

**CITY & COUNTY OF DENVER
COMMUNITY PLANNING & DEVELOPMENT
BUILDING PERMIT POLICY**

Subject: SOLAR PHOTOVOLTAIC (PV) ENERGY SYSTEM PERMITS

Approved: Eric Browning – Chief Building Official

Drafted by: Browning

Number: IRC R324
Replaces IRC M2301

Issued Date: November 2, 2004
Revised: May 17, 2022

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REFERENCE

2019 Denver Building and Fire Code (DBC) Administrative Provisions Section 131, 2018 International Residential Code (IRC) Section R324, the 2020 National Electrical Code (NEC) Articles 690 & 705.

PROCEDURE

The procedure to obtain a permit (or permits, where applicable) for a solar photovoltaic (PV) system is outlined below.

- 1) Ensure you have addressed the Zoning and Landmark conditions listed below if they apply.
 - A. **When zoning permits are required before obtaining electrical permits:** If the panels will be installed at an angle unequal to the slope of the roof and do not meet the definition of “solar panel, flush mounted” per Denver Zoning Code Section 13.3, or if a generator or battery backup system is a part of the project and will be located on the exterior of the structure, you must obtain a zoning permit for the PV system(s) before applying for an electrical permit.
 - B. **When Landmark Preservation approval is required before obtaining electrical permits:** If the structure or site on which the PV system or related equipment (battery storage, generator, etc.) will be mounted is a *designated* structure for preservation or is in a district designated for preservation under the provisions of the Denver Revised Municipal Code (DRMC) Chapter 30, you must obtain approvals from Landmark Preservation before applying for electrical permits.
- 2) After obtaining Landmark approvals and Zoning permits, submit plans and calculations through the ePermits portal at www.denvergov.org/epermits for the appropriate electrical (and potentially construction) permits.
 - A. One- and two-family dwelling and IRC townhouse residential systems under 10 kW in size will be queued to receive a faster plan review based on lesser complexity of the system.
 - B. All commercial systems, those residential systems 10 kW in size and over, all systems with a generator or battery backup, and all solar hot water systems will be queued in alignment with other larger and more complex projects that necessitate multi-agency reviews.

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POLICY

Solar Photovoltaic Systems Policy – Submittal Requirements

A professional engineer's seal and electronic signature is required for all PV installations.

Exception: Flush mounted PV systems less than 10 kilowatts without a generator or battery backup that are located on a single-family dwelling, a two-unit dwelling, or single unit of an IRC townhome.

The documentation listed below is required when submitting plans for review at the time of permit application.

1. Manufacturer's cut sheets and listing information for PV equipment, inverters, and other special equipment, including the system manufacturer, model name and number.
2. One-Line Diagram: Indicate all conductor sizes and insulation types, conduit sizes, fuse and circuit breaker ratings, inverter ratings, ground fault protection device (GFPD), AC and DC disconnect ratings. Specify the PV module's nameplate short circuit current (I_{sc}) and open circuit voltage (V_{oc}). If disconnects, breakers, fuses, GFPD, etc. are part of a larger piece of equipment, show them as such by indicating how they are connected to the other devices and indicating their ratings. The inverter must be shown as either connected to a dedicated branch circuit with back-fed overcurrent protection (NEC 705.12(A)) or connected to the supply side of the service disconnecting means (NEC 705.12). The AC and DC grounding electrode conductors must be shown on the one-line diagram (NEC 690.41).
3. Electrical Calculations: Submit conductor ampacity calculations based upon 156% multiplied by the short circuit current (I_{sc}) (NEC 690.8), or where the PV system rating is greater than 100 kilowatts, submit a documented and stamped PV system design using an industry standard method and provided by a licensed professional electrical engineer to indicate the maximum current value. The current value obtained by using the method indicated in NEC 690.8 cannot be less than 70% of the value calculated using NEC 690.8(A)(1)(1). Also include the temperature derating correction factor per NEC Table 690.31(A). For all roof-mounted flexible wiring, use a worst-case ambient temperature of 61-70°C (141-158°F) per NEC Table 609.31(A).
4. Listed PV breakers or fuses are required in PV source and output circuits per NEC 690.9(B). The PV breakers and fuses must be accessible but are not be required to be readily accessible.
5. Provide calculations showing that the sum of 125% of the inverter(s) output circuit current and the rating of the overcurrent device protecting the AC load center is less than or equal to 120% of the load center bus rating, where the utility and inverter sources are located at opposite ends of the load center busbar (NEC 705.12(B)(3)(2)).
6. Provide calculations showing that the maximum PV system voltage is less than the maximum rated DC inverter input voltage and less than the voltage rating of all connected equipment (NEC 690.7).

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7. The maximum PV system voltage is equal to the open circuit voltage multiplied by the number of modules in the series, multiplied by the NEC lowest expected ambient temperature derating correction factor from Table 690.7(A) for the -21°C to -25°C (-5°F to -13°F) range.
8. Provide calculations indicating that the equipment grounding conductor is sized correctly (NEC 690.43 and 690.45).
9. Provide compliance for rapid shutdown of the PV systems circuits installed on or in buildings (NEC 690.12).
10. Details that show how the panels will be mounted (attached to the frame) and how the frames will be mounted to the roof.
11. Calculations performed by a Colorado registered professional engineer must be submitted to substantiate that the structure can support the design loads specified in Chapter 16 of the International Building Code (IBC) and Denver Building Code Amendments. Details and calculations for the panel connections to the roof must be included.
 - a. If structural alterations are required for a residential or commercial project, sealed and electronically signed drawings must be logged in for a structural review. A separate permit will be issued for this work to an appropriately licensed contractor.
 - b. Colorado registered professional engineering design is required when panels are not flush mounted (parallel to the plane of the roof).
12. Residential Structural Integrity Letter Alternative [to Item 11, above]:
 - A. Residential single-family, two-family, or one unit of an IRC townhome may be provided with a sealed and electronically signed letter from a Colorado licensed (structural) engineer, indicating that the existing structure has been reviewed and can adequately support all PV systems and meets all current applicable code requirements for gravity and wind loads. If additional structural enhancements are required, detailed structural drawings and/or structural enhancements outlined in a report must be signed and sealed by a structural engineer and submitted with the permit.
 - B. The addition of blocking and the “sistering” of roof rafters, joists, or truss top chords can be installed by the licensed (electrical) PV contractor without the need for a separate general construction permit. For residential single-family, two-family, or one unit of an IRC townhome projects, the structural improvements complying with item 12(B) will be noted on the solar panel (electrical) permit. An inspection of this work will not be required.
 - C. Any structural modifications or reinforcement other than blocking or the “sistering” of rafters, joists, or truss top chords shall require a Denver licensed general contractor to obtain a separate permit in addition to the (electrical) PV permit.

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Solar Hot Water Systems Policy

Required information to obtain a permit for a solar hot water system is as follows.

- 1) A piping diagram of the system,
- 2) The name of the testing agency and approval number for the system, and
- 3) If the homeowner is the applicant for the permit, the permit process must follow the procedures outlined in DBC Administrative Sections 131.3, 131.4 and Building Permit Policy Admin 131.3.

Other Electrical (NEC) Points to Incorporate into the Design:

1. Switches, fuses, and breakers on the DC side of the system must be listed and labeled for the DC voltage rating per NEC 690.9(B). Do not use “AC only” rated devices on the DC side of the system.
2. If tied to the grid, the inverter must be listed as utility-interactive (NEC 705.6).
3. The PV system disconnecting means shall be installed at a readily accessible location (NEC 690.13(A)).
4. No more than six PV system disconnecting means, or six circuit breakers mounted in a single enclosure, switchboard, or in a group of separate enclosures are allowed per NEC 690.13(D).
5. PV DC source or output circuits of a utility-interactive listed inverter can run inside a building or structure only when contained in metal raceways, type MC metal-clad cable that complies with NEC 250.118(10), or metal enclosures from the point of penetration of the surface of the building to the first readily accessible disconnecting means (NEC 690.31(G)).

Solar Photovoltaic Systems – Inspections

1. A qualified person must be present at the time of a PV electrical inspection. A qualified person is as follows:
 - a. For IRC structures with an electrical service of 200 amps or less, the qualified person can be either a:
 - i. Licensed master electrician,
 - ii. Licensed journeyman electrician,
 - iii. Residential wireman, or
 - iv. NABCEP-certified (North American Board of Certified Energy Practitioners) solar installer capable of testing the rapid shut down system. If a certified solar installer is present, then the dead front of the electrical panel shall be removed by the electrical inspector.
 - b. For IRC structures with an electrical service *over* 200 amps and International Building Code (IBC) structures, the qualified person can be either a:
 - i. Licensed master electrician or
 - ii. Licensed journeyman electrician.

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2. Except as allowed by item 12(B) above, when structural enhancements are required, a rough framing inspection must be requested for residential and commercial projects.
3. At time of inspection, the contractor must submit written documentation stating that “All grounding and bonding regarding the array has been performed as per NEC Article 690.41 through 690.50, and furthermore, all equipment installed on the roof complies with all NEC guidelines.”
4. A ladder must be provided by the customer for commercial PV electrical inspections where any component of the system is mounted on the roof.
5. The rapid shut down system must be tested at the final electrical inspection with the inspector present.
 - a. If the rapid shut down system is located on the AC side of the system, then this test must be conducted by a licensed electrician.
 - b. If the rapid shut down system is located on the DC side of the system, then a NABCEP certificate holder can conduct this test, in addition to any licensed electrician. The solar installer must provide proof of their NABCEP certificate, which may be done by providing the inspector a photo of the certificate, a copy of the certificate, or by showing the inspector their name on the NABCEP website with a driver’s license to verify.

Permits for Reroofing a Structure Containing PV Panels

When applying for a roofing permit to replace or repair a roof on an existing building that includes solar PV panels, indicate the presence of PV panels on the scope of work on the roofing permit. The scope of work must state if the existing PV on the roof will be removed and reinstalled per the previously reviewed and permitted PV project plans and details.

For the inspector to final the roofing permit, the PV installer must provide a letter to the construction inspector at the time of the final roof inspection that states that no modifications to the permitted PV system were made and the PV system was only removed and will be reinstalled following the completion of the roofing replacement or roofing repair. The letter must be on the company letterhead of the PV company that removed and will reinstall the system. In this instance, no electrical permit is required to remove and reinstall the PV system.

If any changes are proposed to the PV system, then plans must be submitted, and a new electrical permit must be issued. The electrical permit will be finalized after the roof permit.

FEES

Solar systems have reduced building permit fees. A \$50 flat building permit fee will be applied to both single-family residential and commercial PV system installations. Where other non-solar work is required under the project, the \$50 flat fee will only apply to the solar PV system portion of the project.

END OF DOCUMENT