



DRAFT
September 17, 2020

SOLAR ENERGY SYSTEMS FOR 1 & 2 FAMILY DWELLINGS

Category: Residential Construction

Revised: _____ Director

Responsible Bureau: Bureau of Development Services
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- I. **BACKGROUND** The City of Portland encourages property owners to use solar energy as part of building design and redesign. As awareness of clean energy and green building options increases, solar energy systems are becoming a more common energy choice for Portland homeowners. Solar panels can reduce energy costs and lower carbon emissions. For more information on solar incentives and to find solar resources visit the Energy Trust [“Solar for Your Home”](#).

This program guide outlines the application and review procedures for obtaining a permit to install solar panels on new and existing one-and-two-family residential development and accessory structures. It includes a summary of key zoning, structural design, and fire requirements for ground-mounted and roof top mounted systems. It does not include residential solar pool heating or information on solar permits processed as part of the Field Issuance Remodel program (FIR). For information on the Field Issuance Remodel program see the [Field Issuance Remodel City Program Guide](#).

Solar panels are allowed on houses and accessory structures and as stand-alone ground mounted units. This guide includes information on:

- Solar electric and solar water heating energy systems;
- Application and review processes for roof top and ground mounted systems;
- System siting or design elements that may trigger additional reviews; and
- Applicable state and local codes.

II. DEFINITIONS

Accessory Structure (ORSC); A structure not greater than 3,000 square feet in floor area, and not more than two stories in height, the use of that which is accessory to and incidental to that of a dwelling and that is located on the same lot. Accessory structures include but are not limited to garages, carports, cabanas, storage sheds, tool sheds, playhouses, and garden structures.

Array (OSSC); A mechanically integrated assembly of modules or panels with a support structure and foundation, tracker, and other components, as required, to form a power-producing unit.

Module (OSSC); A complete, environmentally protected unit consisting of solar cells, optics and other components, exclusive of tracker, designed to generate power when exposed to sunlight.

OESC; Oregon Electrical Specialty Code

OFC; Oregon Fire Code

One & Two Family Dwelling (ORSC); Any building that contains one or two dwelling units used, intended, or designed to be built, used rented, leased, let or hired out to be occupied, or that are occupied for living purposes.

ORSC; Oregon Residential Specialty Code

OSSC; Oregon Structural Specialty Code

Photovoltaic Panel (ORSC); A collection of photovoltaic modules mechanically fastened together, wired, and designed to provide a field-installable unit.

Portland Zoning Code; Title 33 Planning and Zoning

Trade Permit; Trade permits are a separate type of permit than a building permit. They may be submitted as stand-alone or in conjunction with a building permit. They include development associated with fire, electrical, mechanical and plumbing.

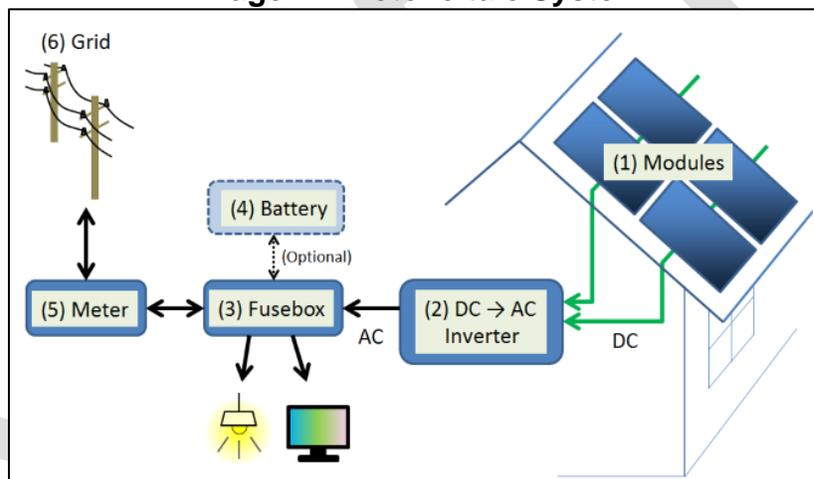
III. SOLAR ENERGY SYSTEM DESCRIPTION This section describes the two most common solar energy systems; solar electric and solar water heating. Solar electric is also referred to as a photovoltaic or PV system. Solar water heating is also referred to as a solar thermal system.

A. Solar Photovoltaic

A solar photovoltaic system produces electricity that is distributed to the home through the main electrical panel. This replaces electric energy that would be purchased through a utility company. Solar photovoltaic systems have two primary components listed below (see Image 1: Photovoltaic System)

1. **Photovoltaic panel**, roof-mounted or ground-mounted.
2. **An inverter**, which converts direct current (DC) electricity produced by the panels into alternating current (AC) electricity to be used by the home.

Image 1: Photovoltaic System



B. Solar Water Heating System

A solar thermal system preheats water so that a dwelling's water heater does less work. The solar collectors preheat potable water in the storage tank by a heat exchanger. This reduces household energy consumption. Solar thermal energy is also used to heat ventilation air. Solar thermal systems have two primary components listed below (See Image 2: Water Heating System).

1. **Solar thermal collectors** that are usually installed on the roof; and
2. **A storage tank** that is typically located with the water heater

Image 2: Water Heating System



IV. REVIEW PROCESS All solar energy systems will follow one of two permitting processes; prescriptive or engineered systems. Applicants should first review the prescriptive checklist, found at [“Checklist and Submittal Requirements for Prescriptive Solar Installations”](#), to determine if a project qualifies for this process. Projects that follow the prescriptive review process typically have lower permitting costs and an expedited permit review timeline. Ground mounted solar installations may not use the prescriptive process and must follow the engineered systems process. Building and electric permits are required for most photovoltaic installations. With some exceptions, solar water heating systems require building, electrical and plumbing permits.

Some accessory structures may be exempt from a building permit. However, a trade permits may still be needed. Building permit exemptions may be applicable for structures less than 200 square feet in size and less than 10 feet in height. For a project to be considered exempt it must meet the exemption criteria from both the Building and Zoning codes. A list of applicable codes can be found at the end of this guide.

A. Prescriptive Process: A solar installation that meets the prescriptive requirements as described in section 3111.3.5.3 of the OSSC will *not* require the system to be designed by an Oregon registered design professional. Solar projects under the prescriptive process are subject to the following reviews:

- 1. Planning and Zoning;** Solar panel projects must meet the requirements of the Zoning Code as described in section VII of this program guide and will be reviewed by the BDS Land Use Services Division.

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2. **Life Safety and Structural;** The BDS Plan Review Division/Permitting Services shall review the project for compliance with ORSC and OSSC.
3. **Fire;** Solar PV installations shall meet the requirements of the Oregon Fire Code and will be reviewed by Portland Fire Bureau for compliance.
4. **Plumbing and Electrical;** All portions of a solar system governed by the plumbing or electrical portions of the ORSC shall comply with the respective requirements of each code section at the time of project installation. In most cases, plumbing and electrical plan review is not required for the installation of a residential solar system. However, electrical and plumbing permits must be obtained either as a separate trade permit or combined with the residential building permit. In all instances, field inspection is required to verify code compliance.

Electrical license. New electrical work shall be conducted by a licensed electrical contractor. In some situations a permit may be issued to a building owner in accordance with [Title 26 Electrical Code](#), Section 26.04.030 Permit to Owner.

- B. Engineered Systems Process:** Systems that do not meet the prescriptive requirements shall be designed by an Oregon registered design professional and subject to the same reviews outlined in section IV.A, 1-4 above. In addition to 1-4 above, Life Safety and Structural reviews will be conducted by BDS Plan Review Division, only.

V. Inspections

- A.** Building inspections are needed to verify that the solar support system is correctly installed. Alterations to existing structures includes two inspections;
1. Final Structural: IVR Code 299
 2. Final Permit: IVR Code 999
- B.** Electrical inspections are needed where the solar system provides power to the electrical system. The inspection will verify the circuits and feeders have been correctly installed. The inspection will also verify the system has been correctly connected. Two electrical inspection are needed.
1. Permanent Electrical Services/Reconnect: IVR Code 120
 2. Final Electrical: IVR Code 199

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C. Plumbing inspections are needed for solar water heating systems. Solar water systems attach to the potable water system, usually a water heater. The inspection will verify that the collection system is correctly attached. If correctly attached, no contamination of the potable system can occur. Two plumbing inspections are needed.

1. Water Heater: IVR Code 340
2. Final Plumbing: IVR Code 399

VI. PERMIT TYPES & SUBMITTAL REQUIREMENTS Solar panel installation plans shall be submitted for permit through the Bureau of Development Services.

A. Permit Types

1. **New construction** When solar panels are proposed as part of a new building, the permitting and inspection process will be part of the new single-family house construction. Please visit our website at www.portlandoregon.gov/bds for additional information on how to submit an application for new construction.
2. **Alteration to an existing building.** When new solar panels are proposed to an existing dwelling or accessory structure the permit will be reviewed as an *alteration*.
3. **Alteration to an existing solar array.** When adding panels or upgrading an existing solar array the permit will be reviewed as an *alteration*.
4. **Installing new solar arrays on multiple buildings on a site.** When a project includes solar panel installations on more than one building on a site a separate building permit application must be submitted for each building.
5. **Adding solar panels to an existing permit.** BDS recommends including solar panels during the initial building permit application, when possible, for the most efficient permitting process. Solar panels *can* be added to a permit already in the review process. However, the additional review may delay permit completion and include additional permitting fees depending on when

the permit revision is submitted. Check with BDS permitting services if you would like to add a solar system to a permit currently under review.

B. Submittal Requirements A complete building permit application including the

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drawings listed below, must be submitted in accordance with the current BDS permit application submittal process available on the BDS website. If an application is missing one or more of the required documents listed in this section, it may not be accepted for review. To avoid delay, submit all the required documents at the time of permit application.

1. **Prescriptive Process:** Structural calculations are not needed for this process. However, the following items are required:
 - a. Building permit application
 - b. Completed “*Checklist and Submittal Requirements for Prescriptive Solar Installations*”
 - c. Site Plan
 - d. Building Elevation
 - e. Roof Framing Plan
 - f. Roof Cross Section
 - g. System Racking Attachment Detail
 - h. Fire Fighter Access Pathways Plan

Please see the “[Checklist and Submittal Requirements for Prescriptive Solar Installations](#)” for detailed requirements.

2. **Engineered Systems Process:** If a solar project does not qualify for the prescriptive process then the solar installation shall be designed and engineered by an Oregon registered design professional. See the, “[Guidelines for Residential Solar Permits Using Engineered Systems](#)” for guidance. The following are the minimum submittal requirements for engineered installations:
 - a. **Site Plan:** A site plan showing building footprints, property lines, location and solar collector dimensions, roof ridgeline, fire fighter access, rapid shut down system, and a description of the solar system. The system must be shown in sufficient detail to assess whether requirements of OSSC section 3111.3.4.8.1 or one of the exceptions for Fire Fighter Access Pathways have been met.

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For ground mounted solar installations, the site plan must also show the size, species and location of all existing trees with a diameter of 12" or greater.

- b. Elevation Drawing:** A simple building elevation is needed to measure the height of the installation above the roof. The elevation must show the height of the building and the height of the solar installation, but does not need to show other building details, unless a Design Review or Historic Resource Review is needed.
- c. Roof Framing:** Roof Framing plan shall include the following:
 - 1) Existing structural framing members including rafters, ridge board or ridge beam, hip or valley framing, and support posts/bearing walls. Posts, bearing or pony walls below the roof which support the roof framing shall be shown, dashed.
 - 2) Size and spacing of roof members impacted by the new PV array installation.
 - 3) The spacing and locations of racking attachment points to the existing roof.
 - 4) Module system layout and mounting overlaid on the roof framing plan.
- d. Building Section:** Provide a full building section at each location where a new PV array is located. Each section should specify:
 - 1) All existing structural framing members (bearing walls, ceiling joists, roof rafters, collar ties, pony walls, ridge beam or rim board, diagonal braces, and/or any other pertinent structural framing member);
 - 2) Any new strengthening members (sistered members, added braces or collar ties, etc.) and the connections to the existing framing;
 - 3) Both new and existing elements;
 - 4) Size and spacing of new or existing members if not already indicated on plan drawing; and
 - 5) Solar rack attachment detail showing the attachment to the existing framing, including PV panel, racking system, attachment hardware, and required fasteners.

- e. **Standing Seam Metal Roof Decks (when applicable):** When S-5, S-5-U Mini Clips or similar clips are used at standing seam metal roof decks the capacity and spacing of the clips, the size and thickness of the standing seam roofing panels and attachment of the standing seam metal panel to the roof, shall be per section 3111.3.5.35.3 of the OSSC.

In addition to requirements for standard installations, solar installation permits utilizing S-5, S-5-U Mini Clips shall contain the following additional information:

- 1) Roof framing plan indicating framing member size and spacing, type of roofing, roofing attachment of metal roofing to framing, and the location and spacing of S-5, S-5-U Mini Clips.
 - 2) Structural calculations demonstrating that uplift demand on the S-5, S-5-U Mini Clip is less than the allowable uplift load.
- f. **Structural Calculations:** Structural calculations prepared by an Oregon registered design professional verifying adequacy of the structure's roof framing, strut or frame supporting the rails (where used), attachment of the rail to the support /strut frame and the attachment to the building's roof framing are required. In some cases, manufacturer's information and installation details may be substituted for required calculation and details.
 - g. **Installations using Ballasted Systems or Wind Tunnel Procedures:** A peer review letter prepared by an Oregon registered design professional is required for installations utilizing ballasted systems or wind tunnel procedures.

VII. LAND USE, STRUCTURAL DESIGN, AND FIRE REQUIREMENTS Solar panel installations must meet minimum standards for land use, building construction, and fire safety requirements. For a typical residential installation, the following land use and construction requirements apply.

A. Land Use the Portland Zoning Code applies to solar installations. The Portland Zoning Code can be found at www.portlandoregon.gov/zoningcode. Below is a summary of those standards. Specific Zoning information regarding a site can be obtained from the BDS Planning and Zoning Section by calling 503-823-7526.

- 1. **Height.** In all instances, installations of solar equipment, including the rails and panels, are subject to the building height limitations of the specific zone where they are being installed. Roof-mounted solar panels may exceed the maximum building height of the zone if the following are met:

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- a. For flat roofs or the horizontal portion of mansard roofs, the panels may extend up to 5 feet above the highest point of the roof. ([See Title 33 Portland Zoning Code, Chapter 900](#) figure 930-5 for examples of roof types).
 - b. For pitched, hipped, or gambrel roofs, the panels must be mounted no more than 12 inches from the surface of the roof at any point, and may not extend above the ridgeline of the roof. The 12 inches is measured from the upper side of the solar panel.
- 2. Setbacks for Ground Mounted Solar Installations.** Residential zones and developments in other zones where all the floor area on the site is in residential uses:
- a. Ground mounted solar installations no larger than 3 feet in width, depth or diameter and not exceeding 8 feet in height are allowed in required building setbacks.
 - b. In R7-IR, C, E, and I zones only, installations that do not meet the above dimensions in IV.A.2.a. are allowed in the side and rear setbacks if all of the following are met:
 - 1) The structure is at least 40 feet from a front lot line, and if on a corner lot, at least 20 feet from a side street lot line;
 - 2) The structure has dimensions that do not exceed 24 feet by 24 feet;
 - 3) No part of the finished structure exceeds 10 feet above finished grade;
 - 4) The portion of the structure within the setback must be screened from adjoining lots by a fence or landscaping, unless it is enclosed within the setback by a wall. Screening is not required for enclosed structures. Screening must comply with the L3 or F2 standards of Chapter 33.248, Landscaping and Screening; and (see section VII.C.2. of this program guide to ensure compliance with both the OFC and screening).
 - 5) The structure does not have a rooftop deck.

*Installations that exceed the above allowances are not allowed in a required setback unless they are approved through a land use review adjustment process.

- c. Commercial Mixed-Use Zones, Employment, and Industrial Zones (except for development where all the floor area on the site is in residential uses):
- d. Generally, the height limit of the zone also applies to ground-mounted solar (detached uncovered vertical structures) except as below:
 - 1) In commercial mixed-use zones, uncovered structures are allowed in required setbacks but can be no closer than 5 feet to a lot line abutting a property zoned RF through RM4.
 - 2) In employment and industrial zones, uncovered structures are allowed in setbacks except setbacks from a lot line abutting residentially zoned property.

3. Design and Historic Resource Review Installations in design overlay zones, historic districts, conservation districts, or individual historic or conservation landmarks are subject to additional requirements. A proposal may meet exemptions, may be eligible to meet non-discretionary development standards, the Community Design Standards, or may require a land use review; either Design or Historic Resource Review.

Contact BDS Planning and Zoning Section at 503-823-7526 for more information about a specific proposal and site for more information about overlay or plan district requirements, including whether your project could be eligible to use Design Standards, or whether a Design or Historic Review may be required.

B. Structural Design Requirements: Solar installations (mounts, rails, etc.) and underlying substructure shall meet the requirements of section 3311 of the

OSSC. The following design requirements from OSSC, shall apply to engineered systems:

1. Dead, Live and Snow Loads.

- a. The weight of solar installation, their support system, and any ballast must be considered as dead load;
- b. The design snow load for solar photovoltaic arrays must be based on the requirements of the latest edition of the Oregon Structural Specialty code. When applicable, snow drift loads created by the PV panels or

modules shall be included; and

- c. Roof systems that provide support for the solar installation must be designed or their adequacy verified considering concentrated loads from support frames for dead, snow and wind loads. In addition, roof systems that provide support for solar installations shall be designed for uniform and concentrated roof live and snow loads assuming that the PV panels or modules are not present. The roof framing supporting the solar installation must be designed for all load combinations specified in the OSSC.

2. **Wind Loads.** Roof top mounted photovoltaic panels and modules and solar thermal collectors shall be designed in accordance with OSSC section 1609. Wind loads for roof top mounted photovoltaic panels and modules and solar thermal collectors are permitted to be determined by wind tunnel tests in accordance with ASCE 7 sections 31.6 and 31.7.

Where wind tunnel tests are used to determine wind loads on a solar installation on one-or two-family dwellings, peer review of the wind tunnel test are required. Please see the *Structural Design Requirements for Solar Installations* web page for wind tunnel testing and peer review requirements.

3. **Seismic Loads.** Roof top mounted photovoltaic panels and modules and solar thermal collectors shall be designed in accordance with ASCE 7 section 13.6.12. Rooftop solar installation must be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity, except that solar photovoltaic arrays without attachment to the roof structure are permitted for a ballasted system.

4. **Ground Mounted Solar installations:** Ground mounted solar installations shall be designed and engineered to meet the requirements of section 1607.13.5.3 of the OSSC.

C. Oregon Fire Code Requirements

1. Building-mounted photovoltaic arrays

- a. A rapid shut down system for photovoltaic arrays is required for residential buildings per NFPA 70.

- b. Each type of rapid shut down system shall have permanent labeling per Oregon Fire Code and include diagrams indicating in RED, portions of PV arrays that remain energized when the rapid shut down switch is turned to the off position.
 - c. The rapid shut down label shall be located within 3 feet of disconnecting switches and shall indicate the location of all identified rapid shut down switches if not in the same location.
 - d. Required labeling shall be included in the plans.
 - e. Firefighter access and escape pathways are required per OSSC and shall be shown on the plans. Refer to the prescriptive checklist for these requirements.
- 2. Ground-mounted photovoltaic arrays**
- a. A clear, brush free area of 10 feet shall be required and maintained around and below PV arrays with either a gravel base or other noncombustible base acceptable to the fire code official.
 - b. Fencing, skirting, or other security barriers shall be installed where required by the fire code official.

VIII. OTHER REQUIREMENTS OR CONSIDERATIONS

Title 11, Trees. Ground disturbance or construction staging that impacts a root protection zone of an existing tree may trigger tree preservation requirements for trees located on private property and/or in the public right-of-way. The value of a project may also trigger tree planting requirements for private property and/or in the public right-of-way. More information may be found at the Portland Trees website at www.portlandoregon.gov/trees.

County Assessment and Taxation. Property taxes are not assessed or collected by the City of Portland. It is recommended that applicants consult their county assessment and taxation office to determine how property taxes may be affected by the addition of solar panels to the property.

APPLICABLE CODES

City of Portland

Title 33 Planning and Zoning
Title 26 Electrical Code

State of Oregon

Oregon Residential Specialty Code
Oregon Structural Specialty Code
Oregon Fire Code
Oregon Electrical Specialty Code
Oregon Plumbing Specialty Code

National Codes

National Fire Protection Association 70
National Electrical Code

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CONTACT INFORMATION

Bureau of Development Services

Development Services Center:

503-823-7310

Residential Inspections:

503-823-7388

Planning and Zoning:

503-823-7526

Hours and General Questions:

503-823-7300

<https://www.portlandoregon.gov/bds>

Portland Parks and Recreation-Urban Forestry

503-823-8733

trees@portlandoregon.gov

Portland Water Bureau

503-823-7368 or

devrev@portlandoregon.gov

Updates January 10, 2015 edition