



SOLAR PHOTOVOLTAIC INSTALLATION GUIDELINE

September 2, 2010

The Beverly Hills Solar Photovoltaic Installation Guideline was developed in a collective effort between The City of Beverly Hills Fire Department and The City of Beverly Hills Department of Community Development, Building and Safety. The Beverly Hills Solar Photovoltaic Installation Guideline is based upon the Final Draft Solar Photovoltaic Installation Guideline developed by the California State Fire Marshall. The technical content of this document is consistent with the California State Fire Marshall document and California State Law Enforced by Building Departments. The document has been amended with clarifying language and additional provisions pertaining to maintaining firefighter safety. The provision of this guideline as adopted by the City of Beverly Hills by local ordinance shall apply to the design, construction and installation of solar photovoltaic systems on buildings regulated by Title 24 of the California Building Standards Codes.

**Beverly Hills Fire Department
SOLAR PHOTOVOLTAIC INSTALLATION GUIDELINE
2010**

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Purpose

Installation of the solar photovoltaic (PV) systems presents additional areas of concern for firefighter safety (energized equipment, trip hazards, etc) and fire fighting operations (restricting venting locations, limiting walking surfaces on structure roofs, etc.) This guideline establishes the minimum standard for the layout design, marking, and installation of solar photovoltaic systems and is intended to mitigate the fire safety issues.

General Information about Solar Photovoltaic Systems

Solar photovoltaic systems generate electricity from the sun. As of September 2007, there are roughly 30,000 solar photovoltaic systems installed on homes, commercial buildings and free-standing structures in California and their numbers continue to expand. Most systems are connected to the electric grid and provide power to the site. The majority of these systems do not have any battery backup equipment – instead, excess power is sent to the electric utility system.

Solar photovoltaic (PV) systems are installed with an AC disconnect at the service panel. Conduit carrying DC power connects the modules to the inverter. The inverter connects the PV system to the utility service panel. AC disconnects are not required in all jurisdictions because the main breaker provides this level of disconnect.

A DC disconnect is installed on the site side of the inverter. Typical systems seen today have an inverter located near the utility service panel. Some inverters (micro inverters, AC modules) are located at the PV module (the solar industry refers to PV panels as “modules”). If the inverter is located at the PV module, the conduit from the modules to the utility power supply is AC. The DC disconnect at the service panel cuts power to the inverter, which is then unable to export power to the utility service panel and prevents any solar electricity from harming service or maintenance workers on the utility side of the panel. Whenever sunlight shines on the modules, there is power in the conduit between the PV modules and the DC disconnect.

The systems will produce up to 8 amps and up to 600 volts of electricity, these values will vary with each system. Multiple strings of series connected modules are connected together in a combiner box. The power output is highest on a bright day with low ambient temperatures and drops as the modules heat up (such as on a very hot day).

There is no power output in the dark and there is no stored energy in the modules themselves. Service lights used by fire crews do not provide enough light to develop any harmful power levels.

Modules are mounted on buildings or on ground supported frames. Roof mounted modules, also sometimes known as panels, can be one of several types:

1. Directly on a building’s roof
2. Integral to the roof system of a building
3. On a rack with a space above the roof surface
4. On a free standing structure but not on the non - habitable structure (such as a trellis or other free standing support structure).

Specifically:

-
- Modules are typically attached to a mounting system, which is attached to the structural elements of the roof.
 - Modules integrated to the roof system are commonly referred to as Building Integrated Photovoltaic's (BIPV) and are of two types:
 - Physically integrated roofing products resemble roof shingles or tiles and are installed along with standard roof shingles or tiles so that they blend into overall appearance of the roof. Physically integrated BIPV modules act as part of a defined roofing system.
 - Aesthetically integrated modules also resemble roof shingles or tiles and are installed along with standard roof shingles or tiles to blend into the overall appearance of the roof. Aesthetically integrated modules do not act as part of a defined roofing system.

Modules are located in a manner to provide the best access to sunlight. This means they are typically mounted on the south or west side facing roof façade. In residential applications, the typical roof area used is about 400 square feet. Larger size systems correspond to a higher site electricity demand.

Although it is not advisable to step or walk on any solar system due to slip and/or trip hazards, the systems should be able to support a firefighter's weight.

Other PV products, such as those integrated with a curtain wall or as windows are not currently addressed in this guideline.

Other types of solar energy systems that might be seen at a site do not generate electricity. These can be broken down into three major types - solar water heating, solar pool heating, and solar space conditioning. In these systems, modules and piping carry water or glycol.

General Requirements

Growing demand for solar photovoltaic products is leading to new products, designs, technologies, and installation methods. As new products and methods become available, local fire departments may encounter solar photovoltaic systems that will require an alternative means of compliance. Solar contractors should contact the Beverly Hills Fire and Building Departments to determine if alternate means or methods would allow for a safe installation that is acceptable to both Departments.

Solar photovoltaic arrays shall be setback and installed in compliance with California State Law, Section 25980 to 25985 of the Public Resources Code.

Solar photovoltaic arrays shall not be installed in any areas that may encroach into any emergency egress, path of travel, exits, roof access points, working space, emergency window exits/access, or other clearances required by other applicable codes. Solar photovoltaic arrays shall not prevent access to utilities, disconnects, or shut-offs.

1.0 MARKING

Photovoltaic Systems must be marked. Marking is needed to provide Beverly Hills Fire personnel with appropriate warning and guidance with respect to isolating the solar electric system. This can facilitate identifying energized electrical lines that connect the solar modules to the inverter, as these should not be cut when venting for smoke removal. Identification shall also be provided for and include the battery backup components and other elements that may continue to produce electricity to the building or structure.

Materials used for marking shall be weather resistant. Use UL 969 as standard to weather rating (UL listing of markings is not required).

1.1 Main Service Disconnect

For residential applications, the marking **should** be placed within the main service disconnect. If the main service disconnect is operable with the service panel closed, then the marking **shall** be placed on the outside cover.

For commercial application, the marking **shall** be placed within three-feet (3') of the main service disconnect in a location clearly visible from the location where the main service lever is operated.

1.1.A Solar Photovoltaic Array Disconnect

Roof mounted arrays shall have an electrical disconnect provided within three-feet (3') from the photovoltaic array or before the circuit conduit enters the building structure. A separate disconnect shall be provided for an array separated by more than six-feet (6') in any direction to another photovoltaic array. The solar array disconnect shall be accessible from the access pathway and comply with the California Electrical Code.

1.1.B Battery Backup Solar Photovoltaic System Disconnect

Photovoltaic systems with battery backup and electrical storage devices shall have an electrical disconnect provided within three feet (3') from the storage battery components. The electrical disconnect shall be accessible from the exterior of the building and shall be marked and identified as required by guideline sections 1.1.1, 1.2, and 1.2.1.

1.1.1 Marking Content and Format

- MARKING CONTENT: CAUTION: SOLAR ELECTRIC SYSTEM CONNECTED
- RED BACKGROUND,
- WHITE LETTERING,
- MINIMUM 3/8" LETTER HEIGHT,
- ALL CAPITAL LETTERS,
- ARIAL OR SIMILAR FONT, NON-BOLD,
- REFLECTIVE, WEATHER RESISTANT MATERIAL SUITABLE FOR THE ENVIRONMENT (Durable adhesive materials meet this requirement)

CAUTION: SOLAR ELECTRIC SYSTEM CONNECTED

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

Markings are required on all interior and exterior DC conduit, raceways, enclosures, cable assemblies, and junction boxes to alert the fire service to avoid cutting them. Marking shall be placed on all interior and exterior DC conduit, raceways, enclosures, and cable assemblies, every 10 feet, at turns and above and below penetrations and all DC combiner and junction boxes.

1.2.1 Marking Content and Format

- MARKING CONTENT: CAUTION: SOLAR CIRCUIT
- RED BACKGROUND,
- WHITE LETTERING,
- MINIMUM 3/8" LETTER HEIGHT,
- ALL CAPITAL LETTERS,
- ARIAL OR SIMILAR FONT, NON-BOLD,
- REFLECTIVE, WEATHER RESISTANT MATERIAL
(Durable adhesive materials meet this requirement)

CAUTION: SOLAR CIRCUIT

1.3 Inverters

The inverter is a device used to convert DC electricity from the solar system to AC electricity for use in the building's electrical system or the grid. Unless required by the National Electrical Code (NEC) or other applicable Code(s).

Markings are required for the inverter. Marking labels shall be in accordance with section 1.2.1 of this guideline.

Marking and /or Labels are in addition to those required by the National Electrical Code.

2.0 ACCESS, PATHWAYS AND SMOKE VENTILATION

Access and spacing requirements shall be observed in order to:

- Ensure access to the roof
- Provide pathways to specific areas of the roof
- Provide pathways and work space areas required for equipment maintenance in accordance with all applicable California Codes.
- Provide for smoke ventilation opportunities area
- Provide emergency egress from the roof

Designation of ridge, hip, and valley does not apply to roofs with 2-in-12 or less pitch. All roof dimensions measured to centerlines.

Roof access points shall be defined as an area that does not place ladders over openings (i.e., windows or doors) and are located at strong points of building construction and in locations where it does not conflict with overhead obstructions such as tree limbs, wires, or signs.

Façade mounted solar photovoltaic systems shall not restrict emergency exiting and shall comply with all applicable California building code requirements, including but not limited to emergency egress, natural light and ventilation, and fire resistive construction.

2.1 Residential Systems—Single and Two-Unit Residential Dwellings

The Beverly Hills Building and Safety Division and Fire Department require plan review for all residential solar photovoltaic systems.

Examples of these requirements appear at the end of this guideline.

2.1.1 Access / Pathways

- a. Residential Buildings with hip roof layouts. Modules shall be located in a manner that provides one (1) three-foot (3') wide clear access pathway from the eave to the ridge on each roof slope where modules are located. The access pathway should be located at a structurally strong location on the building (such as a bearing wall.) Roof overhangs shall not be considered a structurally strong location if overhang is more than eighteen-inches (18") when measured horizontally from the center line of the bearing exterior wall or support beam.
- b. Residential Buildings with a single ridge. Modules shall be located in a manner that provides two (2) three-foot (3') wide access pathways from the eave to the ridge on each roof slope where modules are located.
- c. Hips and Valleys: Modules should be located no closer than one and one half (1.5) feet to a hip or a valley if modules are to be placed on both sides of a hip or valley. If the modules are to be located on only one side of a hip or valley that is of equal length then the modules may be placed directly adjacent to the hip or valley.
- d. Residential Building with flat roofs. Modules shall be located in a manner that provides a minimum of two (2) three-foot (3') access pathways from one perimeter to its opposite perimeter of the building structure.
- e. Any portion of a residential flat roof shall maintain a minimum three-foot (3') wide clear perimeter around the edges of the flat roof.
- f. Access pathways shall be clear of vertical and horizontal projects from vents, equipment, and building extrusions. Access pathways shall include the direct path from the public right of way street or alley to the building and/or structure by a means of driveways and walkways larger than 5 feet in width.

Exception: Horizontal projections with a minimum of seven-feet (7') above the finished access pathway shall be permitted.

2.1.2 Ventilation

Modules shall be located no higher than three-feet (3') below the ridge.

Solar photovoltaic arrays shall not be greater than 75 feet in any dimension.

2.2 Commercial Buildings and Residential Housing Comprised of Three (3) or More Units

The Beverly Hills Building and Safety Division and Fire Department require plan review for all residential solar photovoltaic systems.

Exception: If the Beverly Hills Fire or Building Department determines that the roof configuration is similar to residential (such as in the case of townhouses, condominiums, or single family attached

buildings), the Building or Fire department may make a determination to apply the residential access and ventilation requirements.

Examples of these requirements appear at the end of this guideline.

2.2.1 Access

There shall be a minimum six (6) foot wide clear perimeter around the edges of the roof.

Exception: If either axis of the building is 250 feet or less, there should be a minimum four feet (4') wide clear perimeter around the edges of the roof.

Access pathways shall be clear of vertical and horizontal projects from vents, equipment, and building extrusions. Access pathways shall include the direct path from the public right of way street or alley to the building and/or structure by a means of driveways and walkways larger than 5 feet in width.

Exception: Horizontal projections with a minimum of seven-feet (7') above the finished access pathway shall be permitted.

2.2.2 Pathways

Pathways shall be established in the design of the solar installation. Pathways should meet the following requirements:

- a. Should be over structural members.
- b. Centerline axis pathways shall be provided in both axis of the roof. Center line axis pathways should run on structural members or over the next closest structural member nearest to the center lines of the roof.
- c. Straight-line pathways not less than 4 feet wide clear shall be provided to skylights, ventilation hatches, and roof hatches. 4-foot wide pathways shall be provided around the perimeter of all roof hatches.

2.2.3 Ventilation

- a. Arrays shall be no greater than 150 feet in any dimension.
- b. Ventilation options between array sections shall be either:
 1. A pathway 8 feet or greater in width
 2. 4 feet or greater in width pathway **and** bordering on existing roof skylights or ventilation hatches
 3. 4 feet or greater in width pathway **and** bordering 4' x 8' "venting cutouts" every 20 feet on alternating sides of the pathway

3.0 LOCATION OF DC CONDUCTORS

Conduit, wiring systems, and raceways for photovoltaic circuits shall be located as close as possible to the ridge, hip, or valley and shall run from the ridge, hip, or valley as directly as possible to an outside wall to reduce trip hazards and maximize ventilation opportunities.

Conduit runs between sub arrays and to DC combiner boxes shall use design guidelines that minimize total amount of conduit on the roof by taking the shortest path from the array to the DC combiner box.

The DC combiner boxes are to be located such that conduit runs are minimized in the pathways between arrays.

Weather approved type rigid flex conduit is permitted and shall be installed in accordance with the applicable California Electrical Code.

To limit the hazard of cutting live conduit in venting operations, DC wiring shall be run in metallic conduit or raceways when located within enclosed spaces in a building and should be run, to the maximum extent possible, along the bottom of load-bearing members.

4.0 NON-HABITABLE BUILDINGS

This guideline shall also apply to all non-habitable buildings and structures.

5.0 GROUND MOUNTED PHOTOVOLTAIC ARRAYS

Ground mounted solar photovoltaic arrays shall be setback and installed in compliance with California State Law, Section 25980 to 25985 of the Public Resources Code.

A ten-feet (10') clear brush area is required for ground mounted photovoltaic arrays.

Ground mounted solar photovoltaic arrays shall not be installed in any areas that may encroach into any emergency egress, path of travel, exit, roof access points, working space, or other clearances required by other applicable codes. Ground mounted solar photovoltaic arrays shall not prevent access to utilities, disconnects, or shut-offs.

Diagram 1: Cross Gable Roof

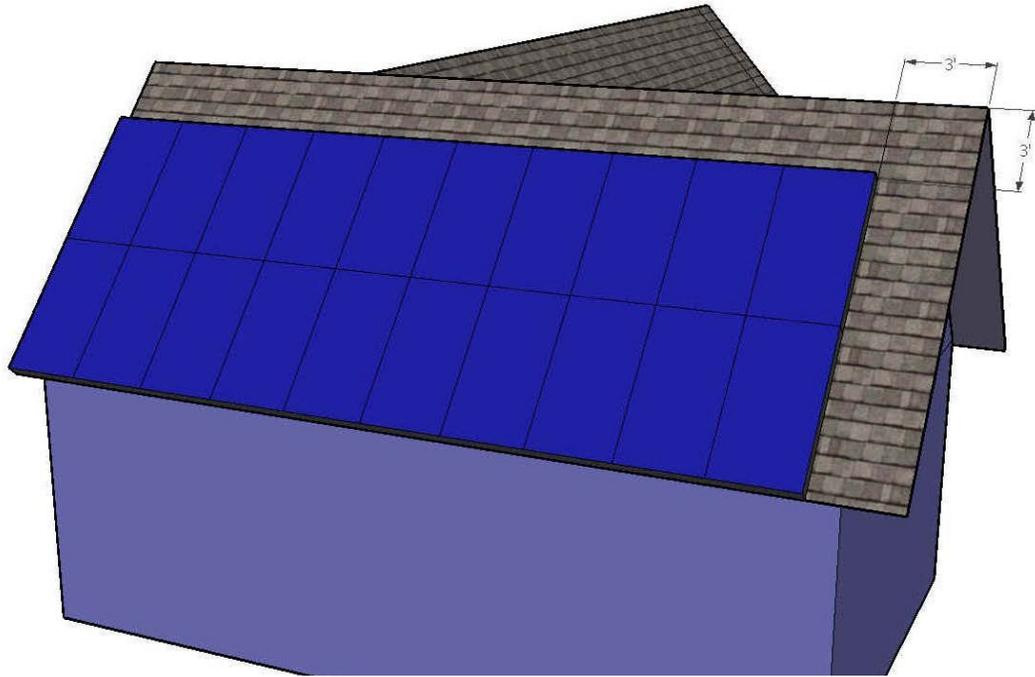


Diagram 2: Cross Gable with Valley

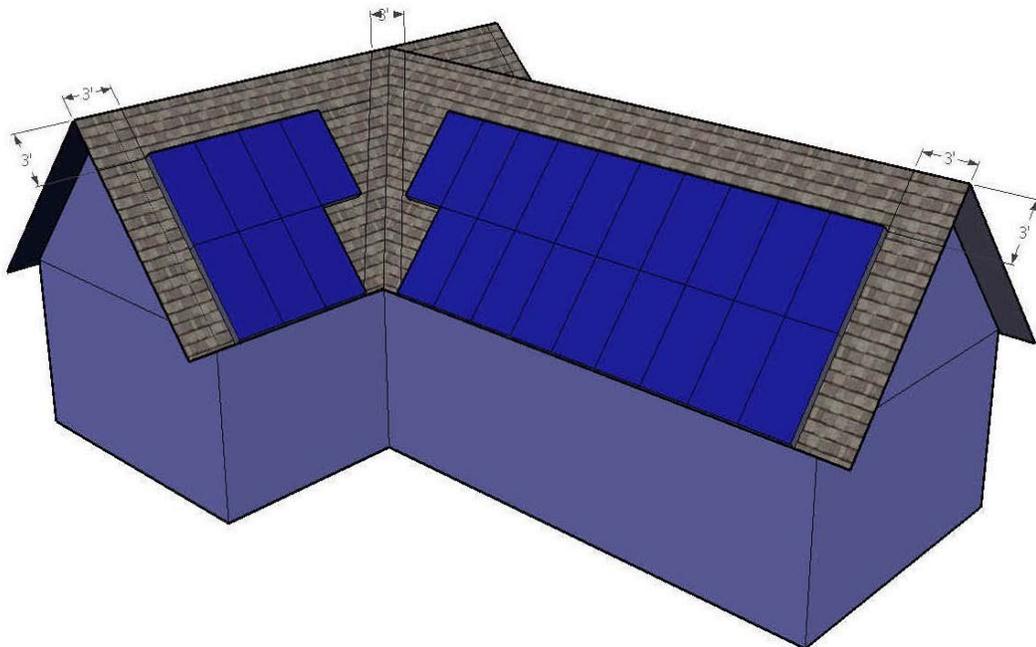
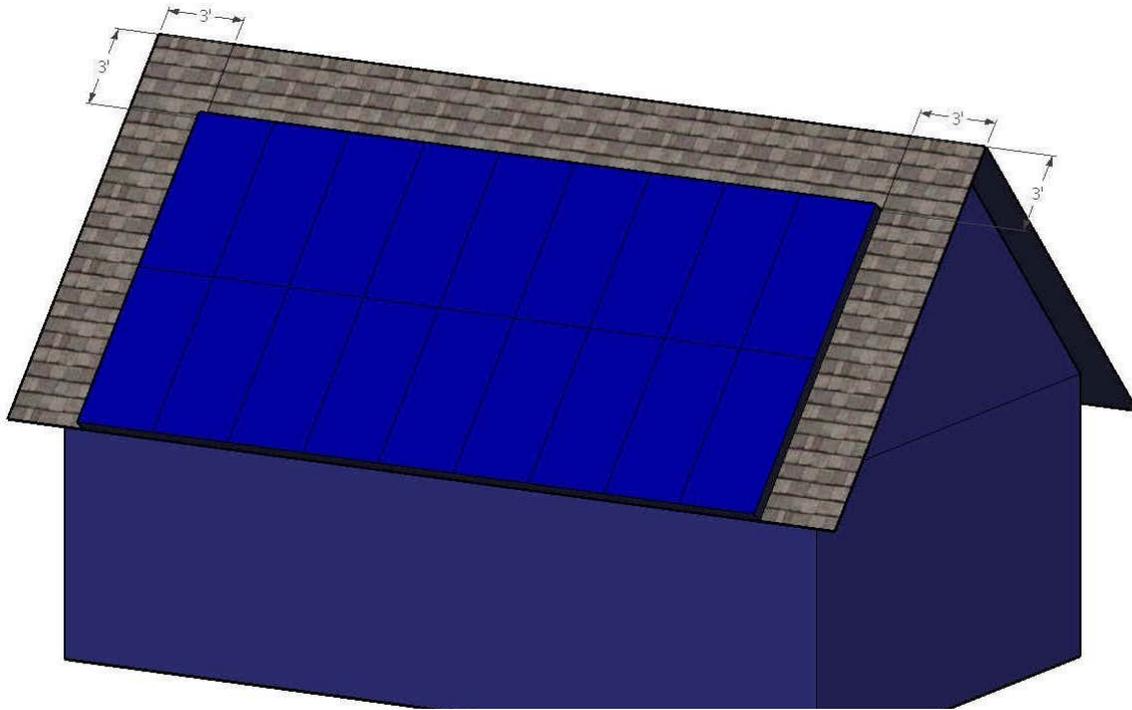
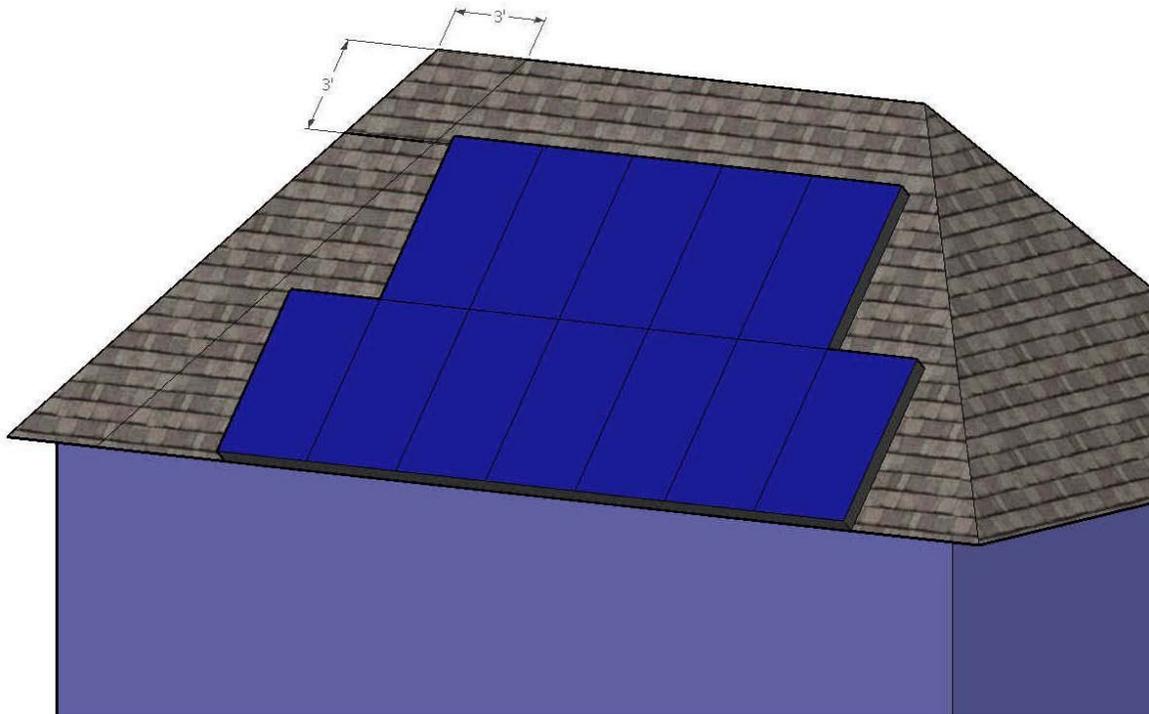
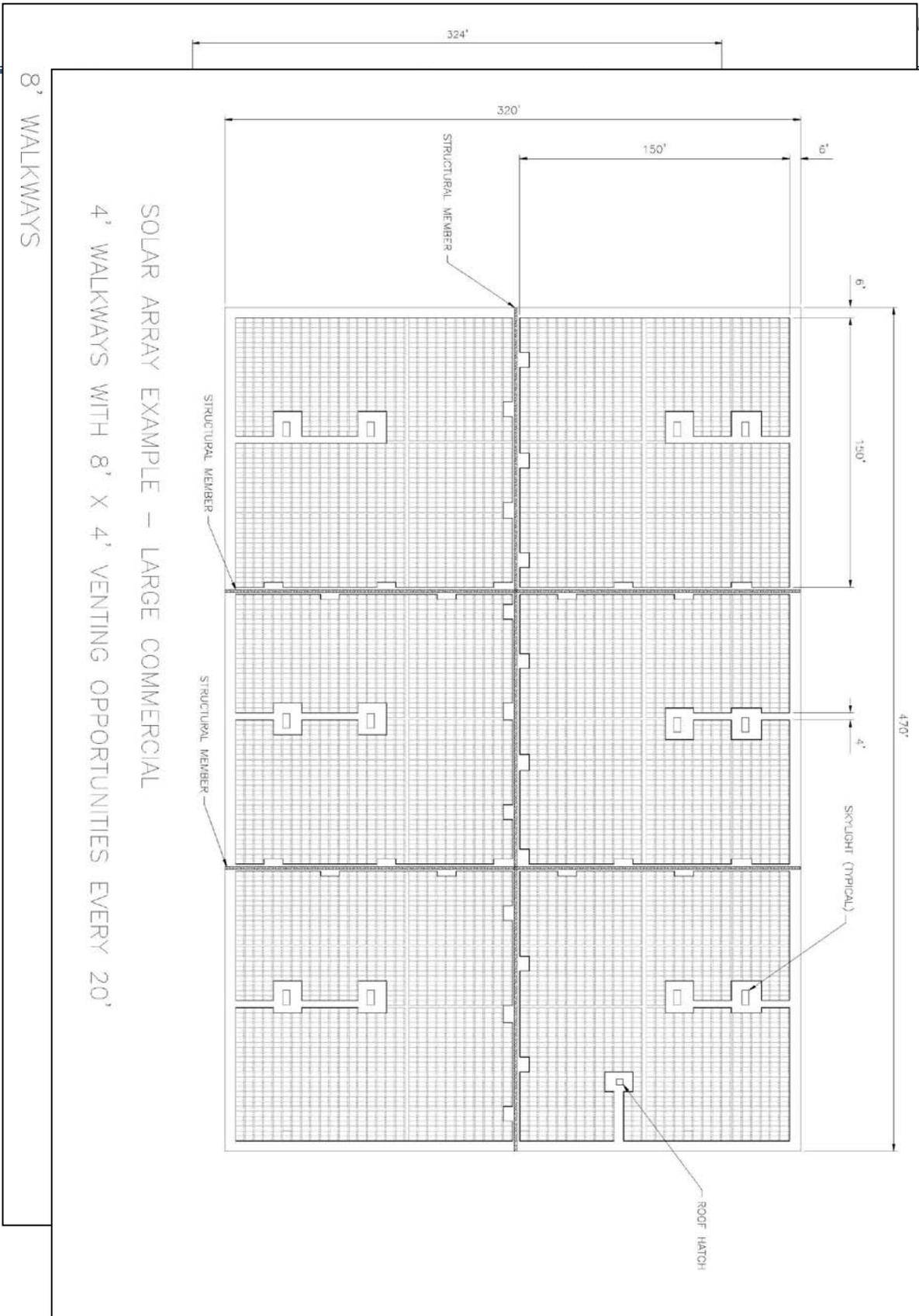


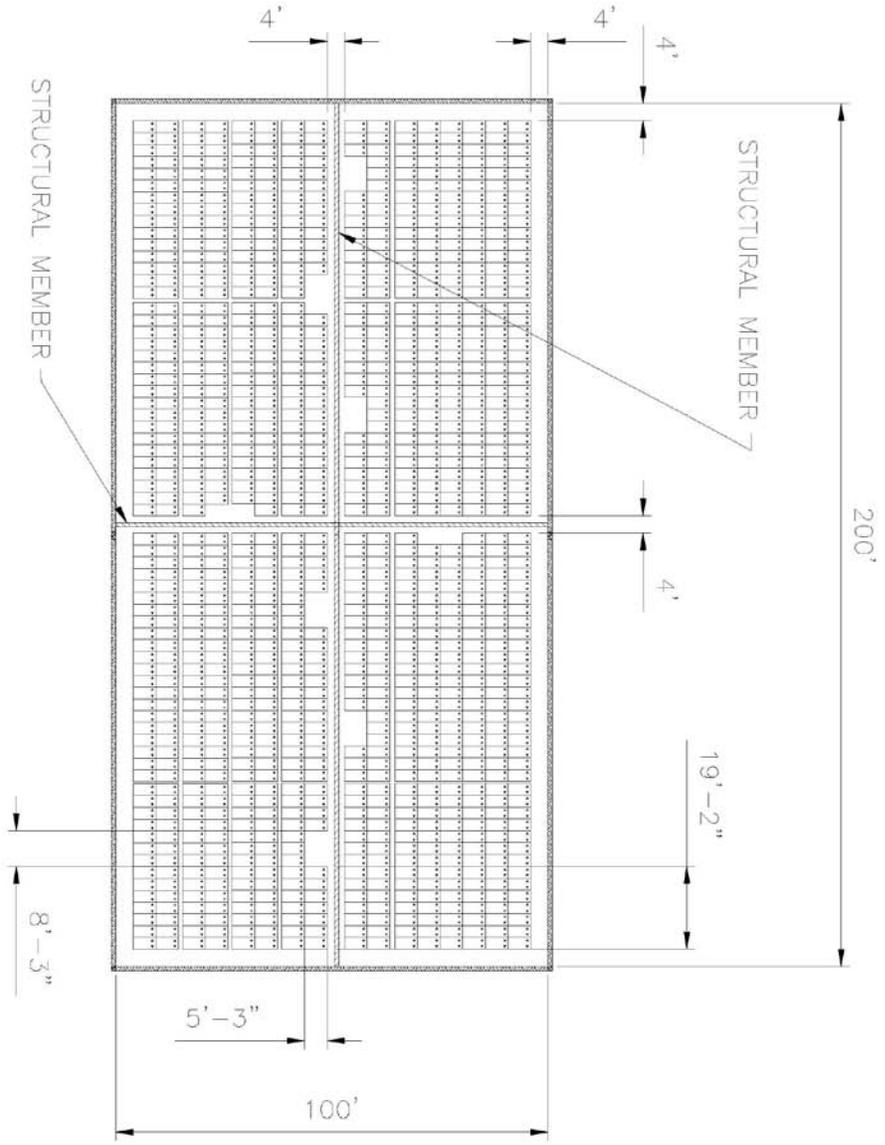
Diagram 3: Full Gable



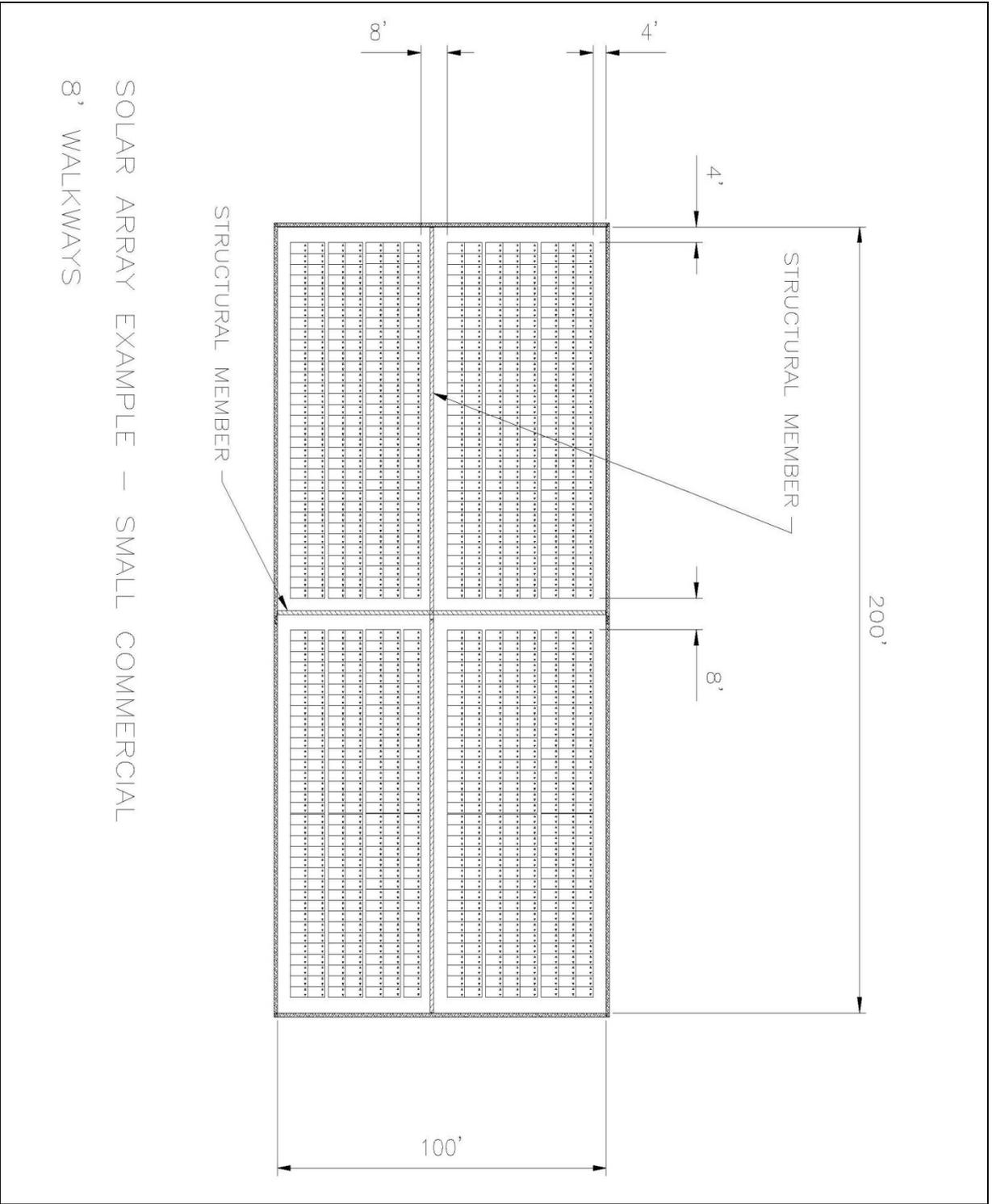
Example 4: Full Hip Roof







SOLAR ARRAY EXAMPLE – SMALL COMMERCIAL
4' WALKWAYS WITH 8' X 4' VENTING OPPORTUNITIES EVERY 20' ALONG WALKWAY



SOLAR ARRAY EXAMPLE – SMALL COMMERCIAL
8' WALKWAYS