the roof are to be paralleled (If none, put N/A) |
|                                                                                                                                              |                                                     | Combiner 1:                                                                                 |
|                                                                                                                                              |                                                     |                                                                                             |
|                                                                                                                                              |                                                     |                                                                                             |
|                                                                                                                                              |                                                     | Combiner 2:                                                                                 |
|                                                                                                                                              |                                                     |                                                                                             |
|                                                                                                                                              |                                                     |                                                                                             |
| Total number of source circuits for inverter 1: _____                                                                                        |                                                     |                                                                                             |
| S6) Are DC/DC Converters used? <input type="checkbox"/> Yes <input type="checkbox"/> No    If No, skip to Step S7. If Yes, enter info below. |                                                     |                                                                                             |
| DC/DC Converter Model #: _____                                                                                                               |                                                     | DC/DC Converter Max DC Input Voltage: _____ Volts                                           |
| Max DC Output Current: _____ Amps                                                                                                            |                                                     | Max DC Output Current: _____ Volts                                                          |
| Max # of DC/DC Converters In an Input Circuit: _____                                                                                         |                                                     | DC/DC Converter Max DC Input Power: _____ Watts                                             |

**S7) Maximum System DC Voltage** — Use A1 or A2 for systems without DC/DC converters, and B1 or B2 with DC/DC Converters.

☐ A1. Module  $V_{oc}$  (STEP S2) = \_\_\_\_\_ x # in series (STEP S5) \_\_\_\_\_ x 1.12 (If  $-1 \leq T_L \leq -5^\circ\text{C}$ , STEP S1) = \_\_\_\_\_ V

☐ A2. Module  $V_{oc}$  (STEP S2) = \_\_\_\_\_ x # in series (STEP S5) \_\_\_\_\_ x 1.14 (If  $-6 \leq T_L \leq -10^\circ\text{C}$ , STEP S1) = \_\_\_\_\_ V

**Table 1. Maximum Number of PV Modules in Series Based on Module Rated  $V_{oc}$  for 600 Vdc Rated Equipment (CEC 690.7)**

|                                               |       |       |       |       |       |       |       |       |       |       |       |       |       |
|-----------------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Max. Rated Module $V_{oc}$ (*1.12)<br>(Volts) | 29.76 | 31.51 | 33.48 | 35.71 | 38.27 | 41.21 | 44.64 | 48.70 | 53.57 | 59.52 | 66.96 | 76.53 | 89.29 |
| Max. Rated Module $V_{oc}$ (*1.14)<br>(Volts) | 29.24 | 30.96 | 32.89 | 35.09 | 37.59 | 40.49 | 43.86 | 47.85 | 52.63 | 58.48 | 65.79 | 75.19 | 87.72 |
| Max # of Modules for 600 Vdc                  | 18    | 17    | 16    | 15    | 14    | 13    | 12    | 11    | 10    | 9     | 8     | 7     | 6     |

Use for DC/DC converters. The value calculated below must be less than DC/DC converter max DC input voltage (STEP S6).

☐ B1. Module  $V_{oc}$  (STEP S2) = \_\_\_\_\_ x # of modules per converter (STEP S6) \_\_\_\_\_ x 1.12 (If  $-1 \leq T_L \leq -5^\circ\text{C}$ , STEP S1) = \_\_\_\_\_ V

☐ B2. Module  $V_{oc}$  (STEP S2) = \_\_\_\_\_ x # of modules per converter (STEP S6) \_\_\_\_\_ x 1.14 (If  $-6 \leq T_L \leq -10^\circ\text{C}$ , STEP S1) = \_\_\_\_\_ V

**Table 2. Largest Module  $V_{oc}$  for Single-Module DC/DC Converter Configurations (with 80 V AFCI Cap) (CEC 690.7 and 690.11)**

|                                                  |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|--------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Max. Rated Module $V_{oc}$ (*1.12)<br>(Volts)    | 30.4 | 33.0 | 35.7 | 38.4 | 41.1 | 43.8 | 46.4 | 49.1 | 51.8 | 54.5 | 57.1 | 59.8 | 62.5 | 65.2 | 67.9 | 70.5 |
| Max. Rated Module $V_{oc}$ (*1.14)<br>(Volts)    | 29.8 | 32.5 | 35.1 | 37.7 | 40.4 | 43.0 | 45.6 | 48.2 | 50.9 | 53.5 | 56.1 | 58.8 | 61.4 | 64.0 | 66.7 | 69.3 |
| DC/DC Converter Max DC Input<br>(Step 6) (Volts) | 34   | 37   | 40   | 43   | 46   | 49   | 52   | 55   | 58   | 61   | 64   | 67   | 70   | 73   | 76   | 79   |

**S8) Maximum System DC Voltage from DC/DC Converters to Inverter** — Only required if Yes in Step S6  
Maximum System DC Voltage = \_\_\_\_\_ Volts

**S9) Maximum Source Circuit Current**  
Is Module ISC below 9.6 Amps (Step S3)? ☐ Yes ☐ No (If No, use Comprehensive Standard Plan)

**S10) Sizing Source Circuit Conductors**  
Source Circuit Conductor Size = Min. #10 AWG copper conductor, 90°C wet (USE-2, PV Wire, XHHW-2, THWN-2, RHW-2)  
For up to 8 conductors in roof-mounted conduit exposed to sunlight at least 1/2" from the roof covering (CEC 310)  
Note: For over 8 conductors in the conduit or mounting height of lower than 1/2" from the roof, use Comprehensive Plan.

**S11) Are PV source circuits combined prior to the inverter?** ☐ Yes ☐ No  
If No, use Single Line Diagram 1 and proceed to Step S13.  
If Yes, use Single Line Diagram 2 with Single Line Diagram 4 and proceed to Step S12.  
Is source circuit OCPD required? ☐ Yes ☐ No  
Source circuit OCPD size (if needed): 15 Amps

**S12) Sizing PV Output Circuit Conductors** — If a combiner box will NOT be used (Step S11),  
Output Circuit Conductor Size = Min. #6 AWG copper conductor

**S13) Inverter DC Disconnect**  
Does the inverter have an integrated DC disconnect? ☐ Yes ☐ No If Yes, proceed to Step S14.  
If No, the external DC disconnect to be installed is rated for \_\_\_\_\_ Amps (DC) and \_\_\_\_\_ Volts (DC)

**S14) Inverter Information**

Manufacturer: \_\_\_\_\_ Model: \_\_\_\_\_  
 Max. Continuous AC Output Current Rating: \_\_\_\_\_ Amps  
 Integrated DC Arc-Fault Circuit Protection? ☐ Yes ☐ No (If No is selected, Comprehensive Standard Plan)  
 Grounded or Ungrounded System? ☐ Grounded ☐ Ungrounded

**AC Information:****S15) Sizing Inverter Output Circuit Conductors and OCPD**

Inverter Output OCPD rating = \_\_\_\_\_ Amps (Table 3)  
 Inverter Output Circuit Conductor Size = \_\_\_\_\_ AWG (Table 3)

**Table 3. Minimum Inverter Output OCPD and Circuit Conductor Size**

| Inverter Continuous Output Current Rating (Amps) [Step 14] | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 | 48 |
|------------------------------------------------------------|----|----|----|----|----|----|----|----|----|
| Minimum OCPD Size (Amps)                                   | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 60 |
| Minimum Conductor Size (AWG, 75°C, Copper)                 | 14 | 12 | 10 | 10 | 8  | 8  | 6  | 6  | 6  |

### Load Center Calculations

**(Omit if a load center will not be installed for PV OCPDs)**

**S20) Load Center Output:**

Calculate the sum of the maximum AC outputs from each inverter.

Inverter #1 Max Continuous AC Output Current Rating [STEP S14] \_\_\_\_\_ × 1.25 = \_\_\_\_\_ Amps

Inverter #2 Max Continuous AC Output Current Rating [STEP S14] \_\_\_\_\_ × 1.25 = \_\_\_\_\_ Amps

Total inverter currents connected to load center (sum of above) = \_\_\_\_\_ Amps

Conductor Size: \_\_\_\_\_ AWG

Overcurrent Protection Device: \_\_\_\_\_ Amps

Load center bus bar rating: \_\_\_\_\_ Amps

The sum of the ampere ratings of overcurrent devices in circuits supplying power to a bus bar or conductor shall not exceed 120 percent of the rating of the bus bar or conductor.

# Solar PV Standard Plan — Simplified Central/String Inverter Systems for One- and Two-Family Dwellings

| DESCRIPTION |                                        | SINGLE-LINE DIAGRAM #3 - ADDITIONAL INVERTER FOR DIAGRAM #1 |                                |
|-------------|----------------------------------------|-------------------------------------------------------------|--------------------------------|
| 1           | SOLAR PV MODULE / STRING               | YES / NO                                                    | (IF YES, STEPS 6 & 8 REQUIRED) |
| 2           | DC/DC CONVERTERS INSTALLED?            | YES / NO                                                    |                                |
| 3           | SOURCE CIRCUIT JUNCTION BOX INSTALLED? | YES / NO                                                    |                                |
| 4           | SEPARATE DC DISCONNECT INSTALLED?      | YES / NO                                                    |                                |
| 5           | INTERNAL INVERTER DC DISCONNECT?       | YES / NO                                                    |                                |
| 6           | CENTRAL INVERTER                       | YES / NO                                                    |                                |
| 7           | SEPARATE AC DISCONNECT INSTALLED?      | YES / NO                                                    |                                |
| 8           | TO LOAD CENTER ON LINE DIAGRAM 1       | YES / NO                                                    |                                |

\* Consult with your local AHJ and / or utility

**INVERTER # 2**

CHECK A BOX FOR WHETHER SYSTEM IS GROUNDED OR UNGROUNDED:

☐ GROUNDED (INCLUDE GEC)

☐ UNGROUNDED

FOR UNGROUNDED SYSTEMS:

- DC OCPD MUST DISCONNECT BOTH CONDUCTORS OF EACH SOURCE CIRCUIT

- UNGROUNDED CONDUCTORS MUST BE IDENTIFIED PER 210.5(C), WHITE-FINISHED CONDUCTORS ARE NOT PERMITTED.

IF DC/DC CONVERTERS ARE USED, CHECK THE BOX BELOW THE CORRESPONDING CONFIGURATION

PARALLEL DC/DC CONVERTERS ON ONE SOURCE CIRCUIT (FIXED UNIT VOLTAGE DC/DC CONVERTERS)

☐

DC/DC CONVERTERS ARE ALL RUN IN SERIES (FIXED SOURCE CIRCUIT VOLTAGE DC/DC CONVERTERS)

☐

ENTER "N/A" WHERE SUITABLE FOR WHEN NOT USING CONDUIT OR CABLE AS PERMITTED BY CODE

| CONDUIT CLOSING SCHEDULE |                                 |                    |              |
|--------------------------|---------------------------------|--------------------|--------------|
| TYPE                     | DESCRIPTION AND CONDUIT CLOSING | NUMBER OF CONDUITS | CONDUIT TYPE |
| Y                        | 0.75-3/4" OR 1-1/4" TYPE III    |                    |              |
| R                        | EC/EC/EC                        |                    |              |
| C                        | EC/EC/EC                        |                    |              |
|                          | EC/EC/EC                        |                    |              |

# Solar PV Standard Plan — Simplified Central/String Inverter Systems for One- and Two-Family Dwellings

| A TAG DESCRIPTION |                                                                         |
|-------------------|-------------------------------------------------------------------------|
| 1                 | SOLAR PV MODULE / STRING                                                |
| 2                 | DC/DC CONVERTER'S INSTALLATION? YES / NO (IF YES, STEPS 8 & 9 REQUIRED) |
| 3                 | SOURCE CIRCUIT JUNCTION BOX INSTALLATION? YES / NO                      |
| 4                 | COMBINER BOX (STEPS 11 & 12 REQUIRED)                                   |
| 5                 | SEPARATE DC DISCONNECT INSTALLED? YES / NO                              |
| 6                 | INTERNAL INVERTER DC DISCONNECT? YES / NO                               |
| 7                 | CENTRAL INVERTER                                                        |
| 8                 | *SEPARATE AC DISCONNECT INSTALLED? YES / NO                             |
| 9                 | TO LOAD CENTER ON LINE DIAGRAM 3                                        |

\* Consult with your local AHJ and / or Utility

### SINGLE-LINE DIAGRAM #4 - ADDITIONAL INVERTER FOR DIAGRAM #2 INVERTER #2

CHECK A BOX FOR WHETHER SYSTEM IS GROUNDED OR UNGROUNDED:

☐ GROUNDED (INCLUDE GEC)

☐ UNGROUNDED

FOR UNGROUNDED SYSTEMS:

- DC OCPD MUST DISCONNECT BOTH CONDUCTORS OF EACH SOURCE CIRCUIT

- UNGROUNDED CONDUCTORS MUST BE IDENTIFIED PER 210.5(C), WHITE-FINISHED CONDUCTORS ARE NOT PERMITTED.

### COMBINER BOX CONDUIT SCHEDULE

| TYPE | DESCRIPTION AND CONDUIT USE | NUMBER OF CONDUITS | CONDUIT SIZE |
|------|-----------------------------|--------------------|--------------|
| 1    | 12-12" OR 14-14" R          |                    |              |
| 2    | 12-12" OR 14-14" R          |                    |              |
| 3    | 12-12" OR 14-14" R          |                    |              |
| 4    | 12-12" OR 14-14" R          |                    |              |

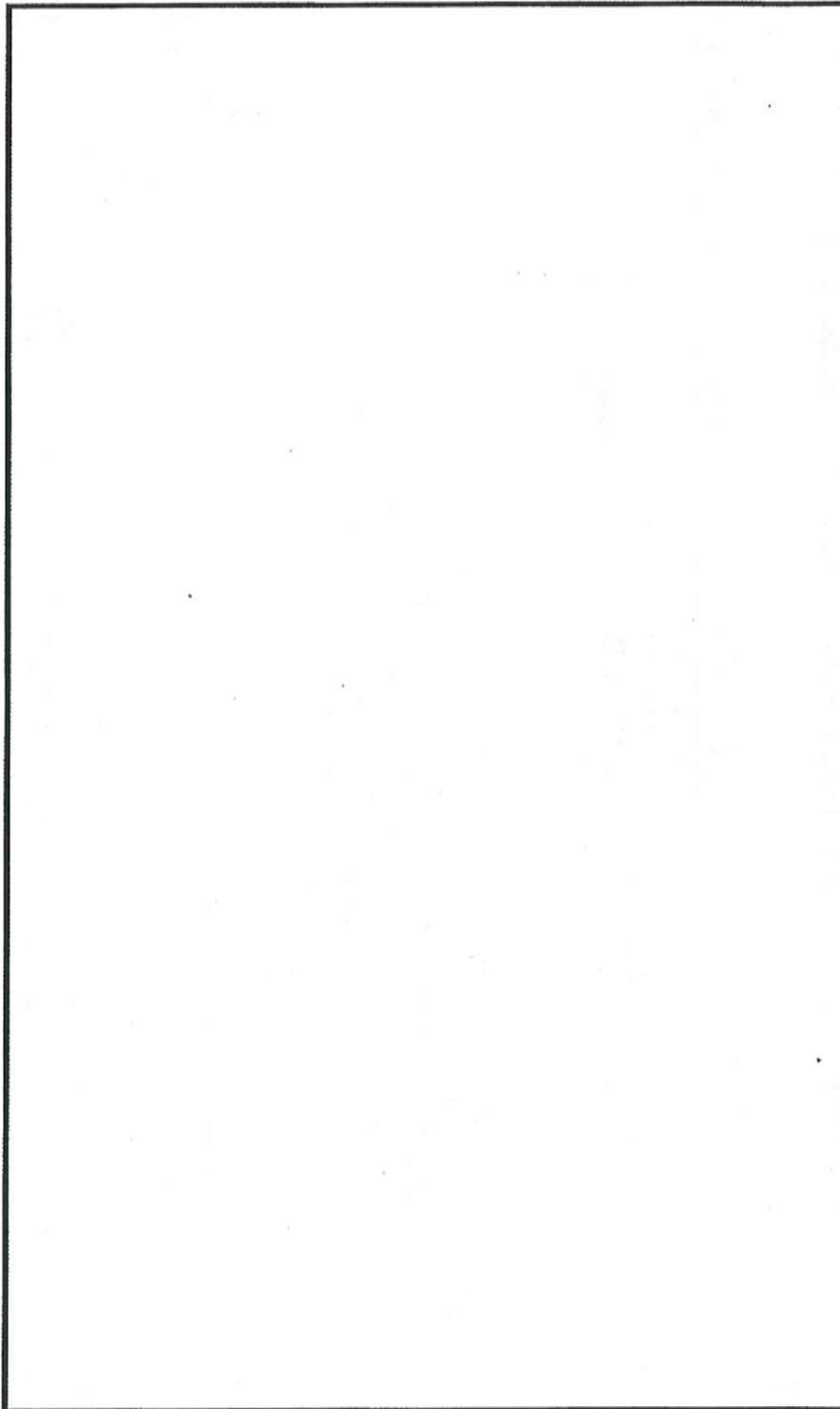
### DC/DC CONVERTER CONDUIT SCHEDULE (IF APPLICABLE)

| TYPE | DESCRIPTION AND CONDUIT USE | NUMBER OF CONDUITS | CONDUIT SIZE |
|------|-----------------------------|--------------------|--------------|
| 1    | 12-12" OR 14-14" R          |                    |              |
| 2    | 12-12" OR 14-14" R          |                    |              |
| 3    | 12-12" OR 14-14" R          |                    |              |
| 4    | 12-12" OR 14-14" R          |                    |              |

ENTER "N/A" WHERE SUITABLE FOR WHEN NOT USING CONDUIT OR CABLE AS PERMITTED BY CODE

IF DC/DC CONVERTERS ARE USED, THEY ARE RUN IN SERIES (FRED SOURCE CIRCUIT VOLTAGE DC/DC CONVERTERS)

**SOLAR PV STANDARD PLAN**  
Roof Layout Diagram for One- and Two-Family Dwellings



Items required: roof layout of all panels, modules, clear access pathways and approximate locations of electrical disconnecting means and roof access points.



## Solar PV Standard Plan — Simplified Microinverter and ACM Systems for One- and Two-Family Dwellings

**SCOPE:** Use this plan ONLY for systems using utility-interactive Microinverters or AC Modules (ACM) not exceeding a combined system AC inverter output rating of 10 kW, with a maximum of 3 branch circuits, one PV module per inverter and with PV module ISC maximum of 10-A DC, installed on a roof of a one- or two-family dwelling or accessory structure. The photovoltaic system must interconnect to a single-phase AC service panel of 120/240 Vac with service panel bus bar rating of 225 A or less. This plan is not intended for bipolar systems, hybrid systems or systems that utilize storage batteries, charge controllers or trackers. Systems must be in compliance with current California Building Standards Codes and local amendments of the authority having jurisdiction (AHJ). Other articles of the California Electrical Code (CEC) shall apply as specified in section 690.3.

**MANUFACTURER'S SPECIFICATION SHEETS MUST BE PROVIDED** for proposed inverters, modules, combiner/junction boxes and racking systems. Installation instructions for bonding and grounding equipment shall be provided and local AHJs may require additional details. Listed and labeled equipment shall be installed and used in accordance with any instructions included in the listing or labeling (CEC 110.3). Equipment intended for use with PV system shall be identified and listed for the application CEC 690.4(D).

### Applicant and Site Information

Job Address: \_\_\_\_\_ Permit #: \_\_\_\_\_

Contractor/ Engineer Name: \_\_\_\_\_ License # and Class: \_\_\_\_\_

Signature: \_\_\_\_\_ Date: \_\_\_\_\_ Phone Number: \_\_\_\_\_

### General Requirements and System Information

☐ Microinverter

Number of PV modules installed: \_\_\_\_\_

Number of Microinverters installed: \_\_\_\_\_

☐ AC Module (ACM)

Number of ACMs installed: \_\_\_\_\_

*Note: Listed Alternating-Current Module (ACM) is defined in CEC 690.2 and installed per CEC 690.6*

Number of Branch Circuits, 1, 2 or 3: \_\_\_\_\_

Actual number of Microinverters or ACMs per branch circuit: 1. \_\_\_\_\_ 2. \_\_\_\_\_ 3. \_\_\_\_\_

Total AC system power rating = (Total Number of Microinverters or ACMs) \* (AC inverter power output) = \_\_\_\_\_ Watts

Lowest expected ambient temperature for this plan in Table 1: For -1 to -5°C use 1.12 or for -6 to -10°C use 1.14 correction factors.

Average ambient high temperature for this plan: = +47 OC

Note: For lower expected ambient or higher average ambient high temperatures, use Comprehensive Standard Plan.

### Microinverter or ACM Information and Ratings

Microinverters with ungrounded DC inputs shall be installed in accordance with CEC 690.35.

Microinverter or ACM Manufacturer: \_\_\_\_\_

Model: \_\_\_\_\_

Rated (continuous) AC output power: \_\_\_\_\_ Watts

Nominal AC voltage rating: \_\_\_\_\_ Volts

Rated (continuous) AC output current: \_\_\_\_\_ Amps

*If installing ACMs, skip [STEPS 0]*

Maximum DC input voltage rating: \_\_\_\_\_ Volts (limited to 79 V, otherwise use the Comprehensive Standard Plan)

Maximum AC output overcurrent protection device (OCPD) \_\_\_\_\_ Amps

Maximum number of Microinverters or ACMs per branch circuit: \_\_\_\_\_

### PV Module Information

*(If installing ACMs, skip to [STEP 4])*

PV Module Manufacturer: \_\_\_\_\_

Model: \_\_\_\_\_

Module DC output power under standard test conditions (STC) = \_\_\_\_\_ Watts

Module  $V_{oc}$  at STC (from module nameplate): \_\_\_\_\_ Volts

Module  $I_{sc}$  at STC (from module nameplate): \_\_\_\_\_ Amps

Adjusted PV Module DC voltage at minimum temperature = [Table 1] \_\_\_\_\_ [cannot exceed Step 0]

| Table 1: Module $V_{oc}$ at STC Based on Inverter Maximum DC Input Voltage Derived from NEC 690.7 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|---------------------------------------------------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Microinverter Max. DC Input [STEP 0] (Volts)                                                      | 34   | 37   | 40   | 43   | 46   | 49   | 52   | 55   | 58   | 61   | 64   | 67   | 70   | 73   | 76   | 79   |
| Max. Module $V_{oc}$ @ STC, 1.12 (-1 to -5°C) Correction Factor (Volts)                           | 30.4 | 33.0 | 35.7 | 38.4 | 41.1 | 43.8 | 46.4 | 49.1 | 51.8 | 54.5 | 57.1 | 59.8 | 62.5 | 65.2 | 67.9 | 70.5 |
| Max. Module $V_{oc}$ @ STC, 1.14 (-6 to -10°C) Correction Factor (Volts)                          | 29.8 | 32.5 | 35.1 | 37.7 | 40.4 | 43.0 | 45.6 | 48.2 | 50.9 | 53.5 | 56.1 | 58.8 | 61.4 | 64.0 | 66.7 | 69.3 |

### Branch Circuit Output Information

Fill in [Table 3] to describe the branch circuit inverter output conductor and OCPD size. Use [Table 2] for determining the OCPD and Minimum Conductor size.

| Table 2: Branch Circuit OCPD and Minimum Conductor Size* |                       |             |                              |                                                              |
|----------------------------------------------------------|-----------------------|-------------|------------------------------|--------------------------------------------------------------|
| Circuit Current (Amps)                                   | Circuit Power (Watts) | OCPD (Amps) | Minimum Conductor Size (AWG) | Minimum Metal Conduit Size for 6 Current Carrying Conductors |
| 12                                                       | 2880                  | 15          | 12                           | ¾"                                                           |
| 16                                                       | 3840                  | 20          | 10                           | ¾"                                                           |
| 20                                                       | 4800                  | 25          | 8                            | 1"                                                           |
| 24                                                       | 5760                  | 30          | 8                            | 1"                                                           |

\*NEC 690.8 and 210.19 (A)(1) Factored in Table 2, Conductors are copper, insulation must be 90°C wet-rated. Table 2 values are based on maximum ambient temperature of 69°C, which includes 22°C adder, exposed to direct sunlight, mounted > 0.5 inches above rooftop, ≤ 6 current carrying conductors (3 circuits) in a circular raceway. Otherwise use Comprehensive Standard Plan.

| Table 3: PV Array Configuration Summary            |          |          |          |
|----------------------------------------------------|----------|----------|----------|
|                                                    | Branch 1 | Branch 2 | Branch 3 |
| Number of Microinverters or ACIMs [Step 0]         |          |          |          |
| Selected Conductor Size [Table 2] (AWG)            |          |          |          |
| Selected Branch and Inverter Output OCPD [Table 2] |          |          |          |

### Solar Load Center (if used)

Solar Load Center is to have a bus bar rating not less than 100 Amps. Otherwise use Comprehensive Standard Plan.

Circuit Power see [STEP 0] = \_\_\_\_\_ Watts

Circuit Current = (Circuit Power) / (AC voltage) = \_\_\_\_\_ Amps

| Table 4: Solar Load Center and Total Inverter Output OCPD and Conductor Size** |                       |             |                              |                            |
|--------------------------------------------------------------------------------|-----------------------|-------------|------------------------------|----------------------------|
| Circuit Current (Amps)                                                         | Circuit Power (Watts) | OCPD (Amps) | Minimum Conductor Size (AWG) | Minimum Metal Conduit Size |
| 24                                                                             | 5760                  | 30          | 10                           | 1/2"                       |
| 28                                                                             | 6720                  | 35          | 8                            | 3/4"                       |
| 32                                                                             | 7680                  | 40          | 8                            | 3/4"                       |
| 36                                                                             | 8640                  | 45          | 8                            | 3/4"                       |
| 40                                                                             | 9600                  | 50          | 8                            | 3/4"                       |
| 41.6                                                                           | ≤ 10000               | 60          | 6                            | 3/4"                       |

\*\*CEC 690.8 and 210.19 (A)(1) Factored in Table 4, Conductors are copper, insulation must be 90°C wet-rated. Table 4 values are based on maximum ambient temperature of 47°C (no rooftop temperature adder in this calculation), ≤ 3 current carrying conductors in a circular raceway. Otherwise use Comprehensive Standard Plan.

### Point of Connection to Utility:

Load Side Connection only! Otherwise use the Comprehensive Standard Plan.

Is the PV OCPD positioned at the opposite end from input feeder location or main OCPD location?

☐ Yes ☐ No (If No, then use 100% row in Table 5)

Per 705.12(D)(2): (Combined inverter output OCPD size + Main OCPD size) ≤ [bus bar size × (100% or 120%)]

| Table 5: Maximum Combined Inverter Output Circuit OCPD            |     |     |     |     |     |     |     |     |     |
|-------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Bus Bar Size (Amps)                                               | 100 | 125 | 125 | 200 | 200 | 200 | 225 | 225 | 225 |
| Main OCPD (Amps)                                                  | 100 | 100 | 125 | 150 | 175 | 200 | 175 | 200 | 225 |
| Maximum Combined Inverter OCPD with 120% of bus bar rating (Amps) | 20  | 50  | 25  | 60† | 60† | 40  | 60† | 60† | 45  |
| Maximum Combined Inverter OCPD with 100% of bus bar rating (Amps) | 0   | 25  | 0   | 50  | 25  | 0   | 50  | 25  | 0   |

†This plan limits the maximum system size to less than 10 kW, therefore the OCPD size is limited to 60 A. Reduction of Main Breaker is not permitted with this plan.

## Grounding and Bonding

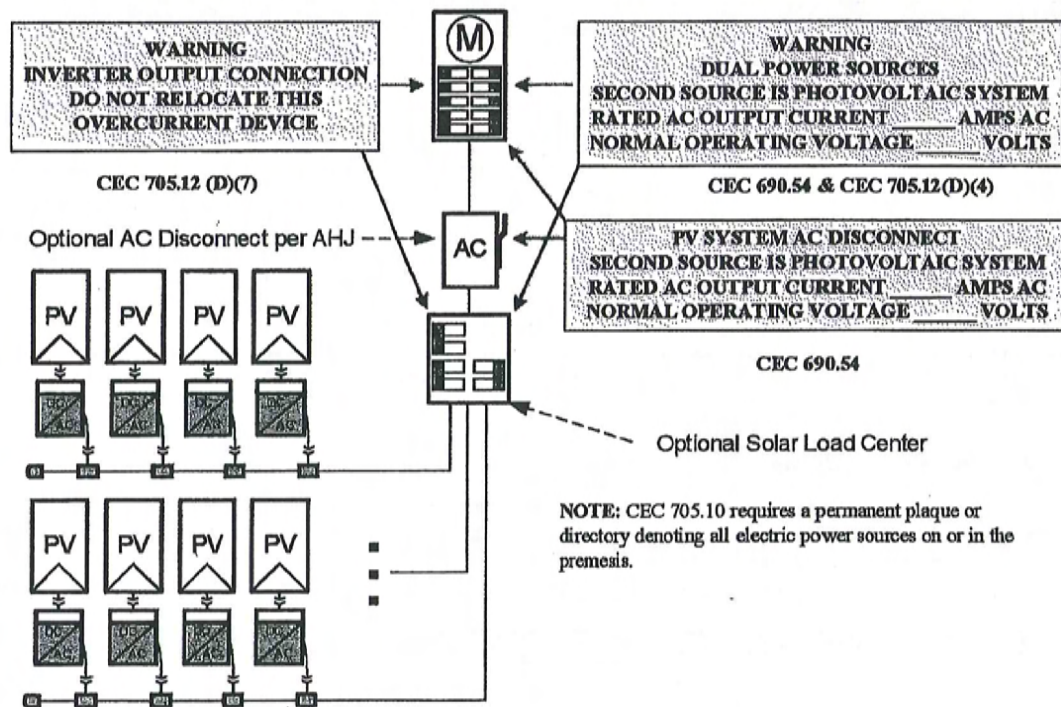
Check one of the boxes for whether system is grounded or ungrounded: ☐ Grounded ☐ Ungrounded

For Microinverters with a grounded DC input, systems must follow the requirements of GEC (CEC 690.47) and EGC (CEC 690.43).

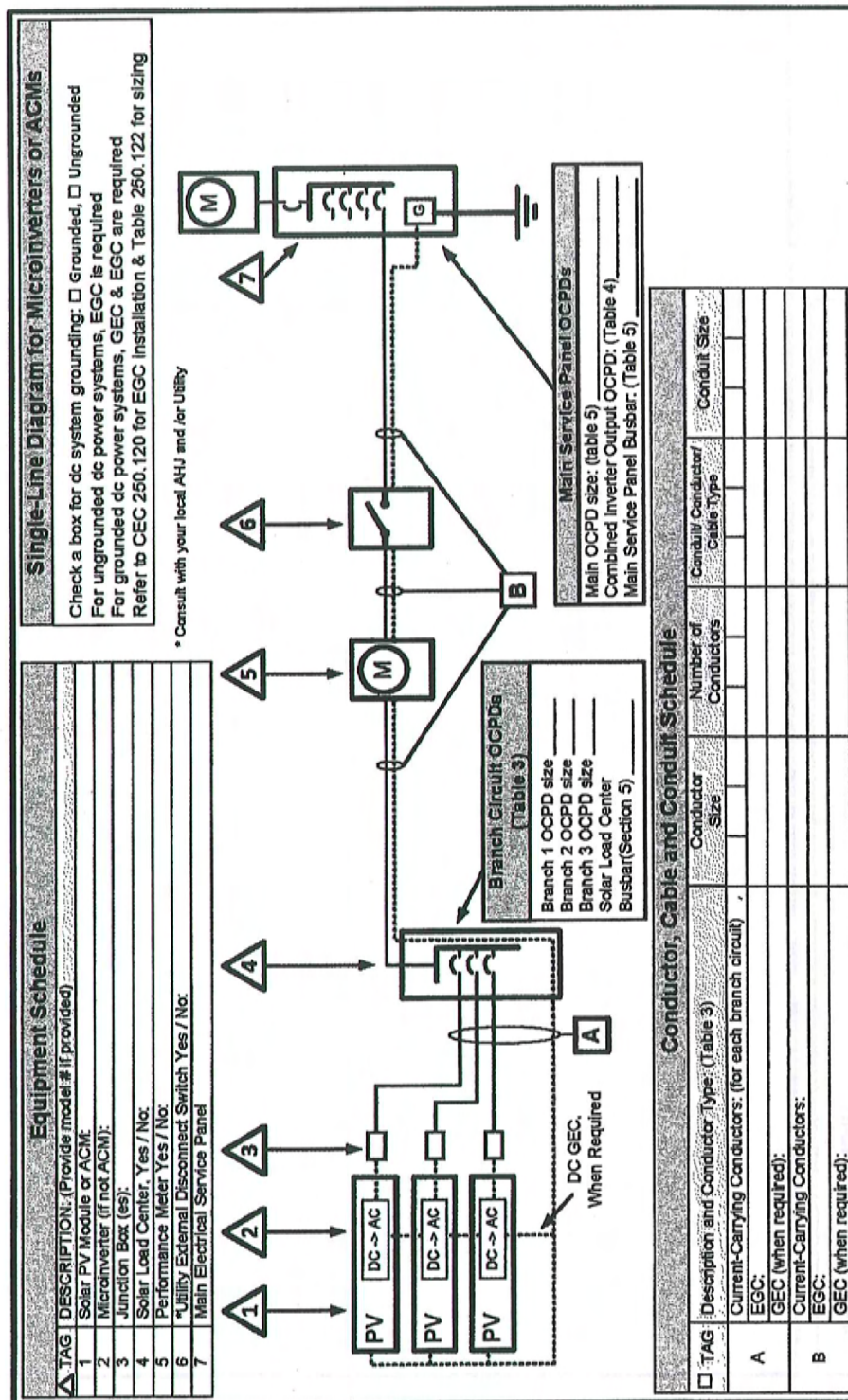
For ACM systems and Microinverters with ungrounded a DC input follow the EGC requirements of (CEC 690.43).

## Markings

Informational note: ANSI Z535.4 provides guidelines for the design of safety signs and labels for application to products. A phenolic plaque with contrasting colors between the text and background would meet the intent of the code for permanency. No type size is specified, but 20 point (3/8") should be considered the minimum.



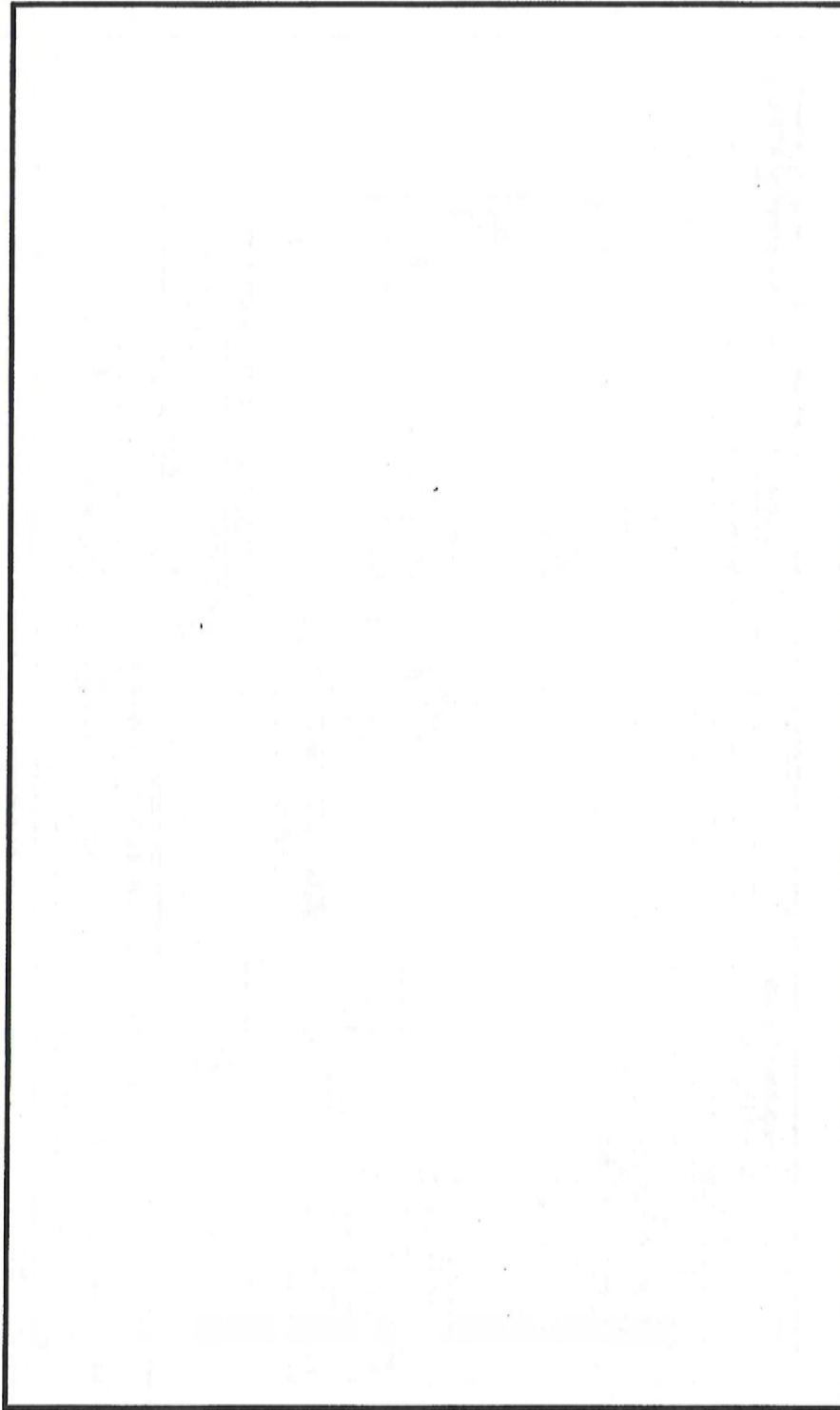
# Solar PV Standard Plan — Simplified Central/String Inverter Systems for One- and Two-Family Dwellings Single-Inverter Line Diagram



# **SOLAR PV STANDARD PLAN — SIMPLIFIED**

Microinverter and ACM Systems for One- and Two-Family Dwellings

ROOF LAYOUT PLAN



Items required: roof layout of all panels, modules, clear access pathways and approximate locations of electrical disconnecting means and roof access points.



## Structural Criteria for Residential Rooftop Solar Energy Installations

### Use of this document

This toolkit document includes a one-page list of structural criteria for over-the-counter or online approval, as well as attached tables and figures that supplement the criteria and explain their use.

This document applies to flush-mounted solar arrays installed on the roofs of wood-framed one- and two-family dwellings. "Flush-mounted" means the modules are installed parallel to, and relatively close to, the roof surface (see the "Solar Array Check" section of the Structural Criteria for specific qualifying requirements). This list is intended to be a simple pre-installation check to gain reasonable assurance that the design of the solar array complies with the structural provisions of the 2013 California Building Code (CBC) and 2013 California Residential Code (CRC). It is not intended to provide post-installation inspection criteria.

### Currently Used Expedited Solar Permitting Approaches

This document is intended for jurisdictions without an expedited process for residential solar structural permitting, and is not intended to replace or supplant procedures for jurisdictions with an expedited process already in place. Good examples from jurisdictions with provisions for expedited structural permitting include the City of Los Angeles, which exempts residential solar installations from structural permitting if five simple requirements are met, and the East Bay Green Corridor's streamlined solar permitting process, which uses structural criteria tailored to typical conditions for that consortium of nine cities.

### Regional and Site Assumptions

This document is based on the following regional and site assumptions:

- The dwelling is located in a ZERO snow load area (see Map 1).
- The dwelling is not in Wind Exposure D (within 200 yards of the ocean or a large coastal bay).
- If in Wind Exposure B (urban, suburban or wooded areas), the dwelling may be located:
  - in a Special Wind Region (see Map 2) with design wind speeds between 110 and 130 mph, or
  - on a tall hill, provided average slope is no steeper than 15%.
- If in Wind Exposure C (within 500 yards of large open fields or grasslands), the dwelling is:
  - in a standard 110 mph design wind speed region, and
  - not on a hill with a grade steeper than 5%.

### Additional Options

The Chief Building Official (CBO) may consider adding rows to the structural criteria, based on personal judgment and their jurisdiction's conditions and history. Possible additional questions include:

- Regional and Site Checks
  - If the jurisdiction is in a mixed snow load area, with zero snow load only at lower elevations, consider asking "is the dwelling lower than elevation \_\_\_\_ feet?"

(Introductory text provided for jurisdiction's reference only. Do not attach to Criteria that follow.)

- If the jurisdiction is in a coastal region, consider asking "is the dwelling farther than 200 yards from the ocean or a large coastal bay?" to verify the dwelling is not in Wind Exposure D.
- If the jurisdiction is in a Special Wind Region with design wind speeds between 115 and 130 mph, consider verifying that the dwelling is in Wind Exposure B by asking "is the dwelling in an urban, suburban or wooded area, and not within 500 yards of open fields and grasslands?"
- If the jurisdiction is in a Special Wind Region with design wind speeds between 115 and 130 mph, consider verifying that there are no significant topographic wind speed-up effects by asking "is the dwelling in a relatively flat area (grade less than 5%) and not within 500 yards of the crest of a tall hill?"
- **Roof Check**
  - Based on the jurisdiction's one- and two-family housing stock and code compliance history, many CBOs will find it reasonable to assume that most dwellings' roof structures were designed to the building code in effect at the time the houses were built. If so, the roof structure code compliance check consists of the Contractor's visual roof audit, checking for unusual sagging or deterioration, without requiring additional measurements of existing rafters to check against span tables.
  - For CBOs of jurisdictions with evidence of structurally deficient one- and two-family housing stock or poor structural code compliance history, the CBO may elect to add the rafter span check option described in the criteria.

### **The Structural Toolkit and CRC Wind Speeds**

The 2013 CRC contains an inconsistency related to wind speeds. Despite referencing ASCE 7-10 as its standard, the 2013 CRC's text and tables use outdated ASCE 7-05 wind speeds. Under the old ASCE 7-05 / CBC 2010, the basic design wind speed in most regions of the state was 85 mph (max. 3 second gust in 50 years). Under ASCE 7-10 / CBC 2013, the design wind speed has increased to 110 mph (max. 3 second gust in 700 years). Despite the different definitions of wind speed, design wind pressures remain essentially unchanged.

Because the Toolkit's structural document is intended to be forward looking, all wind speeds in the Toolkit document are based on the ASCE 7-10. This is clearly stated in the caption to the state wind speed map, and the Table 1 footnotes. This anticipates an obvious and expected correction to the CRC; otherwise the Toolkit would become immediately outdated when the CRC is amended to change the base design wind speed from mph to 110 mph.

2013 CRC text (ASCE 7-05) wind speeds equivalent to the 2013 CRC and CBC Reference Standard (ASCE 7-10) are shown below. See ASCE 7-10 Table C26.5-6 for additional information.

| 2013 CRC text<br><u>ASCE 7-05</u> | 2013 CRC and CBC Referenced Standard<br><u>ASCE 7-10</u> |
|-----------------------------------|----------------------------------------------------------|
| 85 mph                            | 110 mph                                                  |
| 90 mph                            | 115 mph                                                  |
| 95 mph                            | 120 mph                                                  |
| 100 mph                           | 126 mph                                                  |
| 105 mph                           | 133 mph                                                  |

(Introductory text provided for jurisdiction's reference only. Do not attach to Criteria that follow.)

## **Structural Technical Appendix**

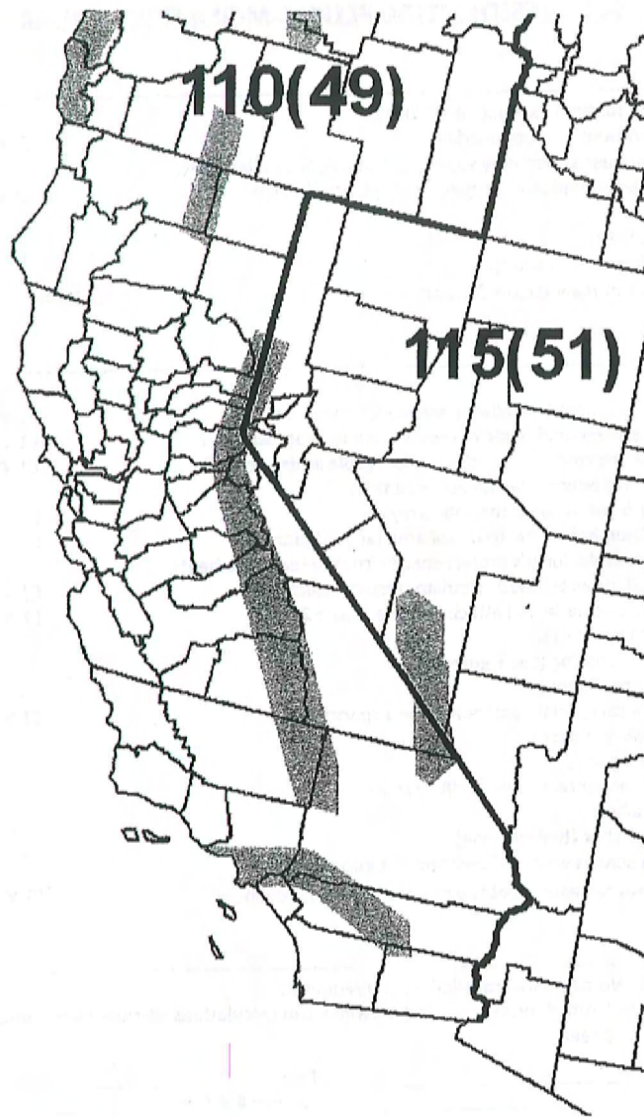
This toolkit document is supported by a Structural Technical Appendix that describes the technical analysis behind these criteria, which are based on structural engineering principles and the California Building and Residential Codes. The Technical Appendix also provides some additional guidance to address non-conforming items, such as when an anchor layout is not based on a solar support component manufacturer's guidelines, or when a coastal site is located within 200 yards of the ocean (Exposure D). This document can be found online.

## **Probability of Code Compliance**

The Structural Technical Appendix includes a section that examines the probabilities associated with the assumptions behind Table 1 that allows six feet cross-slope anchor spacing in some circumstances. That statistical analysis estimates that the probability of code noncompliance for six feet anchor spacing is only 2 in a thousand installations (0.2%). Note that probability of structural failure is orders of magnitude lower than the probability of code *noncompliance*.

(Introductory text provided for jurisdiction's reference only. Do not attach to Criteria that follow.)





**Map 2. California Design Wind Speed Map (Ref: ASCE 7-10).**

The number outside the parentheses represents the design wind speed in mph. Typical design wind speed is 110 mph. The grey shaded areas on the map indicate "special wind regions" where higher wind speeds may apply. When the project is in a grey shaded area, contact the local building department for the design wind speed.

(Map provided for jurisdiction's reference only. Do not attach to Criteria that follow.)

## STRUCTURAL CRITERIA FOR RESIDENTIAL FLUSH-MOUNTED SOLAR ARRAYS

### 1. ROOF CHECKS

#### A. Visual Review/Contractor's Site Audit of Existing Conditions:

- 1) Is the roof a single roof without a reroof overlay? ☐ Y ☐ N
- 2) Does the roof structure appear structurally sound, without signs of alterations or significant structural deterioration or sagging, as illustrated in Figure 1? ☐ Y ☐ N

#### B. Roof Structure Data:

- 1) Measured roof slope (e.g. 6:12): \_\_\_\_\_:12
- 2) Measured rafter spacing (center-to-center): \_\_\_\_\_ inch
- 3) Type of roof framing (rafter or manufactured truss): ☐ Rafter ☐ Truss

### 2. SOLAR ARRAY CHECKS

#### A. Flush-mounted Solar Array:

- 1) Is the plane of the modules (panels) parallel to the plane of the roof? ☐ Y ☐ N
- 2) Is there a 2" to 10" gap between underside of module and the roof surface? ☐ Y ☐ N
- 3) Modules do not overhang any roof edges (ridges, hips, gable ends, eaves)? ☐ Y ☐ N
- B. Do the modules plus support components weigh no more than:  
4 psf for photovoltaic arrays or 5 psf for solar thermal arrays? ☐ Y ☐ N
- C. Does the array cover no more than half of the total roof area (all roof planes)? ☐ Y ☐ N
- D. Are solar support component manufacturer's project-specific completed worksheets, tables with relevant cells circled, or web-based calculator results attached? ☐ Y ☐ N
- E. Is a roof plan of the module and anchor layout attached? (see Figure 2) ☐ Y ☐ N
- F. Downward Load Check (Anchor Layout Check):
- 1) Proposed anchor horizontal spacing (see Figure 2): \_\_\_\_\_' - \_\_\_\_\_" ft-in
- 2) Horizontal anchor spacing per Table 1: \_\_\_\_\_' - \_\_\_\_\_" ft-in
- 3) Is proposed anchor horizontal spacing less than Table 1 spacing? ☐ Y ☐ N

#### G. Wind Uplift Check (Anchor Fastener Check):

- 1) Anchor fastener data (see Figure 3):
- a. Diameter of lag screw, hanger bolt or self-drilling screw: \_\_\_\_\_ inch
- b. Embedment depth of rafter: \_\_\_\_\_ inch
- c. Number of screws per anchor (typically one): \_\_\_\_\_
- d. Are 5/16" diameter lag screws with 2.5" embedment into the rafter used, OR does the anchor fastener meet the manufacturer's guidelines? ☐ Y ☐ N

### 3. SUMMARY

- ☐ A. All items above are checked YES. No additional calculations are required.
- ☐ B. One or more items are checked NO. Attach project-specific drawings and calculations stamped and signed by a California-licensed Civil or Structural Engineer.

Job Address: \_\_\_\_\_

Permit #: \_\_\_\_\_

Contractor/Installer: \_\_\_\_\_

License # & Class: \_\_\_\_\_

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Phone #: \_\_\_\_\_

### Optional Additional Rafter Span Check Criteria

[ At option of CBO, insert rows (4) to (7) below into table above after row 1.B.(3) ]

#### 1. ROOF CHECKS

##### B. Roof Structure Data:

- 4) Measured rafter size (e.g. 13/4 x 33/4, not 2x4): \_\_\_\_\_ x \_\_\_\_\_ inch
- 5) Measured rafter horizontal span (see Figure 4): \_\_\_\_\_' - \_\_\_\_\_" ft-in
- 6) Horizontal rafter span per Table 2: \_\_\_\_\_' - \_\_\_\_\_" ft-in
- 7) Is measured horizontal rafter span less than Table 2 span? ☐ Y ☐ N ☐ Truss

(Jurisdictions may delete "Optional Additional Rafter Span Check" at bottom of this page, or incorporate into main list of Structural Criteria above)

| Table 1 Maximum Horizontal Anchor Spacing |            |                |             |             |
|-------------------------------------------|------------|----------------|-------------|-------------|
| Roof Slope                                |            | Rafter Spacing |             |             |
|                                           |            | 16" o.c.       | 24" o.c.    | 32" o.c.    |
| Photovoltaic Arrays (4 psf max)           |            |                |             |             |
| Flat to 6:12                              | 0° to 26°  | 5'-4"          | 6'-0"       | 5'-4"       |
| 7:12 to 12:12                             | 27° to 45° | 1'-4"          | 2'-0"       | 2'-8"       |
| 13:12 to 24:12                            | 46° to 63° | 1'-4"          | 2'-0"       | 2'-8"       |
| Solar Thermal Arrays (5 psf max)          |            |                |             |             |
| Flat to 6:12                              | 0° to 26°  | 4'-0"          | 4'-0"       | 5'-4"       |
| 7:12 to 12:12                             | 27° to 45° | 1'-4"          | 2'-0"       | 2'-8"       |
| 13:12 to 24:12                            | 46° to 63° | Calc. Req'd    | Calc. Req'd | Calc. Req'd |

Solar support component manufacturer's guidelines may be relied upon to ensure the array above the roof is properly designed, but manufacturer's guidelines typically do NOT check to ensure that the roof itself can support the concentrated loads from the solar array. Table 1 assumes that the roof complied with the building code in effect at the time of construction, and places limits on anchor horizontal spacing to ensure that a roof structure is not overloaded under either downward loads or wind uplift loads. Note 4 below lists the basic assumptions upon which this table is based.

**Table 1 Notes:**

1. Anchors are also known as "stand-offs", "feet", "mounts" or "points of attachment". Horizontal anchor spacing is also known as "cross-slope" or "east-west" anchor spacing (see Figure 2).
2. If anchors are staggered from row-to-row going up the roof, the anchor spacing may be twice that shown above, but no greater than 6'-0".
3. For manufactured plated wood trusses at slopes of flat to 6:12, the horizontal anchor spacing shall not exceed 4'-0" and anchors in adjacent rows shall be staggered.
4. This table is based on the following assumptions:
  - The roof structure conformed to building code requirements at the time it was built.
  - The attached list of criteria are met.
  - Mean roof height is not greater than 40 feet.
  - Roof sheathing is at least 7/16" thick oriented strand board or plywood. 1x skip sheathing is acceptable.
  - If the dwelling is in Wind Exposure B (typical urban, suburban or wooded areas farther than 500 yards from large open fields), no more than one of the following conditions apply:
    - The dwelling is located in a special wind region with design wind speed between 115 and 130 mph per ASCE 7-10, or
    - The dwelling is located on the top half of a tall hill, provided average slope steeper is less than 15%.
  - If the dwelling is in Wind Exposure C (within 500 yards of large open fields or grasslands), all of the following conditions apply:
    - Design wind speed is 110 mph or less (not in a Special Wind Region), and
    - The dwelling is not located on the top half of a tall hill.
  - The solar array displaces roof live loads (temporary construction loads) that the roof was originally designed to carry.
  - The Structural Technical Appendix provides additional information about analysis assumptions.

| Table 2: Roof Rafter Maximum Horizontal Span (feet - inches) <sup>1</sup> |                 |                |                            |          |          |                        |          |          |
|---------------------------------------------------------------------------|-----------------|----------------|----------------------------|----------|----------|------------------------|----------|----------|
| Assumed<br>Vintage                                                        | Nominal<br>Size | Actual<br>Size | Non-Tile Roof <sup>2</sup> |          |          | Tile Roof <sup>3</sup> |          |          |
|                                                                           |                 |                | Rafter Spacing             |          |          |                        |          |          |
|                                                                           |                 |                | 16" o.c.                   | 24" o.c. | 32" o.c. | 16" o.c.               | 24" o.c. | 32" o.c. |
| Post-1960                                                                 | 2x4             | 1½"x3½"        | 9'-10"                     | 8'-0"    | 6'-6"    | 8'-6"                  | 6'-11"   | 5'-6"    |
|                                                                           | 2x6             | 1½"x5½"        | 14'-4"                     | 11'-9"   | 9'-6"    | 12'-5"                 | 10'-2"   | 8'-0"    |
|                                                                           | 2x8             | 1½"x7¼"        | 18'-2"                     | 14'-10"  | 12'-0"   | 15'-9"                 | 12'-10"  | 10'-3"   |
| Pre-1960                                                                  | 2x4             | 1¾"x3¾"        | 11'-3"                     | 9'-9"    | 7'-9"    | 10'-3"                 | 8'-6"    | 6'-9"    |
|                                                                           | 2x6             | 1¾"x5¾"        | 17'-0"                     | 14'-0"   | 11'-3"   | 14'-9"                 | 12'-0"   | 9'-9"    |
|                                                                           | 2x8             | 1¾"x7¾"        | 22'-3"                     | 18'-0"   | 14'-6"   | 19'-0"                 | 15'-6"   | 12'-6"   |

Beyond a visual review by the Contractor checking for unusual sagging or deterioration, some CBOs may want additional assurance that the roof structure complies with structural building code requirements. Table 2 is an optional table some CBOs may elect to use to provide additional assurance by requiring a check of existing roof rafter spans, and supports optional criteria 1.B.5 and 1.B.6. For post-1960 construction, these span tables match the rafter span tables found in the 2013 California Building and Residential codes. For pre-1960 construction, the rafter span tables are based on structural calculations with lumber sizes and wood species & grade appropriate for older construction. Note 5 below lists the basic assumptions upon which this table is based.

**Table 2 Notes:**

1. See Figure 4 for definition of roof rafter maximum horizontal span.
2. "Non-tile Roof" = asphalt shingle, wood shingle & wood shake, with an assumed roof assembly weight of 10 psf.
3. "Tile Roof" = clay tile or cement tile, with an assumed roof assembly weight of 20psf
4. Unaltered manufactured plated-wood trusses may be assumed to be code compliant and meet intent of Table 2.
5. This table is based on the following assumptions:
  - Span/deflection ratio is equal to or greater than 180.
  - For post-1960 construction, wood species and grade is Douglas Fir-Larch No. 2.
  - For pre-1960 construction, wood species and grade is Douglas Fir-Larch No. 1.
  - Other wood species and/or grade are also acceptable if allowable bending stress is equal or greater to that listed above.

(Attach Table 2 ONLY if the Optional Additional Rafter Span Check is added to the list of Structural Criteria)

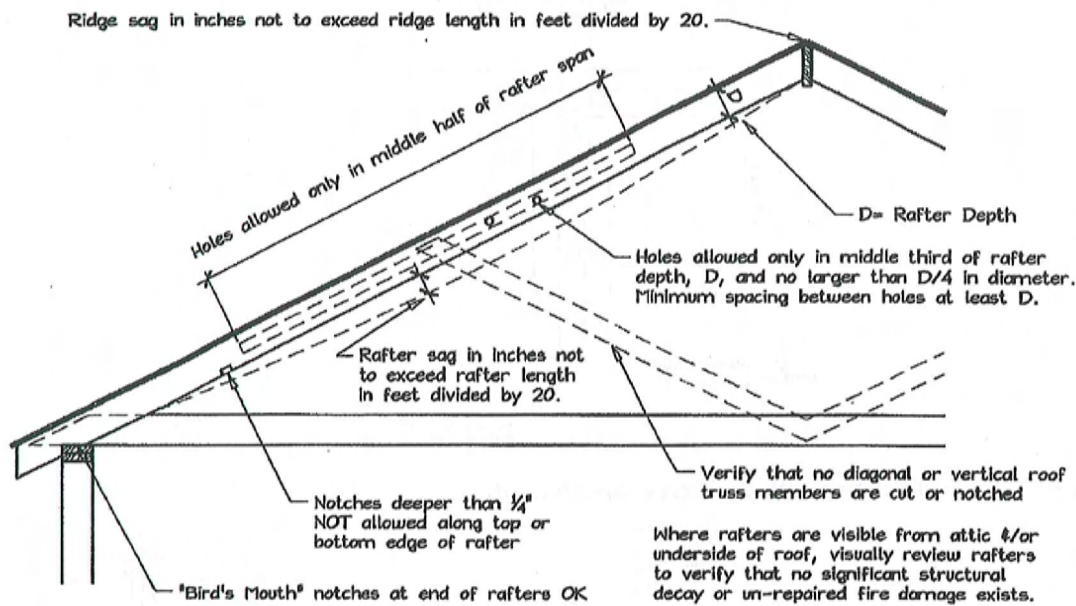


**Figure 1. Roof Visual Structural Review (Contractor's Site Audit) of Existing Conditions.**

The site auditor should verify the following:

1. No visually apparent disallowed rafter holes, notches and truss modifications as shown above.
2. No visually apparent structural decay or un-repaired fire damage.
3. Roof sag, measured in inches, is not more than the rafter or ridge beam length in feet divided by 20.

Rafters that fail the above criteria should not be used to support solar arrays unless they are first strengthened.

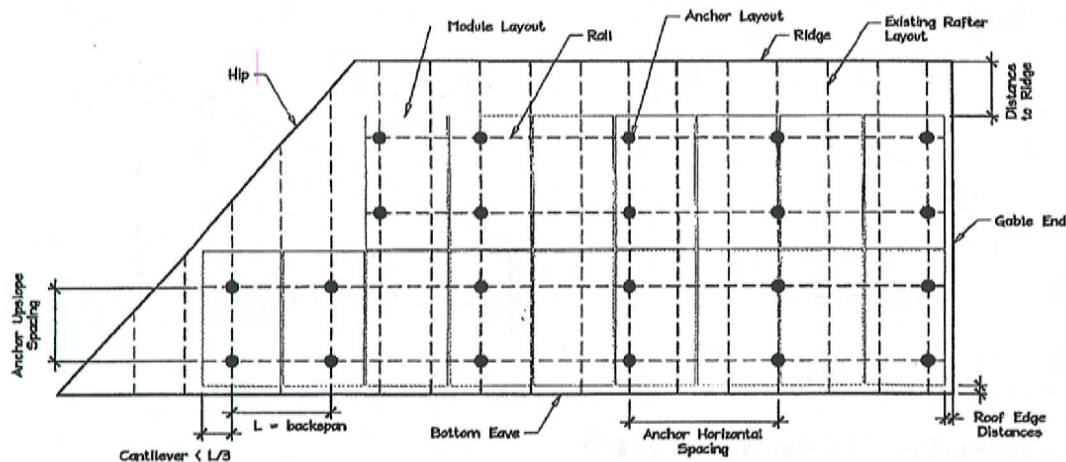


**Figure 2. Sample Solar Panel Array and Anchor Layout Diagram (Roof Plan).**

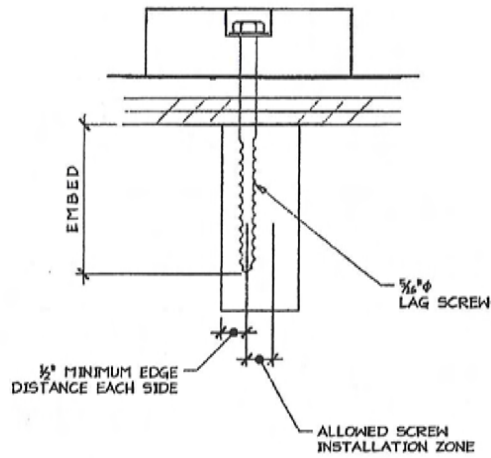


**Figure 3. Typical Anchor with Lag Screw Attachment.**

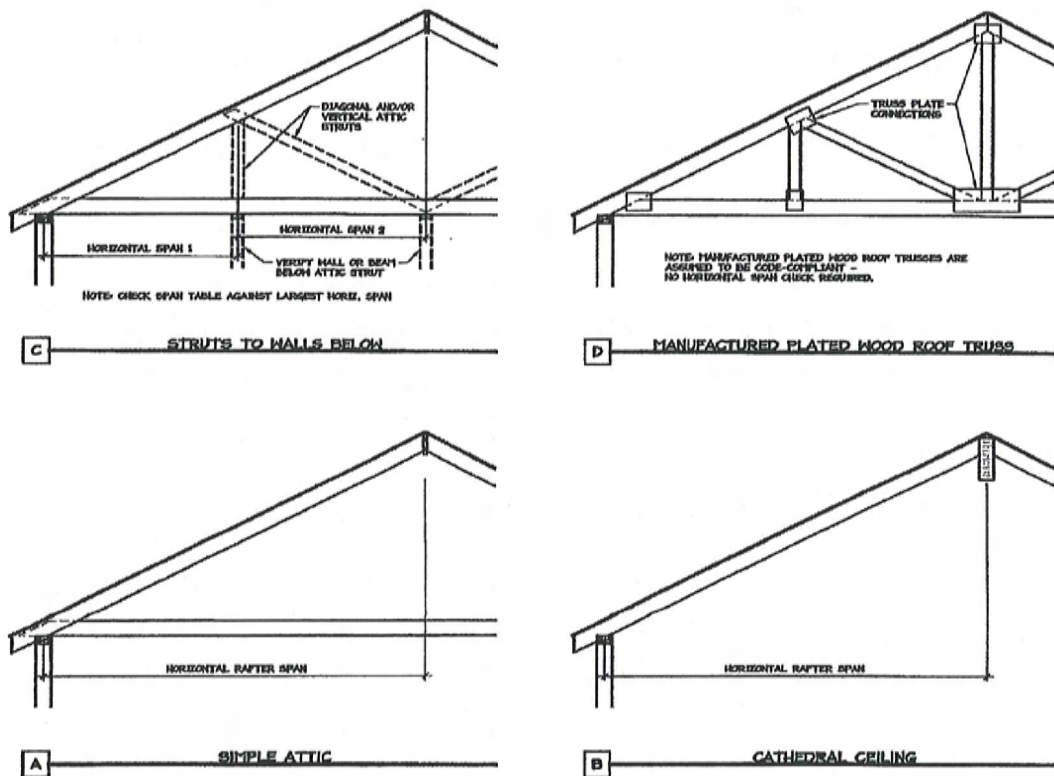


**Figure 4. Definition of Rafter Horizontal Span.**

(Attach Figure 4 ONLY if the Optional Additional Rafter Span Check is added to the list of Structural Criteria)



# CITY OF NEEDLES

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Mayor Edward T. Paget  
Vice Mayor Jeff Williams  
Councilmember Tony Frazier  
Councilmember Jim Lopez  
Councilmember Robert A. Richardson  
Councilmember Louise Evans  
Councilmember Tom Darcy  
City Manager Rick Daniels

## CERTIFICATION

I, Dale Jones, City Clerk of the City of Needles, California, do hereby certify that the foregoing is a true and correct copy of Ordinance Number 572-AC

  
\_\_\_\_\_  
Dale Jones, CMC, City Clerk  
(SEAL)

Date: November 19, 2015