Solar-ready Buildings (nonresidential)

California Statewide Utility Codes and Standards Program

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Solar-ready Nonresidential Buildings

Overview

- The Solar-ready Opportunity
- Key Considerations
  - Allocated solar zone
  - Structural integrity
  - Design interconnection of PV or SWH system
- Proposed Code Language

Solar-ready Nonresidential Buildings

The Big Picture

- As a leader in energy efficiency, California has established aggressive ZNE goals

"BIG BOLD" ENERGY EFFICIENCY STRATEGIES




In order to guide market transformation in a number of key sectors, this Plan embraces four specific programmatic goals, known as the "Big Bold Energy Efficiency Strategies" (BBEES), established by the CPUC in D.07-10-032 and D.07-12-051.These goals were selected not only for their potential impact, but also for their easy comprehension and their ability to galvanize market players.

1. All new residential construction in California will be zero net energy by 2020;
2. All new commercial construction in California will be zero net energy by 2030;
3. Heating, Ventilation and Air Conditioning (HVAC) will be transformed to ensure that its energy performance is optimal for California's climate; and
4. All eligible low-income customers will be given the opportunity to participate in the low income energy efficiency program by 2020.

All new non-residential buildings ZNE by 2030

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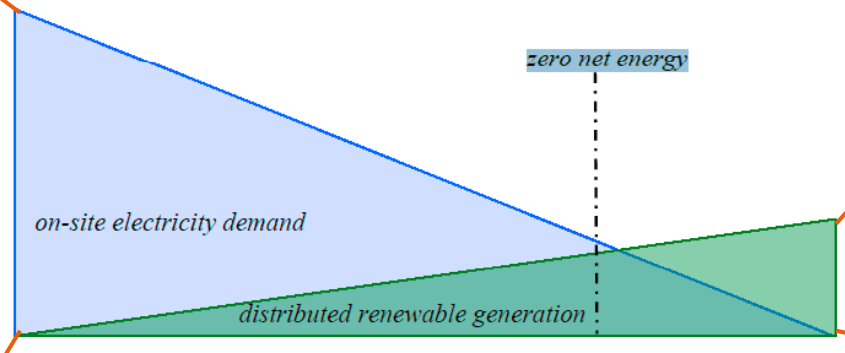
The Big Picture

Current Title 20 & Title 24 Standards address reductions in on-site electricity demand

WHAT IS ZERO NET ENERGY?

Zero net energy is a general term applied to a building with a net energy consumption of zero over a typical year. To cope with fluctuations in demand, zero energy buildings are typically envisioned as connected to the grid, exporting electricity to the grid when there is a surplus, and drawing electricity when not enough electricity is being produced.



- The amount of energy provided by on-site renewable energy sources is equal to the amount of energy used by the building.
- A ZNE building may also consider embodied energy – the quantity of energy required to manufacture and supply to the point of use, the materials utilized for its building.[29]

No existing code requirements address distributed RE generation

- Proposed solar-ready measures begin to address the distributed RE generation wedge

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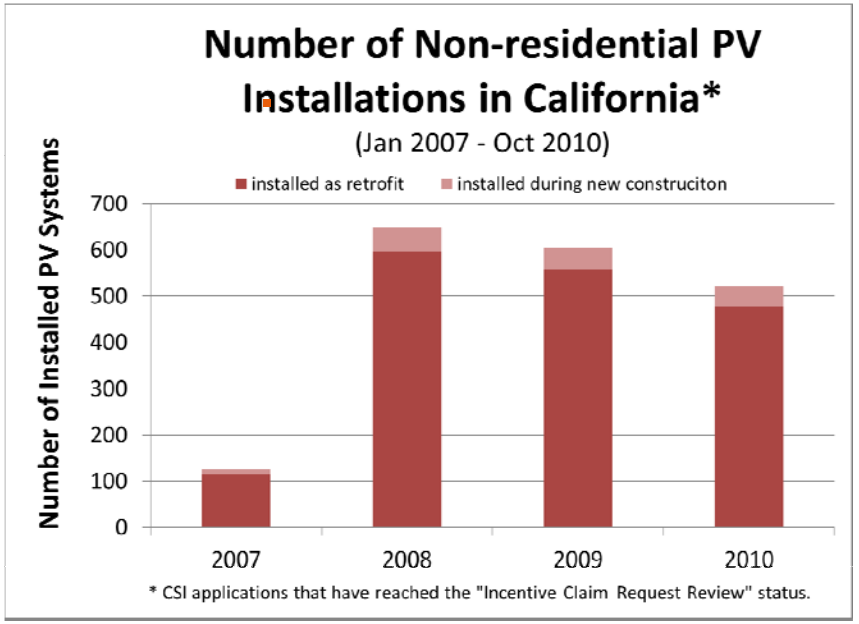
Big Picture

- Current Market Penetration of Distributed RE is low.
  - Estimate that fewer than 1% of newly constructed nonresidential buildings install PV systems
- Need to make progress to meet 2030 ZNE Goal
  - 1% now → ~100% in 2030



Source: CSI

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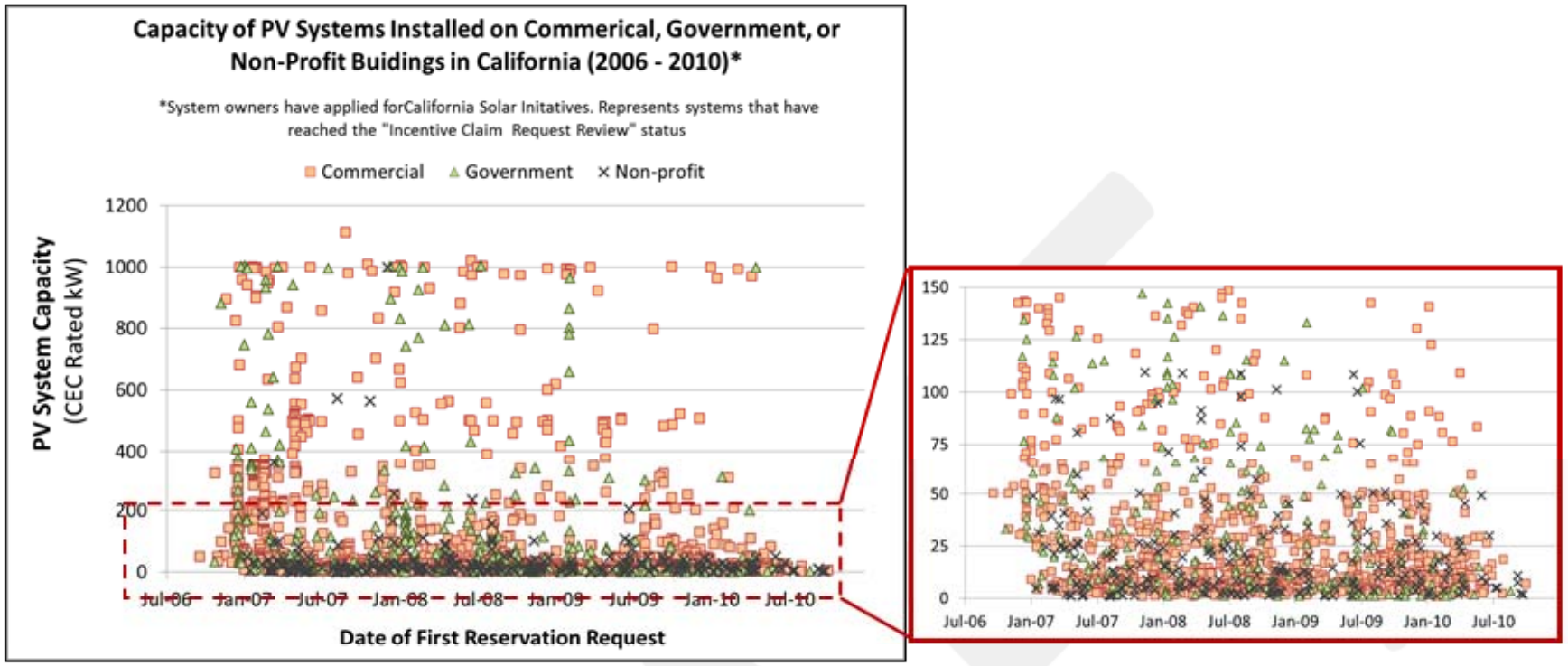
Big Picture

- Capacity of Installed Systems Varies
  - Large (1MW) systems are being install



Source: CSI

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Why Solar-ready Buildings?

- Only ~30 % of existing buildings are suitable for PV or SHW installations
- Buildings unsuitable primarily due to self-shading, obstructions, poor orientation, unfavorable roof design, and aesthetics

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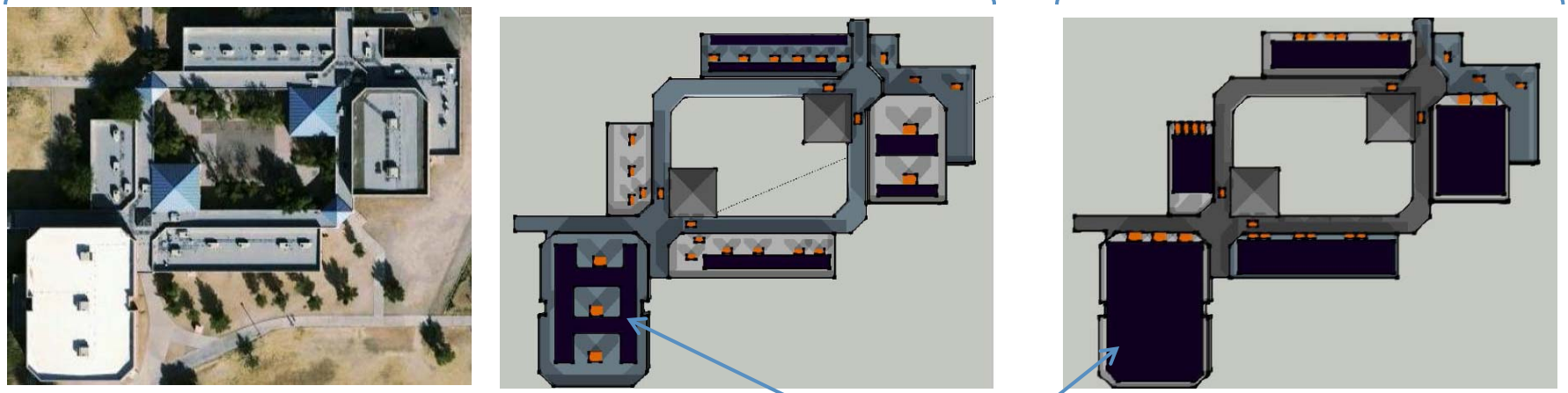
Why Solar-ready Buildings?

Existing Conditions

Rooftop equipment in middle of roof area

Optimized Conditions

Rooftop equipment on north side of roof area



Suitable location for PV or SHW
(unshaded and unobstructed)

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Solar-ready Opportunities

- Solar-ready Building Measure would
  - Make more buildings suitable for future solar installations
  - Increase size of systems that are feasible to install
  - Enable more voluntary PV or SHW installations in the future
- Solar-ready Helps Achieve CA's Long-Term Goals
  - California's long-term energy efficiency and renewable energy goals
  - CA GHG emissions reduction plan (AB 32)

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Energy and Cost Savings

- Potential Energy and Cost Savings: assuming between 1% and 100% of low-rise buildings install PV system of specified size.

Percentage of Buildings that Install PV Systems	Maximum Annual Electricity Savings (MWh)	Maximum PV Capacity Installed (MW)	20-year Electicity Savings (GWh)	Annual Energy Cost Savings ($million/yr) assumes $0.12/kWh	20-year Energy Cost Savings ($million) assumes $0.12/kWh
1%	3,935	2.5	79	$0.47	$9.44
5%	19,675	12.4	393	$2.36	$47.22
10%	39,350	24.8	787	$4.72	$94.44
25%	98,374	62.0	1,967	$11.80	$236.10
40%	157,398	99.2	3,148	$18.89	$377.76
50%	196,748	124.0	3,935	$23.61	$472.20
100%	393,496	248.0	7,870	$47.22	$944.39

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Summary of Proposed Code

- Mandatory requirement that low-rise nonresidential buildings be ready for future solar installation
- Applies to newly constructed buildings and major retrofits if the total roof area is expected to increase by more than 20 percent.
- Code language could end up in Part 6 of Title 24 or in CalGreen (i.e. Title 24, Part 11)

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Summary of Proposed Code

- Record drawings and/or Title 24 compliance forms would clearly label the following:
  1. Allocated solar zone
  2. As-designed dead and live load of solar zone
  3. Designed for connecting PV or SWH system to building electrical or plumbing system

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Allocated Solar Zone

- Desired System Capacity
  - Solar zone needs to be large enough to accommodate a system that could offset a reasonable portion of the building's electricity or hot water demand
    - Desired system capacity set to meet ~20% of expected electricity demand
  - Low energy density buildings like warehouses have enough space to generate much more than 20 percent of expected demand
    - These types of building will be required to have a larger solar zone tom maximize the space available for future installations

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Allocated Solar Zone

- Desired System Capacity *(continued)*
  - Size (area) of solar zone is the larger of option (A) or (B):
    A. Area of solar zone = {(total roof area) – (area covered by skylights)} x 50%
    B. Area calculated using one of two methods:
       i. **Calculated Method:** uses total building square footage and solar zone multipliers to calculate minimum area of solar zone
       ii. **Design Method**: use CEC approved software to design a system that is capable of generating at least 20% of the expected annual electricity demand

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Allocated Solar Zone

- Desired System Capacity (*continued)*
  - **Calculated Method:** solar zone is calculated using the following equation:

Area of Solar Zone	=	**Total Building Square Footage**	x	**Solar Zone Multiplier**

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Allocated Solar Zone

Calculated Method: Solar Zone Multipliers

Building Type	Solar Zone Multiplier (SF Solar Zone / SF floorspace)
Small Office	0.165
Large Office	0.225
Restaurant	0.507
Retail	0.177
Grocery	0.517
Warehouse	0.056
Refrigerated Warehouse	0.252
School	0.094
Colleges	0.155
Lodging	0.153
Other	0.124
Mixed Use	0.187

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Allocated Solar Zone

- Desired System Capacity *(continued)*
  - **Design Method:** design a PV system capable of generating at least 20% of the expected electricity use
    - Calculate with CEC approved software
    - Use CEC guidelines

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Allocated Solar Zone

- Available space
  - Not all buildings have enough roof space (or space on the building site) to accommodate a system.
    - Code does not apply to high-rise buildings
    - Solar zone does not need to be larger than 75 % of the total roof area (net of area covered with skylights)

      max area = [(total roof area) – (area covered by skylights)] x 75%
    - Building does not need to comply with solar ready requirement if PV system covering 75% of roof space (net of area covered by skylights) is not capable of generating at least 1% of expected electricity demand

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Allocated Solar Zone

- Shading
  - Shading from obstructions (rooftop equipment, vents, pipes, etc.)
    - Solar zone must be set back two times the height (above the solar zone) of any obstruction to the south, east or west of the zone.
  - In high-density areas neighboring buildings sometimes shade the entire building site.
    - Omitting high-rise buildings from code helps addresses this concern. Shading constraints from neighboring buildings often happen in high-density areas where high-rise buildings are common.

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Allocated Solar Zone

- Contiguous area
  - It is more advantageous to have contiguous areas for modules as opposed to many small areas.
    - Solar zone can be comprised of up to five smaller sub-areas
    - No area can be smaller than 250SF, unless the total solar zone is less than 250SF
    - All individual areas have to be at least 5 feet wide in the narrowest dimension so that solar modules can easily fit within the zone

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Allocated Solar Zone

- Architectural leeway
  - Code is not intended to limit flexibility designers to use unique building footprints or architectural elements such as sloped roofs or domed roofs.
    - Design method allows more freedom in how the PV system would look
    - Could model system with PV glazings or laminates and use less traditional array orientations or tilts.

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Allocated Solar Zone

- Fire code
  - A PV or SWH system installed on the zone must be compliant with current fire codes (Title 24, Part 9)
    - 2013 revision of fire code will be based on the 2012 International Fire Code, which includes a new solar PV provision (section 605.11)
    - Set solar zone back from edge of building, skylights, and ventilation hatches

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Allocated Solar Zone

- Allowing for Skylighting
  - Passive solar (e.g. skylights) is less expensive than PV or SHW and should be encouraged
    - Define roof space as total roof space minus area covered by skylights

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Structural Integrity

- Record drawings and compliance documents must clearly label as-designed dead and live load
  - Encourages communication amongst design team during initial construction
    - Structural engineers may decided to add additional strength knowing the zone is allocated for PV or SHW
  - Provides PV and SHW designers/installers with a starting point on how to design system that is appropriate for the building
  - Does not change existing structural code

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Design Interconnection

- Designers must plan for the interconnection of the PV or SWH system
  - PV Interconnection
    - Indicate solar zone
    - Indicate space for inverters and metering equipment
    - Indicate electrical interconnection point
    - Indicate pathway (most direct route) or wiring to run from solar zone → inverter(s) → electrical interconnection

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Design Interconnection

- Design interconnection *(continued)*
  - SWH Interconnection
    - Indicate solar zone
    - Indicate space for tanks
    - Indicate plumbing interconnection point
    - Indicate pathway (most direct route) for piping to run from solar zone → tanks(s) → plumbing interconnection

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Proposed Code Change Language

- The proposed change could be incorporated as a new mandatory requirement in either:
  - 1) Part 6 of Title 24, or
    - Subsection 2: All Occupancies—Mandatory Requirements
    - Add section to form ENV-1C: Certificate of Compliance and Field Inspection Energy Checklist.
    - Add a new form, ENV-5C, to ensure solar zone area has been calculated correctly & ensure the interconnection plan has been designed according to code.
  - 2) Part 11 of Title 24
    - Chapter 5 Division 5.2: Nonresidential Mandatory Measures - **Energy Efficiency**. OR Chapter 5, Division 5.6: Nonresidential Mandatory Measures – **Renewable Energy.**
    - Add a new compliance form (EE-1: SOLAR READY or RE-1: SOLAR READY)

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Proposed Code Change Language

SECTION 5.203: SOLAR READINESS

Low-rise nonresidential buildings with three stories or fewer shall provide for the future installation of on-site solar photovoltaic (PV) or solar water heating (SWH). Record drawings shall show allocated solar zone and the designs for interconnecting the PV or SWH system with the building electrical or plumbing system. Section 5.203 applies to major retrofits of low-rise nonresidential buildings that would increase the total roof area by more than 20 percent.

> **EXCEPTION: If a PV system that covers 75 percent of the available space on the building site is not capable of generating at least 1 percent of electrical contribution to the estimated annual building energy budget, the building does not need to comply with section 5.203.**

5.203.1 Allocated Solar Zone.

The building must have an allocated solar zone located on the roof of the building or elsewhere on the building site. The solar zone must be clearly marked on the record mechanical and electrical drawings and total area of the solar zone must be documented and on the EE-1 SOLAR READY compliance form.[7] The solar zone must comply with the following:

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Proposed Code Change Language

1. **Minimum Area. The minimum area of the solar zone shall be the larger of (a) or (b)**

   a. **Minimum area of solar zone = (total roof area in SF) – (area covered by skylights) x 50%**

   b. **An area determined by one of the following methods:**

      i. **Calculated Method. use equation (1) and the solar zone multipliers provided in Table 5.203.1 to calculate the area of the solar zone**

Equation 1: area of solar zone = (total building SF) x (solar zone multiplier) (1)

Table 5.203.1

Building Type	Solar Zone Multiplier (SF Solar Zone / Total Building SF)
Small Office	0.165
Large Office	0.223
Restaurant	0.507
Retail	0.177
Grocery	0.517
Warehouse	0.056
Refrigerated Warehouse	0.252
School	0.094
Colleges	0.155
Lodging	0.153
Other	0.124
Mixed Use	0.187

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Proposed Code Change Language

ii. **Design Method. Use a CEC approved calculator tool to determine the area required to generate at least 20 percent of the electrical contribution to the estimated annual building energy budget, as defined by Section 101 of Title 24 Part 6. Calculations must be completed according to CEC guidelines.**

2. **Maximum Area. No solar zone is required to be larger than the maximum area defined by:**

   Maximum area of solar zone = (total roof area in SF) – (area covered by skylights) x 75%

3. **Obstructions. The solar zone must be free of pipes, vents, ducts, HVAC equipment and other similar obstructions.**

4. **Shading. The solar zone must be set back a distance of at least two times the height of any objects (including features of the building itself, parapets, rooftop equipment, vegetation, or any other feature) located south, east, or west of the solar zone.**

5. **Contiguous Area. The solar zone may be comprised of up to five smaller sub-areas. No sub-area can be smaller than 250SF unless the total area of the solar zone is less than 250SF. All areas must be at least 5 feet wide in the narrowest dimension.**

6. **Fire Code. The solar zone should be designed in accordance with current Fire Code Requirements (see Title 24, Part 9).[8]**

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Proposed Code Change Language

7. **Structural Integrity. The as-designed dead load and live load for the solar zone must be clearly marked on the record drawings and on EE-1 SOLAR READY compliance form.[9]**

EXCEPTION to 5.203.1:

1. **Buildings that have PV or SWH systems installed may count the area the installed system occupies towards the solar zone requirement.**

5.203.2 Designed PV or SWH Interconnection.

Buildings must design for the interconnection of a PV system or a solar water heating system, as specified by (1) and (2) below:

1. **PV System Interconnection Design. The building electrical drawings must indicate the plan for connecting the PV system of the specified capacity to building's electrical system. The interconnection must be designed such that the sum of the supply feeders from inverter(s) serving the busbar is no more than 20 percent of the busbar rating and wiring follows the shortest feasible pathway between the solar zone to the inverter location and from the inverter location the dedicated electrical interconnection point. D Drawings must clearly label the:**

   a. **solar zone**
   b. **location for inverters and metering equipment**
   c. **electrical interconnection**
   d. **pathway for wiring**

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Proposed Code Change Language

2. **SWH System Interconnection Design. The building plumbing drawings must indicate the plan for connecting the SWH system of the specified capacity to building's plumbing system. The interconnection must be designed such that piping follows the shortest feasible pathway between the solar zone and the plumbing interconnection point. Drawings must clearly label the:**

    a. **solar zone**
    b. **location for hot water storage tanks**
    c. **plumbing interconnection**
    d. **pathway for piping**

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QUESTIONS & COMMENTS

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