

IAPMO IS 34-2020



Installation Standard for **Residential Solar Photovoltaic and Energy Storage Systems**



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Preface

This is the first edition of IAPMO IS 34, Installation of Residential Solar Photovoltaic and Energy Storage Systems.

This Standard was developed by the IAPMO Standards Review Committee (SRC) in accordance with the policies and procedures regulating IAPMO industry standards development, Policy S-001, Standards Development Process. This Standard was approved as an IAPMO Industry Standard on November 9, 2020.

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 - (a) *standard designation (number);*
 - (b) *relevant section, table, or figure number, as applicable;*
 - (c) *wording of the proposed change, tracking the changes between the original and the proposed wording; and*
 - (d) *rationale for the change.*
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 - (a) *the edition of the standard for which the interpretation is being requested;*
 - (b) *the definition of the problem, making reference to the specific section and, when appropriate, an illustrative sketch explaining the question;*
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IAPMO IS 34-2020

Installation Standard for Residential Solar Photovoltaic and Energy Storage Systems

1 Scope

1.1 General

This Standard is intended to provide guidelines for the installation of solar photovoltaic (PV) and energy storage systems (ESS) in residential applications. [See Figure 1 through Figure 4 for typical arrangements of solar PV systems with a direct-current (dc) string inverter, power distribution, utility demand response, or net energy metering (NEM).]

1.2 Terminology

In this Standard,

- (a) “shall” is used to express a requirement, i.e., a provision that the user is obliged to satisfy to comply with the Standard;
- (b) “should” is used to express a recommendation, but not a requirement;
- (c) “may” is used to express an option or something permissible within the scope of the Standard; and
- (d) “can” is used to express a possibility or a capability.

Notes accompanying sections of the Standard do not specify requirements or alternative requirements; their purpose is to separate explanatory or informative material from the text. Notes to tables and figures are considered part of the table or figure and can be written as requirements.

2 Reference Publications

This Standard refers to the following publications and, where such reference is made, it shall be to the current edition of those publications, including all amendments published thereto.

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
ASHRAE Handbook – Fundamentals

International Association of Plumbing and Mechanical Officials (IAPMO)
IAPMO/ANSI UMC 1
Uniform Mechanical Code

IAPMO/ANSI UPC 1
Uniform Plumbing Code

IAPMO/ANSI USHGC 1
Uniform Solar, Hydronics and Geothermal Code

National Fire Protection Association (NFPA)

NFPA 13D

Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes

NFPA 70

National Electrical Code

NFPA 70E

Electrical Safety in the Workplace

National Electrical Manufacturers Association (NEMA)

NEMA 250

Enclosures for Electrical Equipment (1000 Volts Maximum)

Underwriters Laboratories (UL)

UL 50E

Enclosures for Electrical Equipment, Environmental Considerations

UL 1699B

Photovoltaic (PV) DC Arc-Fault Circuit Protection

UL 1703

Flat-Plate Photovoltaic Modules and Panels

UL 1741

Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources

UL 2703

Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels

UL 3703

Solar Trackers

UL 4703

Photovoltaic Wire

UL 6703

Connectors for Use in Photovoltaic Systems

UL 8703

Outline of Investigation for Concentrator Photovoltaic Modules and Assemblies

UL 61730-1

Photovoltaic (PV) Module Safety Qualification – Part 1: Requirements for Construction

UL 61730-2

Photovoltaic (PV) Module Safety Qualification – Part 2: Requirements for Testing

UL 62109-1

Safety of Power Converters for Use in Photovoltaic Power Systems – Part 1: General Requirements

3 Definitions and Abbreviations

3.1 Definitions

The following definitions shall apply in this Standard:

Authority Having Jurisdiction – The organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, installations, or procedures. The Authority Having Jurisdiction shall be a federal, state, local, or other regional department or others having statutory authority. In the absence of a statutory authority, the Authority Having Jurisdiction may be some other responsible party. This definition shall include the Authority Having Jurisdiction’s duly authorized representative.

Disconnecting Means – A device, or assembly of devices, that disconnects the conductors of a circuit from their source of supply.

Dwelling Unit – A structure, or part of a structure, which serves as a place of residence and provides complete living facilities for one or more persons.

Energy Storage System – A device which stores energy for later consumption.

Microgrid Interconnection Device – A device which provides a microgrid system with a means of disconnecting from and reconnecting with a primary power source to function in parallel.

Plan View – an orthographic projection of the three-dimensional roof or structure, serving as a space for solar PV installation, from the position of a horizontal plane.

Solar Access – the ratio of solar insolation including shading to that without shading.

Solar Zone – the total area of an available and appropriate space to be used for future solar PV installation.

Solar Zone, Potential – a portion of the solar zone with an annual solar access of at least 70 percent.

3.2 Abbreviations

The following abbreviations apply in this Standard:

ac	—	alternating-current
AHJ	—	Authority Having Jurisdiction
dc	—	direct-current
ESS	—	Energy Storage System
EV	—	Electrical vehicle
MID	—	Microgrid Interconnection Device

MPPT	—	Maximum power point tracking
NEM	—	Net Energy Metering
POC	—	Point of Connection
PPE	—	Personal protective equipment
PV	—	Photovoltaic
PV-ESS	—	Photovoltaic with Energy Storage Systems
SDS	—	Safety Data Sheet

4 General Requirements

4.1 Plan Details

Plan details shall be generated and submitted to the Authority Having Jurisdiction (AHJ) for approval before the installation of a solar PV system. Plan details for a solar PV system shall be in accordance with Section 4.1.1 through Section 4.1.8 and the requirements specified by the AHJ. Plan details for solar photovoltaic with energy storage systems (PV-ESS) shall be in accordance with Section 6.1 and Section 6.1.1. Site plans shall be sized and formatted in accordance with the AHJ. See Annex D for a sample site plan of a residential PV system, and see Annex E for a sample site plan of a residential PV system enabled with electric vehicle (EV) charging.

4.1.1 The following shall be provided with the plan details of a PV system:

- (a) Scope of the project, including the dc system kW•h (J) rating, system architecture, and racking type
- (b) A complete single line diagram including the following:
 - (i) Utility interconnect
 - (ii) Disconnecting means in accordance with Chapter 8 (Part III) of the USHGC or NFPA 70
 - (iii) Alternating-current (ac) disconnect switch with visible blades and lockable handle
 - (iv) Solar to utility Point of Connection (POC)
 - (v) Maximum ratings
 - (vi) Enclosure types
 - (vii) Model numbers
 - (viii) Module strings to MPPTs
 - (ix) Applicable facility loads
- (c) A site plan, identifying the location of system components including, but not limited to, the following:
 - (i) Modules on the roof
 - (ii) Equipment on the wall
 - (iii) Disconnecting means
 - (iv) Cross streets
 - (v) Property line
 - (vi) Fire access points
 - (vii) Pathways
 - (viii) Obstructions on the roof
 - (ix) North arrow
- (d) Type of system (i.e. ac modules, bipolar, grounded, ungrounded, hybrid, isolated, interactive, stand-alone, etc.)
- (e) Utility service operating voltage or class

- (f) Information on the size, type, and number of conductors of the dc and ac side of the PV system
- (g) Type and size of raceway(s)
- (h) Roof plan, including access points, pathways, and roof mounted equipment
- (i) The following information shall be provided for the dc side of the PV system:
 - (i) Number of series-connected modules for each PV source circuit
 - (ii) Number of parallel-connected modules or panel PV source circuits for each array or PV power source
 - (iii) Number of combiner boxes, control boxes, or PV power centers for each array, subarray, or PV power source
 - (iv) Number of PV output circuits
 - (v) Maximum array, panel, or module system voltage
 - (1) Maximum ac or dc string voltage
 - (vi) Short circuit current of modules or panels
 - (1) Specification sheet
 - (vii) Short circuit current of battery system
 - (1) Specification sheet
 - (viii) Disconnecting means electrical ratings including the following:
 - (1) Voltage
 - (2) Maximum current
 - (3) Number of poles
 - (ix) The manufacturer's specifications shall be provided for the PV modules or panels. The manufacturer's specifications shall include the manufacturer's name, catalog numbers, complete electrical information, maximum series fuse rating, and installation instructions.
 - (x) The manufacturer's specifications shall be provided for inverters, converters, charge controllers, and ac modules, indicating the following ratings:
 - (1) Maximum input ac and dc voltage, and the range of operating voltage(s)
 - (2) Nominal ac output voltage
 - (3) Nominal dc voltage and operating range for utility interactive or stand-alone systems with charge controller(s)
 - (4) Maximum input ac and dc, and maximum input short circuit current
 - (5) Maximum inverter output short circuit current and duration
 - (6) Normal operation temperature range
 - (xi) Information indicating where the inverter(s) or charge controller(s) contains current limiting devices that limits the output circuit current to the maximum inverter input dc current rating
 - (xii) The manufacturer's specifications shall be provided for combiner boxes, control boxes, PV power centers, or rapid shutdown equipment. It shall contain the manufacturer's name, model designation, and listing.
 - (xiii) The manufacturer's specifications shall be provided for each connector indicating configuration, construction, type, and grounding member.
 - (xiv) Where the PV-ESS system uses a diversion charge controller as the sole means of regulating the charging of a battery, a second independent means of preventing the storage device from overcharging shall be provided.
 - (xv) Methods of access to the junction, pull, or outlet boxes behind the modules or panels

4.1.2 Circuits

Circuit requirements shall be indicated in the plan details in accordance with Chapter 8 (Part II) of the USHGC or the following:

- (a) Circuit conductors and overcurrent protective devices shall be sized to carry not less than 125 percent of the maximum current as determined in accordance with NFPA 70.
- (b) Overcurrent protection of output circuits with internal current limiting devices shall be not less than 125 percent of the maximum limited current of the output circuit. The conductors in such an output circuit shall be sized in accordance with NFPA 70.
- (c) Common-return conductor of systems with multiple voltages shall not be smaller than the sum of the ampere ratings of the overcurrent devices of the individual output circuits.
- (d) Where a single overcurrent device is used to protect a set of two or more parallel-connected module circuits, the ampacity of each of the module interconnection conductors shall be not less than the sum of the fuse ratings and 125 percent of the short circuit from the other parallel-connected modules.

4.1.3 Overcurrent Protection

Circuits connected to more than one electrical source shall have overcurrent protective devices that provide overcurrent protection from sources indicated on the plan details.

4.1.4 Disconnecting Means

Disconnecting means shall be provided in the plan details for the following:

- (a) PV source circuits (isolating switches with visible blade and lockable handle)
- (b) Inverters
- (c) Batteries
- (d) Charge controllers where applicable

The PV disconnecting means shall be grouped together, and the number of disconnects shall not exceed six.

4.1.5 Grounding

Grounding shall be indicated in the plan details as follows:

- (a) Where components of the system are negatively or positively grounded
- (b) The dc circuit grounding shall be made at a single point on the PV output circuit.
- (c) The equipment-grounding conductor for a PV source and PV output circuits for a roof mounted dc PV array in dwellings shall be sized in accordance with NFPA 70.
- (d) Grounding electrode system used for the ac, dc, or combined ac/dc systems
- (e) The method used to ensure the removal of equipment from the system that shall not disconnect the bonding connection between the grounding electrode conductors and exposed conducting surfaces
- (f) The method used to ensure the removal of a utility-interactive inverter or other equipment that shall not disconnect the bonding connection between the grounding electrode conductor and the PV source and the output circuit grounded conductor, or both
- (g) The ground rod details shall be provided. See Figure 19 for an example of ground rod details.

4.1.6 Ground-Fault Protection

Direct-current ground-fault protection for dwellings with roof mounted dc PV arrays shall be provided on the plan details.

4.1.7 Systems Over 1000 Volts

Plan details for PV systems over 1000 volts shall indicate the following:

- (a) The PV system is in accordance with Chapter 8 of the USHGC or NFPA 70, and other applicable installation requirements.
- (b) The voltage rating of a battery circuit cable shall not be smaller than the charging or equalizing condition of the battery system.

4.1.8 Calculations

Calculations shall be provided for solar PV systems in accordance with the following:

- (a) The maximum system voltage calculation shall be based on the following:
 - (i) Extreme annual mean minimum design dry bulb temperature in accordance with ASHRAE Handbook – Fundamentals, and
 - (ii) Correction factors for ambient temperatures in accordance with Table 804.1.1 of the USHGC or NFPA 70.
- (b) The maximum system open-voltage calculation shall be based on the maximum PV system dc voltage (600 V) for PV power source modules made of materials other than crystalline or multi-crystalline silicon.
 - (i) For PV systems with dc-to-dc converters:
 - (1) The maximum number of dc-to-dc converters in a series shall be calculated based on manufacturer's instructions, or
 - (2) For multiple dc-to-dc converters in series, the sum of the maximum voltage output of the dc-to-dc converter outputs in the series.
 - (ii) For PV systems without dc-to-dc converters using the following formula:

$$V_{MAX} = V_{OC,Module} \times N_M \times CF \quad (E1)$$

Where:

CF	=	Correction factor as in Section 4.1.8(a)(ii)
V_{MAX}	=	Maximum voltage (V)
$V_{OC, Module}$	=	Maximum open circuit voltage per module (V)
N_M	=	Number of modules in series

- (c) The maximum dc circuit current calculation for each PV source circuit
- (d) The maximum dc current calculation for each PV output circuit
- (e) The fault current calculation from the utility side to the ac disconnect(s) and inverter(s)
- (f) Calculations to determine the minimum overcurrent protection device rating for the dc side. Photovoltaic system currents shall be considered as continuous.
- (g) Calculations showing the size of equipment-grounding conductor for the PV source and PV output circuit size shall be not less than 125 percent of the short circuit current from the PV source.
- (h) Calculations showing the required maximum charging current of the interconnected battery cells
- (i) Calculations for the ampacity of the neutral conductor of a two-wire inverter output connected to the ungrounded conductors of a three-wire or a three-phase, four-wire system
- (j) Calculations showing that the total dc leakage current in the dc ground or dc grounded circuits in non-isolated PV systems do not exceed the equipment ground-fault protective device leakage current trip setting
- (k) Calculations showing the required current and voltage ratings of dc diversion charge controllers and diversion loads in a circuit

- (l) Calculations showing the required conductor ampacity and overcurrent protective device rating for circuits containing dc diversion charge controllers and diversion loads
- (m) Calculations showing where expansion fittings are not required for the roof mounted raceways due to thermal expansion or building expansion joints where the raceway is used as an equipment grounding conductor

4.2 Approval Required

An installed solar PV system shall not begin operation before approval is granted by the AHJ and the local utility.

4.3 Electrical Requirements

Electrical connections, wiring, and devices shall be installed in accordance with NFPA 70.

4.3.1 Listing and Labeling

PV equipment shall be listed or labeled in accordance with the appropriate standard, as listed in Table 1. Equipment used in PV systems shall be listed or field labeled, or evaluated for the application and have a field labeled applied.

4.4 Code Requirements

The installation of a solar PV system shall comply with the Uniform Mechanical Code (UMC), Uniform Plumbing Code (UPC), Uniform Solar, Hydronics and Geothermal Code (USHGC) and NFPA 70 (National Electrical Code); or the code requirements as adopted by the Authority Having Jurisdiction.

5 Installation

5.1 Residential Systems – One- and Two-Unit Residential Dwellings

Plan review shall be required, in accordance with the AHJ and the utility, where a PV system is installed on a structure or a rack. See Figure 5 through Figure 18 for illustrations of pathways, setbacks, and access..

5.1.1 Solar Zones

Where new construction of a one- or two-unit residential dwelling is installed with a solar zone, the solar zone shall be in accordance with the AHJ and the following:

- (a) Unshaded and free from obstructions
- (b) Located 90 degrees to 270 degrees true north
- (c) For roof areas not less than 600 square feet (55.74 m²), the solar zone shall be not less than 300 square feet (27.87 m²) exclusive of the setback requirements in Section 5.1.4.1.

Exception: Where a roof area is not less than 600 square feet (55.74 m²) and has less than 70 percent annual solar access, the solar zone shall not be less than 50 percent of the potential solar zone.

5.1.2 Access

Roof access for emergency services shall be provided to pathways specified in Section 5.1.3 or Section 5.1.4 and shall be located in areas without obstructions. Roof access points and ladders shall be located over areas which do not block windows, doors, or other openings. Minimal spacing for smoke ventilation shall be in accordance with Section 5.1.5.

5.1.3 Pathways – Flat Roofs

Where roofs are installed with slopes less than two units vertical in twelve units horizontal (2:12), a 3 foot (914 mm) wide clear pathway shall be provided around the perimeter of the roof plane. Pathways shall be located over areas capable of supporting the live load of fire fighters with all associated gear.

5.1.4 Pathways – Sloped Roofs

Where roofs are installed with slopes not less than two units vertical in twelve units horizontal (2:12), pathways shall be provided in accordance with the following:

- (a) There shall be not less than one 3 foot (914 mm) wide pathway provided for each roof plane where a module is installed. The pathway shall be located from the eave to the ridge on the same roof plane as the modules, straddling the same and adjacent plane, or on an adjacent plane.
- (b) Modules, on a roof with a ridge, shall be located in a manner that provides two separate 3 foot (914 mm) wide pathways from the eave to the ridge on separate roof planes.
- (c) Modules, adjacent to hips and valleys, shall be located not less than 18 inches (457 mm) from a hip or a valley where modules are to be placed on both sides of a hip or valley. Where modules are to be located on one side of a hip or valley that is of equal length, modules shall be permitted to be placed directly adjacent to the hip or valley.
- (d) There shall be not less than one pathway provided on the driveway or street side of the roof.
- (e) Pathways shall be located in areas with minimal obstructions (e.g. chimneys, vents, conduit, and mechanical equipment).

5.1.4.1 Alternate Setback at Ridge

Both sides of a horizontal ridge shall have an unobstructed setback in accordance with the following:

- (a) Where PV arrays occupy more than one-third of the total plan view roof area, a 3 foot (914 mm) wide setback shall be required.
- (b) Where PV arrays occupy not more than one-third of the total plan view roof area, a setback of not less than 18 inches (457 mm) wide shall be required.

Exceptions:

- (1) Where an automatic sprinkler system in accordance with NFPA 13D is installed and PV arrays occupy not more than two-thirds of the total plan view roof area, a setback of not less 18 inches (457 mm) wide shall be required.
- (2) Where an automatic sprinkler system in accordance with NFPA 13D is installed and PV arrays occupy more than two-thirds of the total plan view roof area, a setback of not less 3 feet (914 mm) wide shall be required.

5.1.5 Distance to Plumbing Vents

Where PV panels are installed above a plumbing vent or stack, each vent pipe or stack shall extend through its flashing and shall terminate vertically not less than 6 inches (152 mm) above the roof nor less than 1 foot (305 mm) from a vertical surface, or shall be in accordance with the requirements of the AHJ.

5.1.5.1 Locations in Snow Regions

Where frost or snow closure is likely to occur in locations having a minimum design temperature below 0°F (-17.8°C), the installation of a solar panel shall be in accordance with one of the following:

- (1) The solar panel shall be placed such that the plumbing vent does not terminate under the panel.
- (2) The vent shall be diverted such that it is not under the solar panel. The change in direction shall be made inside the building not less than 1 foot (305 mm) below the roof in an insulated space and terminate not less than 10 inches (254 mm) above the roof and 6 inches (152 mm) from a solar panel, or in accordance with the Authority Having Jurisdiction.

5.2 Ground-Mounted Panel Systems

Plan review shall be required in accordance with the AHJ and the utility where a ground-mounted PV system is installed. See Annex G for a site plan sample of a residential ground-mounted PV-ESS.

Setback requirements shall not apply to ground-mounted and freestanding PV arrays. A clearance of not less than 10 feet (3048 mm) shall be required around ground-mounted PV arrays.

Installation and guarding of readily accessible PV source and output circuits, which operate at greater than 30 volts, shall be in accordance with Section 812.1 of the USHGC or NFPA 70.

6 Energy Storage Systems

6.1 Plan Details

Plan details shall be generated and submitted to the AHJ for approval before the installation of an ESS. Plan details shall be in accordance with Section 6.1.1 and the requirements specified by the AHJ. Site plans shall be sized and formatted in accordance with the AHJ. See Figure 20 through Figure 23 for typical PV-ESS components and configurations. See Figure 24 for an example of a combiner box installed with PV-ESS. See Annex F and Annex G for site plan samples of residential PV-ESS.

6.1.1 The following shall be provided with the plan details of an ESS:

- (a) Scope of the project, including the system kW rating and system architecture. (i.e. dc or ac coupled, etc).
- (b) Complete single line diagram including the following:
 - (i) Utility point of interconnection in accordance with Section 822.2 of the USHGC or NFPA 70
 - (ii) Disconnecting means in accordance with Chapter 8 (Part III) of the USHGC or NFPA 70
 - (iii) All relevant new and existing circuits including, but not limited to, conductor, conduit size, type, and number of conductors
 - (iv) Overcurrent protective device rating
 - (v) Enclosure type maximum ratings in accordance with NEMA 250
 - (vi) Model numbers for new and existing service equipment
 - (vii) Applicable facility loads that are not backed up
 - (viii) Backup loads
 - (ix) Grounding and bonding detail

- (x) Combiner boxes and MIDs
- (c) A site plan identifying the location of system components including, but not limited to, the following:
 - (i) Name and address of the property
 - (ii) Legend or key for the site plan
 - (iii) Plan view of the site
 - (iv) Cross streets
 - (v) Property line
 - (vi) Gates or fences
 - (vii) Clearance from obstructions
 - (viii) Clearance from property lines
 - (ix) North Arrow
 - (x) Equipment on the wall
 - (xi) Disconnecting means
 - (xii) Service drop location and overhead conductors as required by the AHJ
 - (xiii) Trench locations containing ESS circuits
 - (xiv) Location of hidden hazards including, but not limited to, trenched or exposed overhead conductors
- (d) Detailed elevation drawings of the proposed ESS installation including the following:
 - (i) Working clearances
 - (ii) Spacing and separation of not less than 3 feet (914 mm) between individual units unless smaller separation distances are documented through large scale fire testing
 - (iii) Spacing and separation of not less than 3 feet (914 mm) from doors and windows entering a dwelling unit unless smaller separation distances are documented through large scale fire testing
 - (iv) Hazardous containment where required by the AHJ
 - (v) Method and location of ventilation equipment for indoor installations in accordance with Section 827.1 of the USHGC or NFPA 70
- (e) Utility service operating voltage or class
- (f) The manufacturer's specifications for the ESS including the following:
 - (i) Manufacturer's name
 - (ii) Catalog numbers
 - (iii) Complete electrical information
 - (iv) Physical dimensions
 - (v) Maximum recommended overcurrent protective device rating
 - (vi) Current product safety listing
 - (vii) Enclosure environmental rating
 - (viii) Safety data sheet (SDS)
- (g) The manufacturer's installation instructions for the ESS including the following:
 - (i) Wiring diagram
 - (ii) Nominal dc voltage and operating range for utility interactive or stand-alone systems with charge controller(s)
 - (iii) Environmental considerations
 - (1) Normal operating temperature range
 - (2) Location restrictions
 - (3) Spacing and separation requirements as detailed in large scale fire testing
 - (iv) Battery mounting detail
 - (1) Indication of whether the ESS is to be wall mounted, wall supported, or floor mounted

- (2) Where the weight of the ESS, combined or individual on the same wall, is greater than 200lb (90.7 kg), the structural details and calculations shall be provided.
- (3) Where the weight of the ESS, combined or individual on the same wall, is greater than 400lb (181 kg), the structural details and calculations stamped by a licensed structural engineer shall be provided.
- (4) Where an ESS is installed in a garage, warehouse, or other area subject to mechanical damage, the ESS shall be guarded against such damage by being installed behind protective barriers or by being elevated or located out of the normal path of vehicles. [UMC: 305.1.1] The mounting of an ESS shall be included in the plan details.
- (v) Minimum clearances for enclosures
- (h) The manufacturer's specifications shall be provided for panels, combiner boxes, control boxes, power control systems, and disconnecting means. Such specifications shall contain the manufacturer's name, model designation, and listing.
- (i) The manufacturer's specifications shall be provided for each connector indicating configuration, construction, type, and grounding member.
- (j) Where the ESS system uses a diversion charge controller as the sole means of regulating the charging of a battery, a second independent means of preventing the storage device from overcharging shall be provided.
- (k) Exclusions, exceptions, or variances from the manufacturer's specifications, these standards, or the rules from the AHJ, shall be listed prominently on the drawings or the engineer's specifications. These notes shall be annotated with the reason(s) for the modifications to said documents.

6.2 Arc-Fault Circuit Protection

Arc-fault circuit protection shall be provided in accordance with Section 808.0 of the USHGC and NFPA 70.

7 Marking and Labeling

7.1 General

Photovoltaic (PV) systems shall be marked. Materials used for markings shall be weather resistant and capable of withstanding continuous exposure to sunlight.

7.2 Main Service Disconnect

Markings shall be permitted to be placed within the main service disconnect. Where the main service disconnect is operable with the service panel closed, the marking shall be placed on the outside cover.

7.2.1 Marking Content and Format

Marking content and format for main service disconnects shall comply with the following:

- (a) Marking content in accordance with NFPA 70
- (b) Red background
- (c) White lettering
- (d) Minimum 3/8 of an inch (9.5 mm) letter height
- (e) Capital letters
- (f) Arial or similar font, non-bold
- (g) Reflective, weather-resistant material (durable adhesive materials shall meet this requirement)

7.3 Marking for DC Conduit, Raceways, Enclosures, Cable Assemblies, and Junction Boxes

Markings shall be required on interior and exterior dc conduit, raceways, enclosures, cable assemblies, and junction boxes. Markings shall be placed on interior and exterior dc conduit, raceways, enclosures, and cable assemblies every 10 feet (3048 mm), at turns; on both sides of a penetration; and at dc combiner and junction boxes.

7.3.1 Marking Content and Format

Marking content and format for dc conduit, raceways, enclosures, cable assemblies, and junction boxes shall comply with the following:

- (a) Marking content in accordance with NFPA 70
- (b) Red background
- (c) White lettering
- (d) Minimum 3/8 of an inch (9.5 mm) letter height
- (e) Capital letters
- (f) Arial or similar font, non-bold
- (g) Reflective, weather-resistant material (durable adhesive materials shall meet this requirement)

Table 1
Product Safety Standards for PV Equipment
(See Section 4.3.1)

Equipment	Standard
Building-Integrated PV Modules and Panels	UL 1703 or UL 61730-1 ¹ , UL 61730-2 ¹
Building-Integrated PV Mounting Systems	UL 2703
Charge Controllers	UL 1741
Combiner Boxes	UL 1741
Concentrator PV Modules	UL 8703
DC-to-DC Converters	UL 1741 or UL 62109-1
Enclosures for Electrical Equipment, Environmental Considerations	UL 50E
Flat-Plate PV Modules	UL 1703 or UL 61730-1 ¹ , UL 61730-2 ¹
Inverters	UL 1741 or UL 62109-1
PV AC Modules	UL 1703 ² , UL 1741 ² or UL 61730-1 ¹ , UL 61730-2 ¹
PV Modules and Panels	UL 1703 or UL 61730-1 ¹ , UL 61730-2 ¹
PV DC Arc Fault Circuit Interrupters	UL 1699B
PV DC Connectors	UL 6703
PV Solar Trackers	UL 3703
PV Wire	UL 4703
Rack Mounting Systems	UL 2703
Rapid Shutdown Equipment and Systems	UL 1741

Notes:

- (1) UL 61730-1 shall be used in conjunction with UL 61730-2.
- (2) UL 1703 shall be used in conjunction with UL 1741.

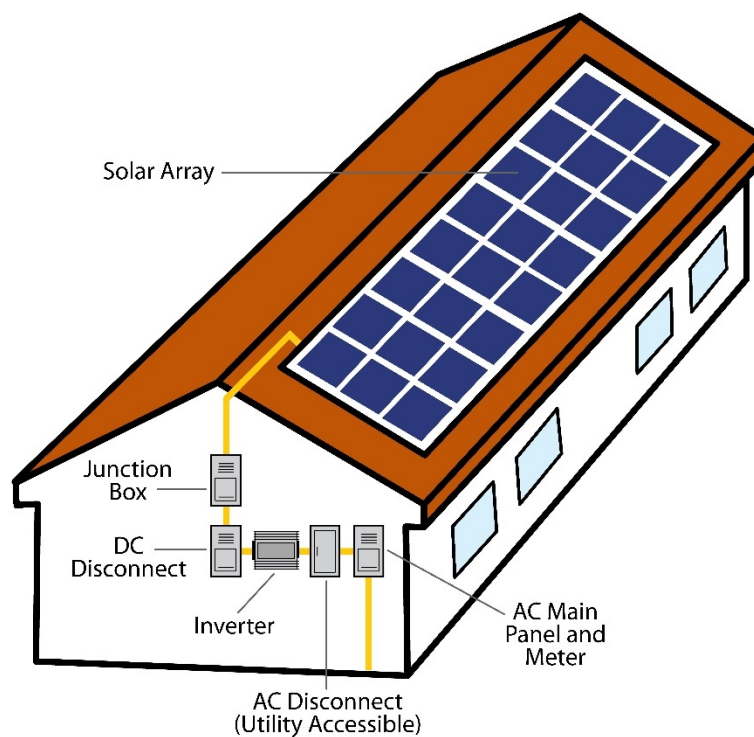


Figure 1
Solar PV System – DC String Inverter
 (See Section 1.1)

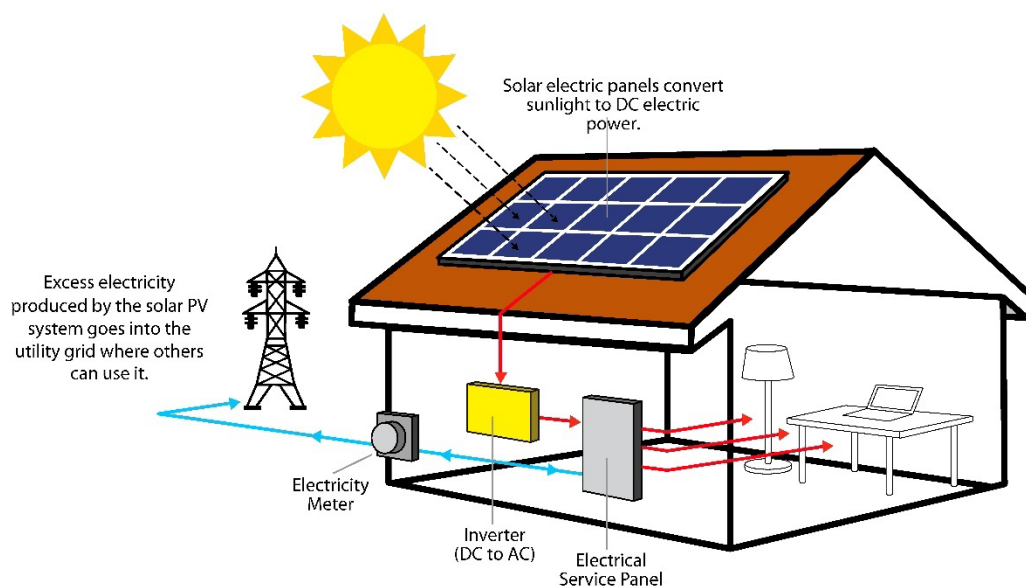


Figure 2
Solar PV System – Power Distribution
 (See Section 1.1)

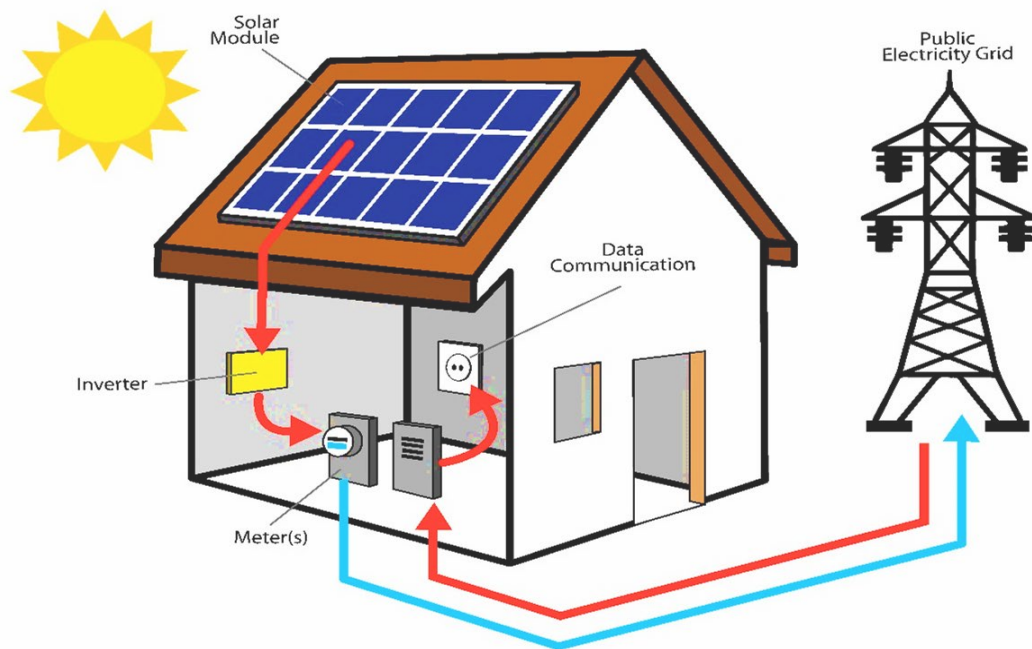


Figure 3
Solar PV System – Utility Demand Response
 (See Section 1.1)

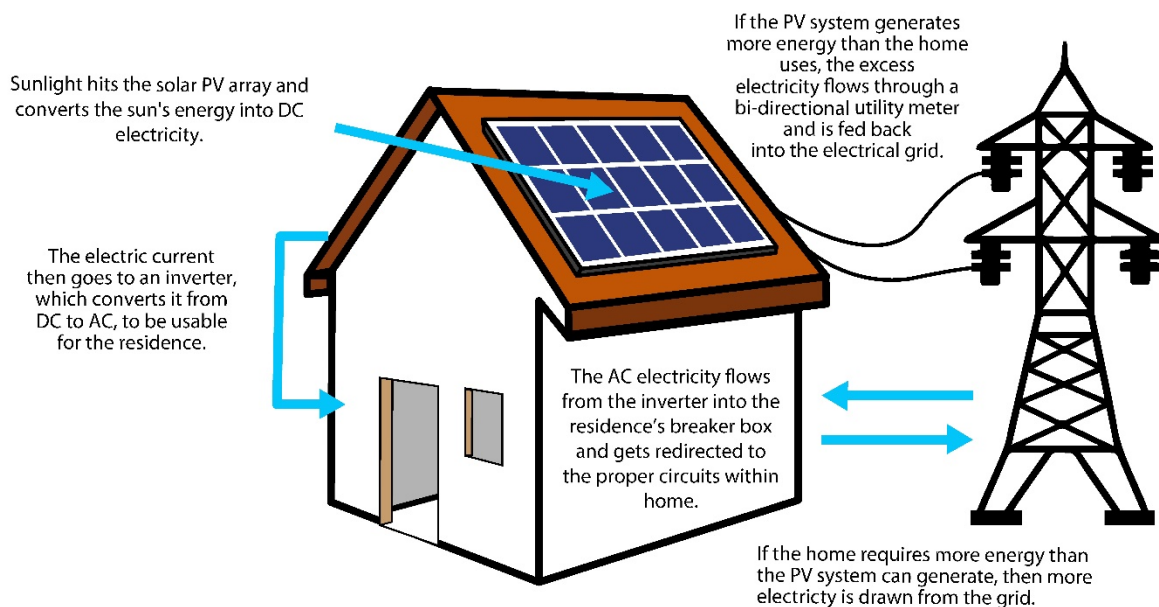
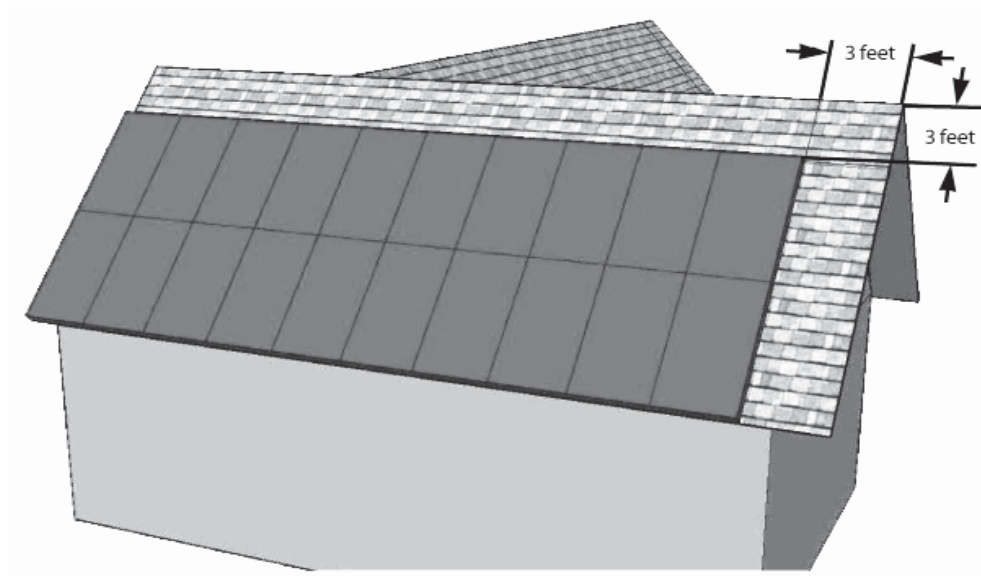
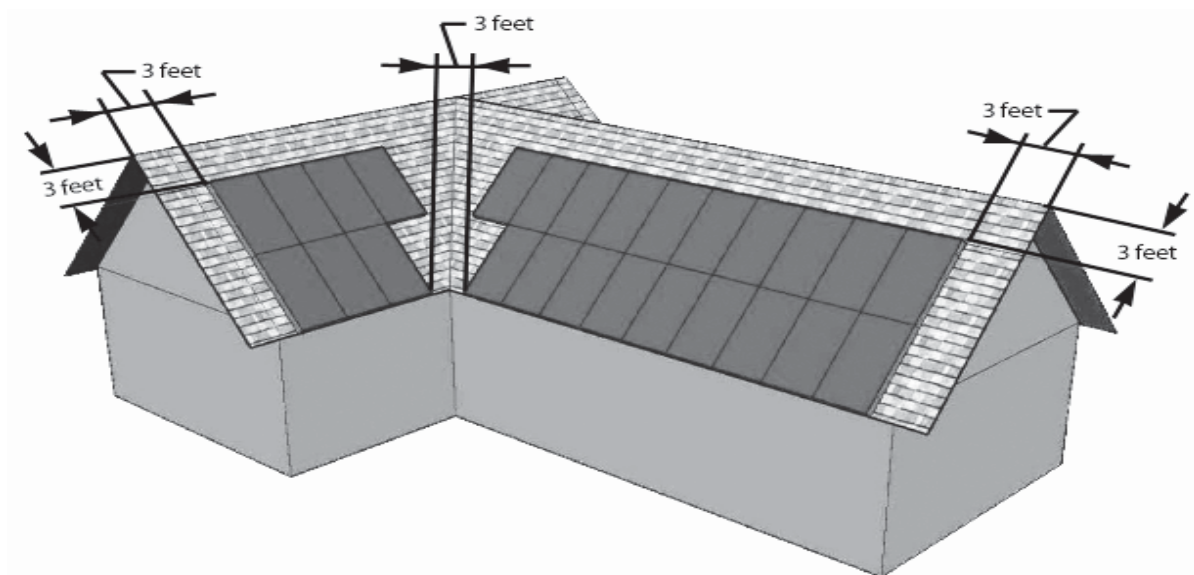


Figure 4
Solar PV System – NEM Process (Simplified)
 (See Section 1.1)



For SI units: 1 foot = 304.8 mm

Figure 5
Pathways and Setbacks on Cross Gable Roof
(See Section 5.1)



For SI units: 1 foot = 304.8 mm

Figure 6
Pathways and Setbacks on Cross Gable Roof with Valley
(See Section 5.1)