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NY-Sun

NY-Sun Solar Guidebook

for Local Governments in New York State

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New York State is undertaking significant changes in how it generates and delivers energy, and solar power is emerging as the technology of choice for many New Yorkers. The *NY-Sun Solar Guidebook for Local Governments in New York State* is a compilation of tools and fact sheets to provide communities with resources and information that addresses new complexities such as land use, taxation, and permitting.

Reforming the Energy Vision is Governor Andrew M. Cuomo's strategy to build a clean, resilient, and affordable energy system for all New Yorkers. The Clean Energy Standard, an important component for the realization of REV goals, requires that 50% of New York State's electricity come from renewable energy sources like solar by 2030.

New York is well on its way. **Governor Cuomo's $1 billion NY-Sun initiative has accelerated solar growth across the State**. NY-Sun, a dynamic public-private partnership, will drive growth in the solar industry and make solar technology more affordable for all New Yorkers. From 2012 to 2015 solar has grown 575 percent. Solar is good for New York State's environment and economy. More solar projects create a cleaner environment, more jobs, and more local spending in communities. According to an analysis by solar industry experts, **spending $1 million on solar power installations brought up to $850,000 in localized spending, and up to $330,000 in increased wages**. Adoption of solar energy in communities is a critical part of this continued growth.

Committed to providing information, resources, and tools for local governments

In addition to this guidebook, local governments can access resources and assistance through the **NY-Sun PV Trainers Network**. Through education, training, and technical assistance, the Network helps local governments identify opportunities, mitigate barriers, and create programs that drive the development of solar markets in communities across New York State. The Network is composed of experts that develop and deliver training at various locations across the State. Local government officials can also contact the PV Trainers Network with questions and receive one-on-one technical assistance.

Understanding Solar PV Permitting and Inspecting in **New York State**

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Understanding Solar PV Permitting and Inspecting in New York State

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1 Introduction

This tool is intended to help local government officials and authorities having jurisdiction (AHJs) understand and streamline the solar photovoltaic (PV) permitting and inspection process to ensure efficiency, transparency, and safety. Standardizing the process across New York State's more than 1,600 AHJs will help reduce costs for municipalities and solar customers, create local jobs, and advance New York's clean energy goals.

The NY-Sun team at NYSERDA developed this tool in collaboration with the New York Department of State, solar contractors, and other stakeholders. It supports NY-Sun's efforts to implement a unified permitting process for residential solar PV systems. A copy of the New York State Unified Solar Permit application is provided in Appendix A.

Also included are resources to help inspectors and AHJs review solar electric project proposals, including an overview of design issues and a field inspection checklist. Information about solar basics, including equipment, financing, and terminology, is provided in Appendix B. Finally, the tool is also intended to help solar PV installers complete permit applications that meet the standards of AHJs.

1.1 What the Tool Is

This tool is a free resource to help code enforcement officials review and evaluate solar electric systems for grid-tied residential solar PV installations of 25 kW or less. Off-grid and commercial-scale solar PV systems are more complex and warrant greater detail than this tool provides.

1.2 What the Tool Is NOT

This tool is not all-encompassing. Electric construction is a complicated process governed by several building codes. This tool highlights many common and important design issues referenced in the National Electrical Code (NEC), but it should not be considered comprehensive.

1.3 Components and Intended Use

Design and Inspection Issues. An overview of select technical issues and considerations for designing effective and code-compliant solar PV systems.

Design Review of Construction Documents. Provides guidance and a checklist for how AHJs can evaluate the technical documents solar PV contractors submit.

Field Inspection Checklist. AHJs may inspect completed installations, or use approved third party inspectors. This section includes an inspection checklist, complete with NEC references to common installation errors.

Additional Resources include:

- **NY-Sun and PV Trainers Network.** Resources from NYSERDA's solar PV program and solar PV training program, including ones for AHJs, zoning officials, and inspectors.
- **Solar terms.** A glossary of solar PV terminology.
- **Information on Rooftop Access and Ventilation Requirements.**
- **Sample wiring diagrams.** Two examples of detailed electrical wiring diagrams.
- **Sample site map.** An example of a detailed site map for a roof-mounted solar PV system.
- **Sample construction photos of correctly installed equipment.** AHJs are welcome to use this document as a basis for their own photo reviews.

1.4 Distribution

AHJs and other entities are welcome to use and distribute this tool. AHJs may wish to update the Unified Solar Permit Application itself and Submittal Instructions to reflect any unique requirements that apply to their municipality (such as a schedule of fees). The inspection and design review checklists can also be changed to reflect additional requirements.

AHJs should keep in mind that changing the Unified Solar Permit's contents may diminish consistency and increase the cost of solar energy for their constituents. Changes may not be obvious to contractors working across many local governments, so AHJs should highlight any changes made to the standard documents.

1.4.1 Disclaimer

This document and the New York Unified Solar Permit are provided to support and standardize the solar permitting process. These documents should not be used as a substitute for proper solar PV system design calculations. Users of these documents assume all responsibility for solar PV system design, installation, and permitting, as required by New York State law. NYSERDA and its contractors cannot be held liable for any errors or omissions in these documents.

2 Solar PV System Design Issues

This chapter provides an overview of issues involved in solar PV system design. It is critical that designers optimize safety and performance because systems have expected lifespans of 20-30 years.

2.1 Array Siting

Designing a solar PV system involves many factors, but the most important is siting the array to maximize sunlight. South-facing roofs are ideal, but PV modules ("panels") can be located on southwest- or southeast-facing roofs with minimal losses. North-facing roofs and heavily shaded roofs should be avoided. Prior to installation, solar PV contractors measure the amount of sunlight a location receives annually, either with a hand-held tool or aerial imagery software.

Residents planning to remove trees to increase solar access should clearly mark the trees on construction documents submitted with their permit application. The projected growth of vegetation should also be considered when designing a system, especially for ground-mounted arrays.

When a house does not have a clear south-facing roof, contractors can install on garages, outbuildings, or in the ground. Experienced designers will maximize solar access and minimize wire runs, building penetrations, and labor costs. Depending on the layout of a house, conductors can be run on exterior roofs and walls, through attic or basement spaces, or in wall cavities.

2.2 Irradiance and Temperature

Solar electric modules convert solar radiation into electric current. Their power output is variable, based on the intensity of sunlight (irradiance) and the temperature of the cells. All modules have a nameplate capacity, which states the power (Wattage) produced by the module under Standard Test Conditions (STC), defined as 1,000 Watts per square meter at 25 °C. The module's actual output at a specific point in time is typically lower than the nameplate capacity, but can be higher under certain conditions.

Solar electric modules have the greatest power output when exposed to high levels of irradiance (intensity of sunlight) at low temperatures. There is a positive relationship between irradiance and the current (Amperes) solar PV modules produce: as irradiance increases, current increases (with little change in voltage). There is an inverse relationship between temperature and a PV module's voltage: at temperatures below 25 °C, modules produce voltage higher than during STC. At higher temperatures, voltage decreases (see NEC690.7), with no significant change to amperage.

In addition to reducing voltage (and therefore Wattage), high temperatures have other detrimental effects on solar PV systems. Prolonged exposure to high temperatures accelerates the rate at which solar PV cells degrade. Therefore, most roof-mounted arrays are located on racking, which places the PV cells 3 to 6 inches above the roof surface and allows airflow under the array. Inverters may be installed outdoors but perform slightly better when not in direct sunlight. High temperatures must be considered when sizing conductors located on hot roofs (NEC 310.15(B) (2-3)), as the current carrying capacity of conductors decreases when exposed to heat. Conduit runs must also have expansion fittings (as required by code) to account for thermal expansion and contraction.

Because the output voltage of solar PV modules increases significantly in colder weather, installers must account for the lowest expected ambient temperature when determining the maximum number of solar PV modules per string (NEC 690.7).

2.3 System Sizing and Equipment Selection

Solar electric installations are highly customized. Installers must carefully design systems to meet site-specific conditions and choose equipment that satisfies detailed technical requirements. Solar electric modules have different STC electrical outputs (voltage and current), which vary with temperature and irradiance. At residential sites the NEC limits the maximum DC string voltage to 600 volts, so installers must determine the maximum number of modules per string, based on design low temperatures (i.e. when module voltage is highest). DC strings of modules must also have a minimum voltage (based on design high temperatures) greater than the minimum voltage required to activate the system's inverter. Certain technologies allow for increased flexibility in system design, such as multiple power point trackers (MPPTs), DC optimizers, and microinverters.

DC array sizes should not exceed an inverter's maximum input rating. If an inverter is significantly undersized for an array, solar PV production during peak hours will be limited. Generally, a solar PV system's DC Wattage should not exceed 1.3 times the AC rating of its inverter. Many inverter manufacturers have developed computer programs that assist in string sizing and optimizing system design, such as **www.fronius.com/froniusdownload/tool.html**

2.4 Grounding

One of the more challenging aspects of solar PV system design and installation is thoroughly grounding and bonding the system in accordance with the NEC.

The grounding electrode conductor (GEC) is the reference ground that establishes the voltage relationships between the ungrounded conductors and earth ground. The GEC must be run with irreversible splices from any separately derived power supply (i.e., inverters that contain transformers) to the grounding electrode. All solar PV systems with a transformer-based inverter will require a GEC from the inverter to the grounding electrode. Table 250.66 in the 2014 NEC governs the sizing of the GEC. The GEC must be a minimum of number six American Wire Gauge Building Wire (#6 AWG) when exposed and must be bare, or covered with green insulation. When exposed and insulated, the wire must be UV-protected.

The grounded conductor (or "neutral" conductor) is intentionally grounded and carries current under normal conditions. It is always insulated and may be white or gray in color. Current flows out on the ungrounded conductors and returns on the grounded conductor, completing the circuit.

The equipment grounding conductor (EGC) does not carry current under normal conditions. It provides a path back to the grounded conductor (neutral) when a fault occurs. The EGC may include all bonded metal components, such as the racking, boxes, enclosures, building steel, and metal roofing materials. (Bonding is the physical connecting of metal components so that they are at equal potential. They may or may not be grounded. Bonding jumpers may be extensions of the GEC, EGC, or grounded conductor.) Table 250.122 in the 2014 NEC governs EGC sizing. The EGC is required on both grounded and ungrounded (transformer-less) systems. The EGC must be a minimum of #6 AWG when exposed and must be bare, or insulated green. When exposed and insulated, the wire must be UV-protected.

The GEC, EGC, and grounded conductor must be bonded together at the main service disconnect(s) and at the overcurrent protection/disconnects when performing a supply-side connection.

2.5 Labeling

The NEC provides many unique labeling requirements for solar PV systems, located in Section 690 and elsewhere. To assist contractors and inspections, NY-Sun and The Cadmus Group have developed an extensive Labeling Guide, located as Appendix C of this document.

2.6 Zoning Considerations

Solar electric is a relatively new technology. Many municipalities are unsure how solar PV installations fit into their existing zoning and land-use regulations. Large-scale systems in particular raise land use, aesthetic, decommissioning, and disposal concerns.

Municipalities should review their existing zoning requirements to ensure they clearly describe how solar PV systems are classified, and what restrictions are placed upon them. Several excellent resources are available to help zoning boards, including the *Zoning for Solar Energy: Resource Guide*, available on the NY-Sun PV Trainers' Network website at **training.ny-sun.ny.gov/resources**. NY-Sun posted a land use guide to **nyserda.ny.gov/All-Programs/Programs/NY-Sun/Learn-About-Solar**

2.7 Wind and Snow Loads

Solar electric contractors are responsible for ensuring that their installations do not jeopardize the structural integrity of the buildings upon which they are mounted. Due to their large surface areas, solar PV arrays can catch updrafts and create significant amounts of uplift during windy conditions. Forces are especially strong when modules are located at the ridge of a roof, when they are mounted a significant distance above the roof surface, or when they are not mounted parallel to the roof surface. Ground-mounted arrays are also subject to large wind forces. Detailed calculations are required to determine the exact amount of pressure for which systems should be designed.

Solar electric arrays, including racking and mounting hardware, typically add 4-6 pounds per square foot of dead load to a structure. Although this amount is modest, it may become significant when combined with a roof's existing dead load and snow load. The International Residential Code provides snow load data, which range from 20-80 pounds per square foot in New York State.

A Professional Engineer or Registered Architect should perform detailed calculations to ensure solar PV designs meet all structural requirements, taking wind load and snow load into account.

Figure R301.2(4)A from the 2015 International Residential Code: Ultimate Design Wind Speeds[1]

[1] *Measurements given in miles per hour with meters per second in parentheses.*

Figure R301.2(5) from NYS Building Standards and Codes 2016 Uniform Code Supplement Ground Snow Loads[1]

[1] www.dos.ny.gov/DCEA/pdf/2016%20DOS_UniformCodeSupplement_03212016.pdf
Snow loads given in pounds per square foot.

3 Design Review of Construction Documents

As part of their permit application, applicants must submit a site plan, an electrical wiring diagram, a structural analysis, and specification sheets for the modules, inverter, and racking system. This chapter includes checklists of items for code officials to check as part of their design review.

The construction documents must be stamped by a New York State licensed professional engineer (PE) or registered architect (RA).[3] The local code official will determine the depth of review necessary. The following three-part checklist may be expanded should the code official require examination at greater depth, such as checking wire sizing and other calculations.

3.1 Site Plan

<table>
<tr><th>Yes/No</th><th>Site Plan</th></tr>
<tr><td></td><td>Construction document prepared and stamped by a New York State licensed professional engineer or registered architect, who incorporated the following into system design.</td></tr>
<tr><td colspan="2">• Street address and tax map parcel number
• All required setbacks, including rooftop access and ventilation requirements as applicable[4]
• Location of array, inverter, disconnects, and point of interconnection
• Array azimuth and tilt
• For ground mounted systems, length and location of trenches
• Location and type of rapid shutdown device, if applicable (2014 NEC 690.12)</td></tr>
</table>

[3] Part 1203 - Uniform Code: Minimum Standards for Administration and Enforcement of Rules and Regulations - Department of State Title 19 (NYCRR) Chapter XXXII - Division of Code Enforcement and Administration.

[4] Including the NYS 2016 Uniform Code Supplement http://www.dos.ny.gov/dcea/pdf/2016%20DOS_UniformCodeSupplement_03212016.pdf

3.2 Electrical Diagram

Yes/No	Electrical Wiring Diagram
	Electrical wiring diagram prepared and stamped by a New York State-licensed Professional Engineer or Registered Architect, who incorporated the following into system design.

- Solar electric module array information – number of modules in series, number of strings.
- Quantity, make, and model of UL-listed solar PV modules.
- All conductor types, ratings, and conduit type (if applicable). Solar electric source circuit conductors are USE-2 or solar PV wire (NEC 690.31(B)).
- Max voltage of 600 VDC (NEC 690.7(C)) (1,000 VDC wire may be used on 600 VDC systems).
- Rating (voltage and current) for all disconnects.
- Voltage drop is minimized (NEC 210.19(A)Informational Note No. 4).
- Provision for Rapid Shutdown per 690.12 in the 2014 NEC. Using microinverters or string inverters with DC Power optimizers is one way of meeting this requirement.
- DC disconnect is present (may be integral to inverter) (NEC 690.13).
- Quantity, make, and model of UL-listed inverter provided.
- AC disconnect appropriately sized for inverter output (690.8(A)(3), 690.8(B)(1)).
- Conductor type, rating, and conduit type (if applicable) provided for all conductors.
- If supply-side connection, meets all requirements of NEC 705.12, including:
    - Service-rated AC disconnect specified, at least 60 amps, with appropriate overcurrent protection device. If breaker used, must meet or exceed utility fault current kAIC rating.
    - Conductors between disconnect and point of interconnection are sized at least 60 amps (#6 or larger).
    - Supply side connection made between main service panel's main disconnect and utility meter.
- If load side connection, meets all requirements of NEC 705.12, including:
    - Inverter output connection is made at a dedicated circuit breaker or fusible disconnect.
    - Sum of ampere ratings of all breakers supplying power to panel doesn't exceed 120% of bus or cable rating.
    - Backfed breaker located at opposite end of buss bar from main breaker.
- Equipment grounding conductor (EGC) present at all components likely to become energized, and sized according to NEC 250.122.
- If not using an isolated/ungrounded/transformer-less inverter, grounding electrode conductor (GEC) present and continuous from inverter to service disconnect, sized according to NEC 250.66.

3.3 Structural Analysis

Yes/No	Structural Analysis
	Structural analysis prepared and stamped by a New York State licensed professional engineer or registered architect, who incorporated the following into their review.

- Weight of the existing roofing (composition shingle, metal, masonry, etc.).
- Number of layers of roof covering.
- Method of waterproofing penetrations (flashing is required by the 2015 International Residential Code and International Building Code).
- Type of racking system (engineered product) and height of solar PV modules from surface of roof.
- Location-specific wind load and snow load.
- Type, dimensions, and spacing of roof structural framing.
- Calculations must be provided if any of the following apply:
    - Roofing is not lightweight, or roof has multiple layers of covering.
    - Racking system is not engineered for mounting of solar PV modules.
    - Modules will be mounted more than 18 inches above roof surface.
    - Modifications must be made to framing to strengthen roof structure.
    - Solar electric system and racking will add more than 5 pounds per square foot to dead load, or more than 45 pounds per attachment point, calculated as follows:
        - Total weight of solar PV modules, racking, and mounting hardware ____________pounds.
        - Total number of attachment points to roof ____________.
        - Weight per attachment point (A ÷ B) ____________pounds.
        - Total area of solar PV array ____________square feet.
        - Distributed weight of solar PV array on roof (A ÷ D) ____________pounds/square foot.

4 Field Inspection Checklist

The Field Inspection Checklist in this chapter can be used directly by the AHJ or provided to a third-party inspection agency, where applicable. The checklist is intended to highlight key system characteristics and common installation errors. Completing the checklist should take approximately 20 minutes per field inspection. Not all sections may apply to a given installation.

A “rough inspection” (which occurs when all boxes and wires are installed to the point when walls or trenches are ready to be closed) is **not** necessary on most small residential installations with existing construction.

When a field inspection is necessary, inspectors should consider bringing the following items:

- Ladder with non-conductive sides.
- Binoculars for surveying inaccessible roof-mounted equipment.
- Screwdriver for opening enclosures.
- A copy of the contractor’s submitted design.

Code enforcement officers should consider asking solar PV contractors for a set of construction photos. Contractors typically document their installation progress with photos, which are sometimes required by their internal quality assurance team or financing partners. NY-Sun also requires construction photos from participating contractors. Code enforcement officers can use such photos to review hard-to-access parts of the installation (such as roof-mounted racking).

References to construction and equipment photos in Chapter 5 are included in the following checklist, where applicable.

4.1 **Array** (All photos are located in Appendix C)

1. Circuit conductors are properly supported and are not touching the roof surface [NEC 338.10(B)(4) and NEC 334.30] (Photo 10)	N	Y	N/A
2. Circuit conductors are same conductor type/size as on plan set	N	Y	N/A
3. Module count matches plan set. If no, investigate stringing configuration (Photo 3)	N	Y	N/A
4. Module manufacturer/model matches plan set (Photo 4)	N	Y	N/A
5. Modules are effectively grounded using lugs, WEEBs, or a racking integrated grounding method [NEC 690.43] (Photo 9)	N	Y	N/A
6. Modules and racking are properly secured (Photos 5, 6, 7)	N	Y	N/A
7. DC optimizers are properly grounded [NEC 690.43 and NEC 110.3(B)]	N	Y	N/A
8. Wire ties are UV-rated (generally black) (Photo 10)	N	Y	N/A
9. All electrical connections are secured to ensure no arcing	N	Y	N/A
10. Racking system is properly grounded (EGC bonding the rails, [NEC 690.43]) (Photo 8)	N	Y	N/A
11. Conductors are properly identified (ungrounded, grounded, grounding) [NEC 200.7, NEC 200.6, NEC 250.119] (Photo 13)	N	Y	N/A
12. Outdoor components are UL-listed for the environment [NEC 110.3(B)]	N	Y	N/A
13. Roof vents are not covered by the modules (2015 IRC/2015IBC) (Photo 3)	N	Y	N/A
14. DC conduit is labeled "WARNING: PHOTOVOLTAIC POWER SOURCE" every 10 feet, and is reflective, and meets color and size requirements [NEC 690.31(G)(3) and (4)]	N	Y	N/A

4.2 **DC Optimizer** (All photos are located in Appendix C)

1. DC Optimizer chassis is properly grounded per manufacturer's instructions [NEC 690.43, NEC 250 NEC 110.3(B)]	N	Y	N/A
2. EGC is protected if smaller than #6AWG [NEC 690.46 and NEC 250.120] (Photo 9)	N	Y	N/A
3. DC Optimizer GEC is sufficiently sized per manufacturer instructions [NEC 690.47(C), NEC 250.66, NEC 250.122, NEC 250.166]	N	Y	N/A
4. Rapid Shutdown label is present and meets the requirements of NEC 690.56(C).	N	Y	N/A
5. DC Output circuit conductor insulation type is rated for environment (Shall not be type: USE-2, THWN-2, RHW-2) [NEC 310.10]	N	Y	N/A

Note 1: Many violations from the "Array" section also apply to the "DC Optimizer" section.

Note 2: DC optimizer can have an integrated ground, or not. Bring the specifications sheet to the inspection for quick reference.

4.3 Structural (Roof-Mounted Only) (All photos are located in Appendix C)

1. All roof penetrations are properly flashed and sealed 2015 IRC/ 2015 IBC (Photos 6, 12)	N	Y	N/A
2. Rafter spacing/material matches construction documents	N	Y	N/A
3. Roof appears to be in good condition, with no signs of leaking or damage; Roof is free of debris (Photo 3)	N	Y	N/A
4. All racking splices are properly supported per manufacturer requirements (generally splices must be supported on both sides of the joint by a structural attachment)	N	Y	N/A
5. Modules cannot be moved by pushing or pulling with one hand (Photo 7)	N	Y	N/A

4.4 Junction Box (All photos are located in Appendix C)

1. Wire nuts and splices are suitable for the environment [NEC 110.3(B), NEC 110.14, NEC 110.28] (Photo 13)	N	Y	N/A
2. Junction box is UL listed for the environment [NEC 110.3(B)] (Photo 14)	N	Y	N/A
3. Junction box is properly grounded [NEC 690.43(A), NEC 250.4, NEC 110.3(B)]	N	Y	N/A
4. Grounding equipment is properly installed (NEC 690.43, NEC 250.8, NEC 250.12) (Photo 13)	N	Y	N/A

4.5 Inverter (All photos are located in Appendix C)

1. The number of strings match the plan set (Photo 18)	N	Y	N/A
2. The conductors have sufficient ampacity for each string	N	Y	N/A
3. DC conductors in metal when on or inside a building [NEC 690.31(G)] (Photos 11, 12)	N	Y	N/A
5. Conduit penetrations are properly sealed between conditioned and unconditioned space [NEC 300.7(A)]	N	Y	N/A
6. Conduit is properly supported e.g., [LFMC NEC 350.30, EMT NEC 358.30, PVC NEC 352.30] (Photo 15)	N	Y	N/A
7. Conduit is not being used as conductor support [NEC 300.11(B)] (Photo 15)	N	Y	N/A
8. The enclosure is properly grounded [NEC 690.43, NEC 250.8, NEC 250.12] (Photo 16)	N	Y	N/A
9. Grounding equipment is properly installed [NEC 690.43, NEC 250.8, NEC 250.12] (Photos 16, 19)	N	Y	N/A
10. Enclosure is labeled as a PV disconnect [NEC 690.13(B)]	N	Y	N/A
11. DC characteristics label is present [NEC 690.53]	N	Y	N/A
12. The ungrounded DC conductors are properly identified (shall not be white, gray, or white striped) [NEC 200.7(A)] (Photo 16)	N	Y	N/A
13. Max string voltage below inverter max [NEC 110.3(B) and NEC 690.7]	N	Y	N/A
14. Inverter string fuses are rated for use in application [NEC 690.9]	N	Y	N/A
15. DC and AC disconnecting means are located within sight of or in each inverter [NEC 690.15 (A)] (Photos 15, 18)	N	Y	N/A
16. AFCI protection is present and enabled [NEC 690.11]	N	Y	N/A
17. System is equipped with Rapid Shutdown [NEC 690. 12]	N	Y	N/A
18. System is marked with a permanent label with the following wording: "PHOTOVOLTAIC SYSTEM EQUIPPED WITH RAPID SHUTDOWN" [NEC 690.56(C)]	N	Y	N/A

4.6 Microinverter (All photos are located in Appendix C)

1. Microinverter chassis is properly grounded per manufacturer's instructions [NEC 690.43(A), 250.4, 110.3(B)]	N	Y	N/A
2. EGC is protected if smaller than #6 AWG [NEC 690.46 and 250.120(C)] (Photo 5)	N	Y	N/A
3. Microinverter GEC is sufficiently sized per manufacturer instructions [NEC 690.47(C), NEC 250.66, NEC 250.122, NEC 250.166]	N	Y	N/A
4. Rapid Shutdown label is present and meets the requirements of [NEC 690.56(C)]	N	Y	N/A

Note 1: Many items from the "Array" section also apply to the "Microinverter" section.

Note 2: Microinverters can have an integrated ground, or not. This information is found on the specification sheet.

Note 3: As long as the microinverters are listed, they are inherently equipped with rapid shutdown, which is required by NEC Article 690.12. This does not negate the label requirement in 690.56(C).

4.7 AC Combiner (All photos are located in Appendix C)

1. The number of branch circuits match the plan set. (Photo 20)	N	Y	N/A
2. The conductors have sufficient ampacity for each branch circuit.	N	Y	N/A
3. The Overcurrent Protective Device (OCPD) for the conductors have a rating sufficient to protect them [NEC 240.4] (Photo 20)	N	Y	N/A
5. Conduit penetrations are properly sealed between conditioned and unconditioned space [NEC 300.7(A)]	N	Y	N/A
6. Conduit is properly supported e.g., [LFMC NEC 350.30, EMT NEC 358.30, PVC NEC 352.30] (Photo 15)	N	Y	N/A
7. Conduit is not being used as conductor support [NEC 300.11(B)] (Photo 15)	N	Y	N/A
8. The enclosure is properly grounded [NEC 690.43, NEC 250.8, NEC 250.12] (Photo 20)	N	Y	N/A
9. Grounding equipment is properly installed [NEC 690.43, NEC 250.8, NEC 250.12] (Photo 20)	N	Y	N/A
10. Enclosure is labeled as a disconnect [NEC 690.13]	N	Y	N/A
11. AC characteristics label is present (voltage and amperage), [NEC 690.54]	N	Y	N/A
12. "Multiple Sources" indication label is present [NEC 705.12(D)(3)]	N	Y	N/A
13. The sum of all overcurrent devices (excluding main) do not exceed the rating of the buss bar [NEC 705.12(D)(2)(3)(c)]	N	Y	N/A
14. The enclosure is labeled "Do Not Add Loads" [NEC 705.12(D)(2)(3)(c)]	N	Y	N/A
15. The main breaker is fastened in place [NEC 408.36(D)]	N	Y	N/A
16. Grounded conductors are isolated from enclosure [NEC 250.24(A)(5)] (Photo 20)	N	Y	N/A

4.8 Load-Side Connection (All photos are located in Appendix C)

1. Circuit conductors have sufficient ampacity [NEC 690.8, 310.15]	N	Y	N/A
2. The OCPD is sufficient to protect the circuit conductors [NEC 240.4]	N	Y	N/A
3. Grounded conductors properly identified [NEC 200.6(A)&(B)]	N	Y	N/A
4. The GEC is present and sufficiently sized [NEC 690.47(C), NEC 250.66, NEC 250.122, NEC 250.166]	N	Y	N/A
5. The GEC is continuous (or irreversibly spliced) [NEC 250.64(C), 690.47(C)]	N	Y	N/A
6. Ferrous conduit and the enclosure are appropriately bonded to the GEC [NEC 250.64(E), NEC 250.4(A)(5)]	N	Y	N/A
7. PV breakers are properly identified [NEC 408.4(A)] (Photo 23)	N	Y	N/A
8. AC characteristics label is present and suitable for the environment (voltage and amperage) [NEC 690.54, NEC 110.21]	N	Y	N/A
9. Dissimilar metals are separated and will not cause a galvanic reaction [(NEC 110.14, RMC NEC 344.14, EMT NEC 358.12(6)]	N	Y	N/A
10. Inverter directory present [NEC 690.15(A) and NEC 705.10]	N	Y	N/A
11. Backfed breaker sized to protect circuits [NEC 690.8(B)(1) and/or NEC 310.15]	N	Y	N/A
12. Source breakers follow 120% rule [NEC 705.12(D)(2)(3)(b)]	N	Y	N/A
13. Backfed breaker properly located in panel [NEC 705.12(D)(2)(3)(b)] (Photo 23)	N	Y	N/A
14. Clearances maintained/live parts secured [NEC 110.27(A) and NEC 110.26] (Photo 18)	N	Y	N/A

4.9 Supply Side Connection (All photos are located in Appendix C)

1. Disconnect is service-rated and has a current rating of at least 60 Amp [NEC 230.79(D)] (Photo 22)	N	Y	N/A
2. Circuit conductors have sufficient ampacity [NEC 690.8, NEC 310.15]	N	Y	N/A
3. New service entrance conductors are less than 10 feet [NEC 705.31] (Photo 18)	N	Y	N/A
4. The OCPD is sufficient to protect the circuit conductors [NEC 240.4] (Photo 21)	N	Y	N/A
5. The disconnect utility conductors are on LINE terminals [NEC 110.3(B), NEC 240.40(if fusible)]	N	Y	N/A
6. There is no OCPD in the grounded conductor [NEC 230.90(B)] (Photo 21)	N	Y	N/A
7. The AIC rating on the OCPD meets, or exceeds the rating of other main OCPD on the premises [NEC 110.9, NEC 110.10]	N	Y	N/A
8. The neutral is bonded to the PV disconnect enclosure/GEC [NEC 250.24(C)]	N	Y	N/A
9. The GEC is present and sufficiently sized [NEC 690.47(C), NEC 250.66, NEC 250.122, NEC 250.166] (Photo 24)	N	Y	N/A
10. The GEC is continuous (or irreversibly spliced) [NEC 250.64(C), NEC 690.47(C)]	N	Y	N/A
11. Ferrous conduit and the enclosure are appropriately bonded to the GEC [NEC 250.64(E), NEC 250.4(A)(5)] (Photo 24)	N	Y	N/A
12. AC characteristics label is present and suitable for the environment (voltage and amperage) [NEC 690.54, NEC 110.21]	N	Y	N/A
13. Power source directory is present, denoting all locations of power sources and disconnects on premises, at each service equipment location [NEC 110.21, NEC 690.56, NEC 705.10]	N	Y	N/A
14. AC disconnect label is present and suitable for the environment (NEC 690.13(B), NEC 110.21]	N	Y	N/A
15. Dissimilar metals are separated and will not cause a galvanic reaction [NEC 110.14, RMC NEC 344.14, EMT NEC 358.12(6)]	N	Y	N/A

4.10 General

1. Work is done in a neat and workmanlike manner [NEC 110.12] (Photos 5, 10, 13, 28)	N	Y	N/A
2. Working clearances are observed per NEC 110.26 (Photo 18)	N	Y	N/A

5 Resources

5.1 NY-Sun and PV Trainers Network

As part of the NY-Sun initiative, NYSERDA is committed to providing resources to local governments to help them better understand the solar PV contracting and construction process. General information on solar electric, including Community Solar and Solarize, and NY-Sun's initiatives, is available at **nyserda.ny.gov/All-Programs/Programs/NY-Sun**

Of particular relevance is the PV Trainers Network page (**training.ny-sun.ny.gov**), which contains:

- Free videos of trainings on solar electric-related topics, such as zoning, installing shared solar, and fire and safety considerations.
- A Municipal Solar Procurement Toolkit for towns interested in developing their own solar PV project.
- Information on zoning and land use planning for solar PV systems.
- Frequently Asked Questions.
- A section for local governments to request an in-person training session.

5.2 Residential Rooftop Access and Ventilation Requirements

Section 324 in the 2015 International Residential Code concerns roof top access and ventilation requirements for solar PV systems. New York State has adopted additional Errata requirements to Section 324. The purpose of these requirements is to provide firefighters and first responders access to the rooftop for ventilation purposes during a fire.

NYSERDA has developed an illustrated guide to these new requirements, called Residential Roof Top Access and Ventilation Requirements. Find it at **nyserda.ny.gov/All-Programs/Programs/NY-Sun/Project-Developers/Residential-Small-Commercial-MW-Block/Resources-Residential-Small-Commercial-MW-Block**

5.3 Sample Wiring Diagram 1: Microinverters with Supply Side Connection

Equipment Schedule	
TAG	DESCRIPTION: (Provide manufacturer and model number if applicable)
1	Solar PV Module or ACM: (45) Trina TSM250PA05: (3) strings of (15)
2	Microinverter (if not ACM): (45) Enphase M250
3	Junction Box(es): (3) Soladeck NEMA 3R, on roof
4	Solar Load Center, Yes / No: YES, 60 amps with (3) 20 amp breakers.
5	Performance Meter Yes / No: YES, online monitoring through Enphase Envoy unit
6	*Utility External Disconnect Switch Yes / No: Yes
7	Supply Side Disconnect with OCPD: Disconnect rating 60 amps. OCPD Rating 60 amps
8	Main Electrical Service Panel: Cutler-Hammer 200-amp bus, 200-amp main breaker

Single Line Diagram for Microinverters or ACMs

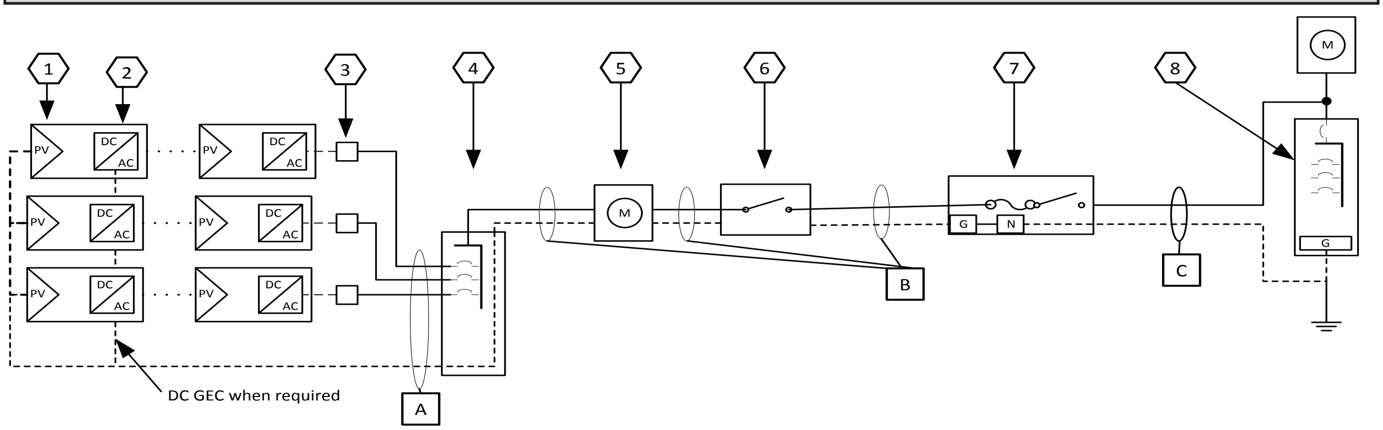
Check a box for DC system grounding: ❑ Isolated, ☒ **Non-Isolated**

For Isolated DC power systems, EGC & GEC are required.

For Non-Isolated DC power systems, EGC is required.

Refer to NEC 250.120 for EGC installation & Table 250.122 for sizing.

DC Rapid Disconnect (NEC690.12) not required for microinverter systems, as DC conductors are under 5 feet.



Conductor, Cable, and Conduit Schedule													
Tag	**Description and Conductor Type: (Table 3)**	**Conductor Size**			**Number of Conductors**			**Conductor/Cable Type**			**Conduit Size and Type**		
A	Current carrying conductors (for each branch circuit):	#10	#10	#10	2Hot 1N	2Hot 1N	2Hot 1N	THWN-2	THWN-2	THWN-2	½ inch EMT	½ inch EMT	½ inch EMT
	EGC:	#8AWG Cu											
	GEC (when required):	n/a											
B	Current carrying conductors:	#6AWG Cu			(2) plus (1) Neutral			THWN-2			¾ inch PVC		
	EGC:	#8AWG Cu											
	GEC (when required):	n/a											
C	Current carrying conductors:	#6AWG Cu			(2) plus (1) Neutral			THWN-2			¾ inch EMT		
	EGC:	#8AWG Cu			(1)								
	GEC (when required):	n/a											

5.4 Sample Wiring Diagram 2: String Inverter with Supply Side Connection

Equipment Schedule	
TAG	DESCRIPTION: (Provide manufacturer and model # if applicable)
1	Solar PV Module: (24) SolarWorld SW280 Mono, (2) strings of (12)
2	Grounding Electrode for Array
3	Junction Box(es): Soladeck NEMA 3R, on roof
4	Inverter Model: (1) Fronius Primo 6.0-1, Transformerless
5	Performance Meter Yes / No
6	*Utility External Disconnect, or AC disconnect grouped with inverter if not grouped with main service panel
7	Backfed AC breaker in Main Service Panel rating: 35 amps
8	Main Service Panel Main Breaker rating:200 amps; Bus Bar rating: 200 amps

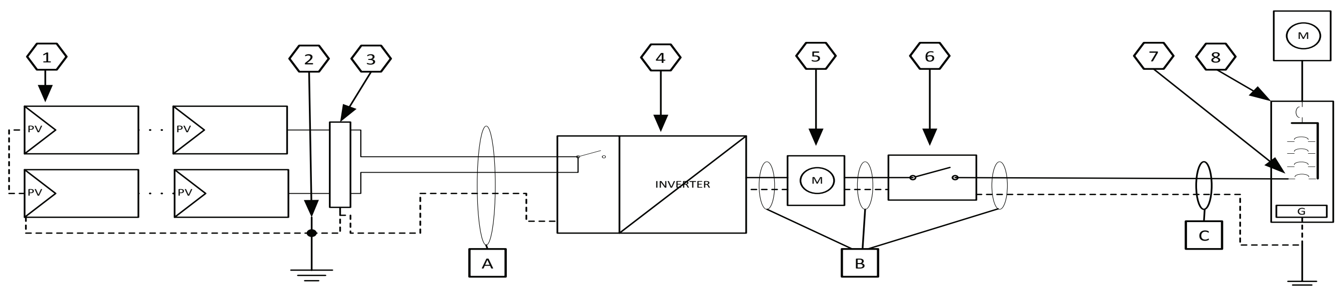
Single Line Diagram for String Inverter

Check a box for DC system grounding: ❑ Isolated, ☒ **Non-Isolated**

For Isolated DC power systems, EGC & GEC are required.

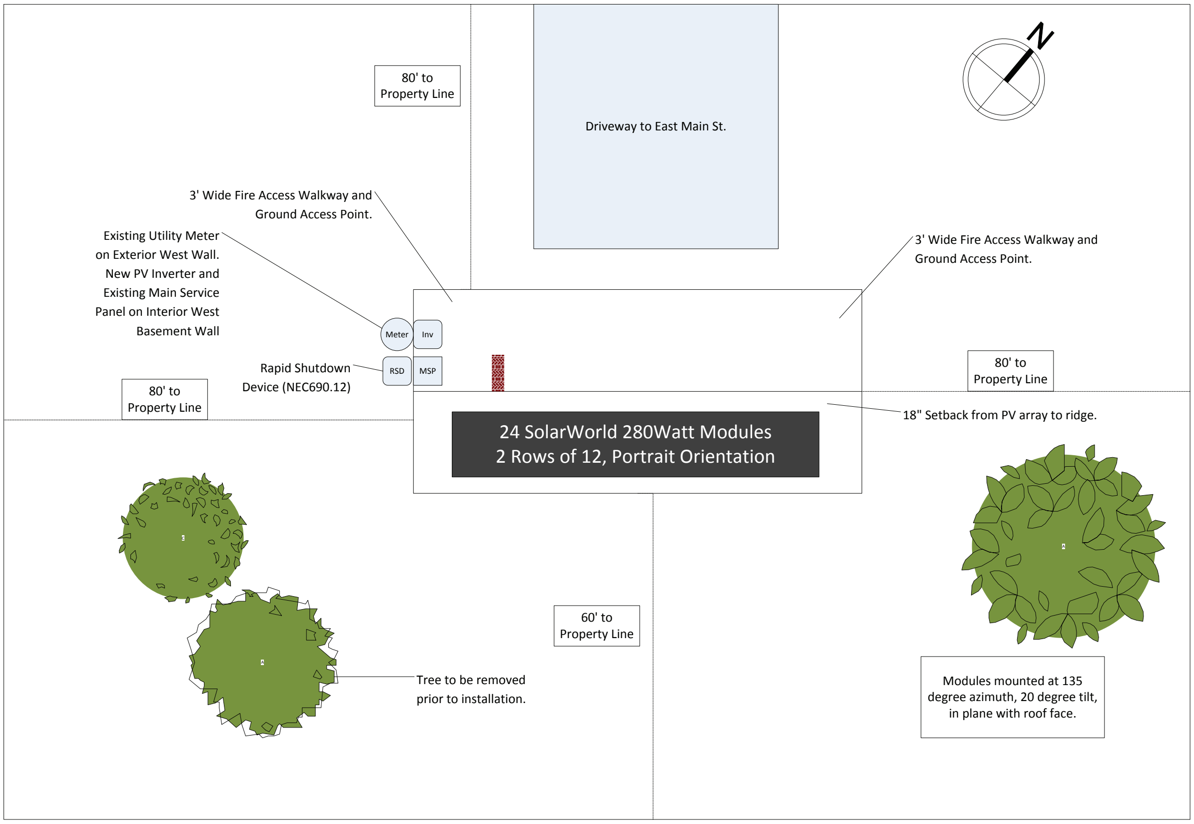
For Non-Isolated DC power systems, EGC is required.

Refer to NEC 250.120 for EGC installation & Table 250.122 for sizing.



Conductor, Cable, and Conduit Schedule					
Tag	**Description and Conductor Type:**	**Conductor Size**	**Number of Conductors**	**Conductor/Cable Type**	**Conduit Size and Type**
A	Current carrying conductors:	#10AWG Cu	2	THWN-2	½ inch EMT
	EGC:	#10AWG Cu	1		
	GEC (when required):	n/a			
B	Current carrying conductors:	#8AWG Cu	(2) plus (1) Neutral	THWN-2	¾ inch PVC
	EGC:	#10AWG Cu			
	GEC (when required):	n/a			
C	Current carrying conductors:	#8AWG Cu	(2) plus (1) Neutral	THWN-2	¾ inch EMT
	EGC:	#10AWG Cu	(1)		
	GEC (when required):	n/a			

5.5 Sample Site Map



Site Plan for
John Smith,
123 East Main St,
Albany NY 12208
Tax Map Parcel
#77-66-5555

ABC Solar Inc,
518-555-5123

PERMIT APPLICATION

NY State Unified Solar Permit

Unified solar permitting is available statewide for eligible solar photovoltaic (PV) installations. Municipal authorities that adopt the unified permit streamline their process while providing consistent and thorough review of solar PV permitting applications and installations. Upon approval of this application and supporting documentation, the authority having jurisdiction (AHJ) will issue a building and/or electrical permit for the solar PV installation described herein.

PROJECT ELIGIBILITY FOR UNIFIED PERMITTING PROCESS

By submitting this application, the applicant attests that the proposed project meets the established eligibility criteria for the unified permitting process (subject to verification by the AHJ). The proposed solar PV system installation:

☐ Yes ☐ No 1. Has a rated DC capacity of 25 kW or less.

☐ Yes ☐ No 2. Is not subject to review by an Architectural or Historical Review Board. (If review has already been issued answer YES and attach a copy)

☐ Yes ☐ No 3. Does not need a zoning variance or special use permit. (If variance or permit has already been issued answer YES and attach a copy)

☐ Yes ☐ No 4. Is mounted on a permitted roof structure, on a legal accessory structure, or ground mounted on the applicant's property. If on a legal accessory structure, a diagram showing existing electrical connection to structure is attached.

☐ Yes ☐ No 5. The Solar Installation Contractor complies with all licensing and other requirements of the jurisdiction and the State.

☐ Yes ☐ No 6. If the structure is a sloped roof, solar panels are mounted parallel to the roof surface.

For solar PV systems not meeting these eligibility criteria, the applicant is not eligible to participate in the expedited permitting process and additional approvals by the Building Saftey Division, Kingston Historic Landmarks Commision, Planning Board and/or Heritage Area Commision will be required.

SUBMITTAL INSTRUCTIONS

For projects meeting the eligibility criteria, this application and the following attachments will constitute the Unified Solar Permitting package.

- This application form, with all fields completed and bearing relevant signatures.
- For system sizes up to 5KW $50, from 5.1KW - 7.5KW $125, from 7.51KW - 10KW $250, and for any system size over 10KW $500 via credit card or check made payable to the Building Safety Division. Additional fees may be required additional agency reviews.
- Required Construction Documents for the solar PV system type being installed, including required attachments.

Completed permit applications can be submitted electronically to buildings@kingston-ny.gov or in person at 5 Garraghan Dr. Kingston NY 12401 during business hours.

APPLICATION REVIEW TIMELINE

Permit determinations will be issued within 14 calendar days upon receipt of complete and accurate applications. The municipality will provide feedback within 7 calendar days of receiving incomplete or inaccurate applications.

FOR FURTHER INFORMATION

City of Kingston Building Safety Division

Attn: Joe Safford - 5 Garraghan Dr. Kingston NY 12401\Phone: (845)331-1217 Fax (845)331-1224 | Email application and documents to buildings@kingston-ny.gov

PROPERTY OWNER

Property Owner's First Name | Last Name | Title

Property Address

City | State | Zip

Section | Block | Lot Number

EXISTING USE

☐ Single Family ☐ 2-4 Family ☐ Commercial ☐ Other

PROVIDE THE TOTAL SYSTEM CAPACITY RATING (SUM OF ALL PANELS)

Solar PV System: _________ kW DC

SELECT SYSTEM CONFIGURATION

Make sure your selection matches the Construction Documents included with this application.

- ☐ Supply side connection with microinverters
- ☐ Supply side connection with DC optimizers
- ☐ Supply side connection with string inverter
- ☐ Load side connection with DC optimizers
- ☐ Load side connection with microinverters
- ☐ Load side connection with string inverter

SOLAR INSTALLATION CONTRACTOR

Contractor Business Name

Contractor Business Address | City | State | Zip

Contractor Contact Name | Phone Number

Contractor License Number(s) | Contractor Email

Electrician Business Name

Electrician Business Address | City | State | Zip

Electrician Contact Name | Phone Number

Electrician License Number(s) | Electrician Email

Please sign below to affirm that all answers are correct and that you have met all the conditions and requirements to submit a unified solar permit.

Property Owner's Signature | Date

Solar Installation Company Representative Signature | Date

NY State Unified Solar Permit

This information bulletin is published to guide applicants through the unified solar PV permitting process for solar photovoltaic (PV) projects 25 kW in size or smaller. This bulletin provides information about submittal requirements for plan review, required fees, and inspections.

Note: Language in [ALL CAPS] below indicates where local jurisdictions need to provide information specific to the jurisdiction. Language in italics indicates explanatory notes from the authors of this document that may be deleted from the distributed version.

PERMITS AND APPROVALS REQUIRED

The following permits are required to install a solar PV system with a nameplate DC power output of 25 kW or less:

a) Unified Solar Permit

b) Kingston Historic Landmarks Commision review [IS/IS NOT] required for solar PV installations of this size in Historic Districs. Planning review [IS/IS NOT] required for solar PV installations of this size. Fire Department approval [IS/IS NOT] required for solar PV installations of this size.

SUBMITTAL REQUIREMENTS

In order to submit a complete permit application for a new solar PV system, the applicant must include:

a) Completed Standard Permit Application form which includes confirmed eligibility for the Unified Solar Permitting process. This permit application form can be downloaded at [WEBSITE ADDRESS].

b) Construction Documents, with listed attachments Understanding Solar PV Permitting and Inspecting in New York State can be found at http://www.nyserda.ny.gov/-/media/NYSun/files/Understanding-Solar-PV-Permitting-Inspecting.pdf. Construction Documents must be by stamped and signed by a New York State Registered Architect or New York State Licensed Professional Engineer.

The City of Kingston, through adopting the Unified Solar Permitting process, requires contractors to provide construction documents, such as the examples included in the Understanding Solar PV Permitting and Inspecting in New York State document. Should the applicant wish to submit Construction Documents in another format, ensure that the submittal includes the following information:

- Manufacturer/model number/quantity of solar PV modules and inverter(s).
- String configuration for solar PV array, clearly indicating the number of modules in series and strings in parallel (if applicable).
- Combiner boxes: Manufacturer, model number, NEMA rating.
- From array to the point of interconnection with existing (or new) electrical distribution equipment: identification of all raceways (conduit, boxes, fittings, etc.), conductors and cable assemblies, including size and type of raceways, conductors, and cable assemblies.
- Sizing and location of the EGC (equipment grounding conductor).
- Sizing and location of GEC (grounding electrode conductor, if applicable).
- Disconnecting means of both AC and DC including indication of voltage, ampere, and NEMA rating.
- Interconnection type/location (supply side or load side connection)
- For supply side connections only, indication that breaker or disconnect meets or exceeds available utility fault current rating kAIC (amps interrupting capacity in thousands).
- Ratings of service entrance conductors (size insulation type AL or CU), proposed service disconnect, and overcurrent protection device for new supply side connected solar PV system (reference NEC 230.82, 230.70).
- Rapid shutdown device location/method and relevant labeling.

c) (For Roof Mounted Systems) A roof plan showing roof layout, solar PV panels and the following fire safety items: approximate location of roof access point, location of code-compliant access pathways, code exemptions,
solar PV system fire classification, and the locations of all required labels and markings.

d) Provide construction drawings with the following information:

- The type of roof covering and the number of roof coverings installed.
- Type of roof framing, size of members, and spacing.
- Weight of panels, support locations, and method of attachment.
- Framing plan and details for any work necessary to strengthen the existing roof structure.
- Site-specific structural calculations.

e) Where an approved racking system is used, provide documentation showing manufacturer of the racking system, maximum allowable weight the system can support, attachment method to roof or ground, and product evaluation information or structural design for the rack.

PLAN REVIEW

Permit applications can be submitted to City of Kingston Building and Safety Division in person at 5 Garraghan Dr. and electronically through: buildings@kingston-ny.gov.

FEES

For system sizes up to 5KW $50, from 5.1KW - 7.5KW $125, from 7.51KW - 10KW $250, and for any system size over 10KW $500 via credit card or check made payable to the Building Safety Division. Additional fees may be required additional agency reviews.

INSPECTIONS

Once all permits to construct the solar PV installation have been issued and the system has been installed, it must be inspected before final approval is granted for the solar PV system. On-site inspections can be scheduled by contacting Building Safety Division by telephone at (845)331-1217 or electronically at buildings@kingston-ny.gov. Inspection requests received within business hours are typically scheduled for the next business day. If next business day is not available, inspection should happen within a five-day window. Third party inspections are availible. For the list of approved inspectors, please contacts Building and Safety Division at (845)331-1217

In order to receive final approval, the following inspections are required:

[ROUGH INSPECTION, IF REQUIRED] During a rough inspection, the applicant must demonstrate that the work in progress complies with relevant codes and standards. The purpose of the rough inspection is to allow the inspector to view aspects of the system that may be concealed once the system is complete, such as:

- Wiring concealed by new construction.
- Portions of the system that are contained in trenches or foundations that will be buried upon completion of the system.

It is the responsibility of the applicant to notify Building Safety Division by telephone at (845)331-1217 or electronically at buildings@kingston-ny.gov before the components are buried or concealed and to provide safe access (including necessary climbing and fall arrest equipment) to the inspector. The inspector will attempt, if possible, to accommodate requests for rough inspections in a timely manner.

[FINAL INSPECTION] The applicant must contact Building Safety Division when ready for a final inspection. During this inspection, the inspector will review the complete installation to ensure compliance with codes and standards, as well as confirming that the installation matches the records included with the permit application. The applicant must have ready, at the time of inspection, the following materials and make them available to the inspector:

- Copies of as-built drawings and equipment specifications, if different than the materials provided with the application.
- Photographs of key hard to access equipment, including;
  - Example of array attachment point and flashing/sealing methods used.
  - Opened rooftop enclosures, combiners, and junction boxes.
  - Bonding point with premises grounding electrode system.
  - Supply side connection tap method/device.
  - Module and microinverter/DC optimizer nameplates.
  - Microinverter/DC optimizer attachment.

The City of Kingston has adopted a standardized inspection checklist, which can be found in the Understanding Solar PV Permitting and Inspecting in New York State document, found here: http://www.nyserda.ny.gov/-/media/NYSun/files/Understanding-Solar-PV-Permitting-Inspecting.pdf..
The inspection checklist provides an overview of common points of inspection that the applicant should be prepared to show compliance. If not available, common checks include the following:

- Number of solar PV modules and model number match plans and specification sheets number match plans and specification sheets.
- Array conductors and components are installed in a neat and workman-like manner.
- Solar PV array is properly grounded.
- Electrical boxes and connections are suitable for environment.
- Array is fastened and sealed according to attachment detail.
- Conductor's ratings and sizes match plans.
- Appropriate signs are property constructed, installed and displayed, including the following:
  - Sign identifying PV power source system attributes at DC disconnect.
  - Sign identifying AC point of connection.
  - Rapid shutdown device meets applicable requirements of NEC 690.12.
- Equipment ratings are consistent with application and installed signs on the installation, including the following:
  - Inverter has a rating as high as max voltage on PV power source sign.
  - DC-side overcurrent circuit protection devices (OCPDs) are DC rated at least as high as max voltage on sign.
  - Inverter is rated for the site AC voltage supplied and shown on the AC point of connection sign.
  - OCPD connected to the AC output of the inverter is rated at least 125% of maximum current on sign and is no larger than the maximum OCPD on the inverter listing label.
  - Sum of the main OCPD and the inverter OCPD is rated for not more than 120% of the buss bar rating.

UNIFIED SOLAR PERMITTING RESOURCES

The jurisdiction has adopted the following documents from the New York Unified Solar Permit process:

Delete any documents not adopted by the jurisdiction.

- Standard Application [WEB ADDRESS]
- Understanding Solar PV Permitting and Inspecting in New York State document, which includes sample construction documents, inspection checklist, design review checklist, and labelling guide [WEB ADDRESS]

DEPARTMENTAL CONTACT INFORMATION

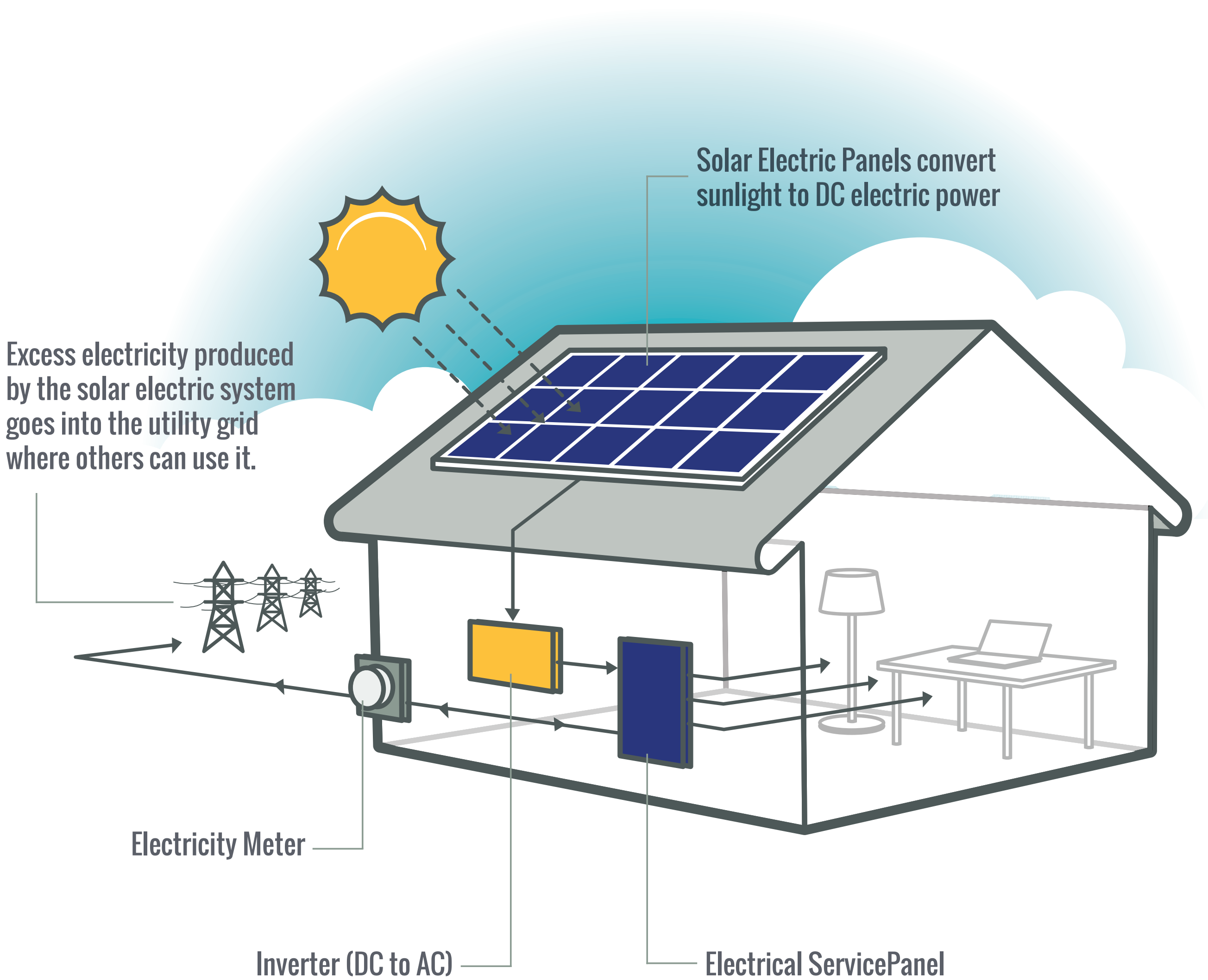
For additional information regarding this permit process, please consult our departmental website at http://kingston-ny.gov or contact Building Safety Division by telephone at (845)331-1217.

Appendix B. Solar Basics

B.1 What is a solar PV system?

Solar electric systems convert the energy in sunlight into electrical current, which can power electric loads, be fed back to the electric grid, or be stored in batteries. All solar electric systems consist of the same basic components, but vary widely in terms of size and complexity. This tool focuses on utility grid-tied residential solar PV systems under 25 kW in size. Solar electric systems should not be confused with solar thermal systems, which are a separate technology that captures the sun's thermal energy to heat water and air.

When sunlight strikes a solar electric array, electrons in the array are agitated into motion, creating direct current (DC). The electrical current flows along conductors from the array to an inverter. The inverter transforms the DC into alternating current (AC), which powers most common electrical appliances. The AC flows through conductors to the site's electric service panel, and then to individual branch circuits and loads. If the solar PV system is grid-tied (connected to the electric grid) and produces more electricity than is used at the site, the excess current is pushed back into the utility grid. This basic description of a solar electric system applies to most installations.



Most of New York's solar PV installations are residential, utility grid-tied, and do not include battery storage. They are typically roof-mounted and range from 4 to 10 kW. New York State's Standardized Interconnection Requirements (SIR; **www3.dps.ny.gov/W/PSCWeb.nsf/All/DCF68EFCA391AD6085257687006F396B**) allow residential solar PV systems up to 25 kW.

B.2 System Components

B.2.1 Modules

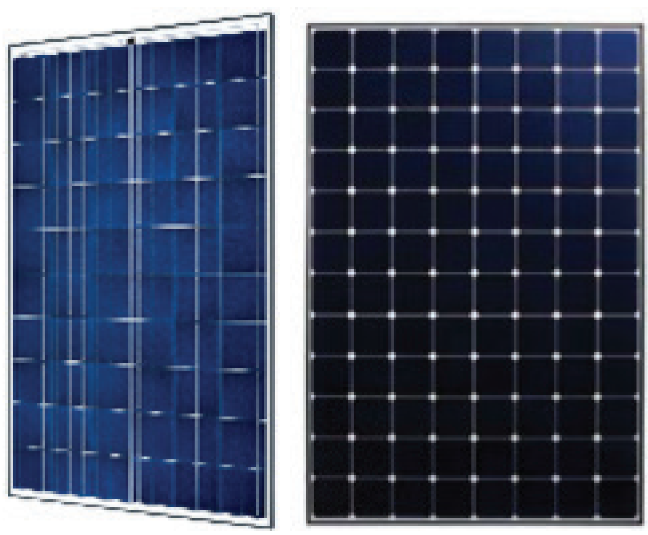
A solar PV module or "solar panel" is an electrical generation device that produces DC current when exposed to sunlight. Most modules consist of 60-72 small, conjoined solar cells, an aluminum frame, and a tempered glass front piece. Modules are roughly three feet by five feet and are mounted in either a portrait (a vertical rectangle) or landscape orientation (a horizontal rectangle). In monocrystalline modules, individual cells are made from single pieces of silicon. Polycrystalline modules feature cells made from multiple pieces of silicon.

Installers wire together multiple modules to combine their voltage. Multiple strings of modules can be combined to add their current (amperage).

The size of solar PV systems is typically given in rated DC capacity at standard test conditions (STC). For example, a system with 10 modules rated at 300 Watts each is a 3,000 Watt (3 kilowatt) system. Most solar PV modules come with a manufacturer's production warranty of 25 years and are expected to have a useful life of approximately 30 years.

A SolarWorld Polycrystalline module (left) and a SunPower Monocrystalline module (right)

Source: SolarWorld and SunPower



B.2.2 Inverter

All utility grid-tied solar PV systems have at least one inverter, which converts DC to AC. Most residential solar PV systems have one or two string inverters, which are connected to one or more strings of modules. Inverters are generally mounted vertically on basement, garage, or exterior walls, and can be located indoors or outdoors.

Microinverters are a special type of inverter that are mounted on the underside of individual solar PV modules. Unlike string inverters, each microinverter services only 1-2 modules, which permits greater flexibility in system design.

Most solar PV professionals describe system size in terms of module capacity (kilowatts DC), whereas most electric utilities refer to system size by inverter capacity (kilowatts AC).

A Fronius String Inverter (left) and an Enphase Microinverter (right)

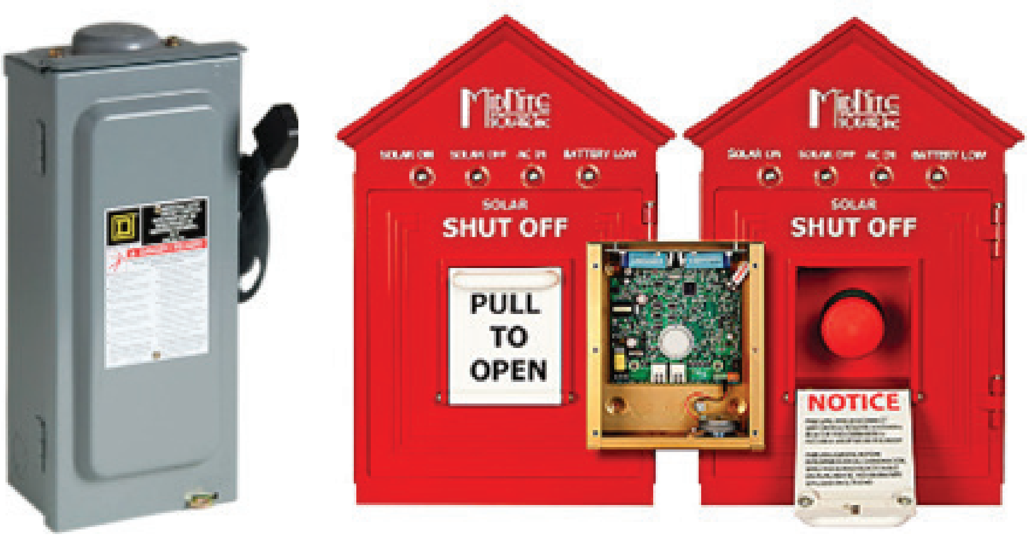
Source: Fronius and Enphase

B.2.3 Balance of System Components

"Balance of system" (BOS) generally refers to all equipment in a solar PV installation except the modules and inverter. (Occasionally, inverters are included in the term.) BOS components include racking, conductors, conduit, disconnects, fuses, mounting hardware, combiner boxes, and occasionally batteries.

BOS Components: A Square D Fusible AC Disconnect (left) and a MidNite Solar Rapid Shutdown Device (right)

Source: Square D and MidNite Solar



B.2.4 Racking

Most solar PV arrays are mounted to roofs using specially-designed aluminum racking systems. Typically, L-shaped brackets are connected to the roofing members of a house with lag bolts. Long aluminum rails are bolted onto the L-feet, and individual modules are attached to the rails with clamps. All roof penetrations must be flashed to prevent leaks and roof damage[5], and the system designer must ensure that the roof is structurally strong enough for the additional load of a PV system. Any necessary replacement or repair work on a roof must be done prior to the installation of the solar PV system.

A Solar Electric Racking System (left) and Detail of an L-Foot with a SnapNrack Flashing (right)

System designers may choose to use a ballast mounting system on flat roofs. Instead of using lag bolts to anchor the racking to the building's structural members, heavy concrete blocks weigh down the array. Ballasted systems are less likely to create leaks in the roof membrane, but add substantial weight and may be too heavy for some roofs.

Solar electric arrays are also commonly ground-mounted. Arrays can be mounted on racking directly on the ground, or atop a metal pole. As with roof mounts, metallic racking must be bonded (made electrically continuous to provide a path for fault currents). When designing a ground-mounted system, the designer must account for soil conditions. Voltage drop is a concern for ground mounted systems, which often have long conductor runs.

Ground-mounted solar PV arrays sometimes include tracking equipment, which rotates the array throughout the day to follow the sun's trajectory. Tracking may occur along one or two axes. The additional energy produced by these systems must be weighed against their additional cost, complexity, and maintenance.

B.2.5 Conductors

Conductors (wire) coming from the modules are typically factory-assembled "PV Wire" with a factory-formed termination (see NEC 690.31). These factory leads are labeled "PV Wire" or "Type USE-2" and are rated to withstand all weather conditions. They are then spliced with standard building wire, using appropriate connectors and enclosures. The standard building wire is installed in raceway (conduit) to its next point of connection. Under certain conditions, conductors may be direct burial or part of a cable assembly. NEC 690.32 and NEC 310 provide guidance on allowable conductor types and methods.

The maximum allowable voltage for residential solar PV systems is 600 volts DC, but nonresidential systems may run up to 1,000 volts DC (NEC690.7(C)). Conductors must be protected from accidental contact. When exposed, they must be installed in raceway (such as conduit), or otherwise rendered inaccessible. For example, the exposed conductors on the back side of a ground-mounted array must be guarded, or located at least eight feet above ground.

[5] Section 1503.2 of the International Building Code, Section 903.2 of the International Residential Code.

B.2.6 Raceway (Conduit)

Raceway includes conduit, boxes, fittings, and enclosures that provide a pathway and protection for individual conductors. All raceway systems must be suitable for the environment in which they are installed. All metal raceways must be bonded to form part of the equipment grounding conductor.

All DC conductors that enter a structure must be installed in a metal raceway NEC 690.31(G) or MC cable that meets NEC 250.118(10). Flexible and nonmetallic conduits may be permitted under certain conditions. In addition to NEC 690, refer to Chapter 3 of the NEC for types of permitted conduits and uses.

B.2.7 Battery Backup

Most residential solar PV systems are utility grid-tied, but do not include a battery backup system. In the event of a blackout or grid failure, such solar PV systems de-energize and do not function until grid power is restored, as required by NYS' Standardized Interconnection Requirements (SIR; **www3.dps.ny.gov/W/PSCWeb.nsf/All/DCF68EFCA391AD6085257687006F396B**).

Off-grid ("stand-alone") solar PV systems are not connected to the grid. Solar PV output is stored in a battery bank, which provides power to the site's electric loads. In addition to a battery bank, these systems include one or more charge controllers, which determine the amount and rate of power that can be stored and drawn from the battery bank.

Battery-backup solar PV systems are utility grid-tied and include a battery system that is used in the event of grid failure. Due to the high cost and additional complexity, battery backup on solar PV systems is currently rare. Section 690.71 of the NEC contains additional requirements for solar PV systems with batteries.

B.3 Net Metering

Solar electric systems are a distributed generation (DG) technology that currently qualifies for net metering in New York State. Any power produced by a solar PV system that isn't consumed on-site is pushed into the utility grid. The solar PV system owner receives a credit for this production on their monthly utility bill. Utilities typically install a meter at solar PV sites, which tracks the amount of electricity taken from and fed into the grid. The site owner is billed for only the net electricity consumed. Nonresidential solar PV systems can credit their production to off-site electric accounts through remote net metering, but this type of arrangement is outside the scope of this document.

B.4 Financial Considerations

Most homeowners view the installation of a solar PV system as a financial investment. Over time, the power it produces generates savings on their electric bills.

B.4.1 Incentives

Although the costs of residential solar PV systems have fallen significantly in recent years, they still typically cost tens of thousands of dollars. The project cost includes the modules, inverters, balance of system components, and "soft costs," such as installation and administrative labor, customer acquisition, and engineering.

Several incentives make projects more affordable for homeowners. NYSERDA's NY-Sun Incentive Program administers a step-down megawatt block incentive program.[6] New York State offers a 25% residential income tax credit,[7] and in December 2015 the U.S. Congress extended a 30% federal income tax credit.[8] Other incentives may exist at the local level, including real property tax exemptions, and a real property tax abatement program in New York City. Unlike most residential home improvements, most solar PV installations in New York State do not increase the taxable value of a home.[9] However, local governments can opt out of this exemption. One excellent resource to navigate incentives is **www.dsireusa.org**. Customers should consult a tax advisor to determine their eligibility for tax credits.

[6] http://www.nyserda.ny.gov/All-Programs/Programs/NY-Sun
[7] https://www.tax.ny.gov/pit/credits/solar_energy_system_equipment_credit.htm
[8] https://www.energystar.gov/about/federal_tax_credits
[9] https://www.tax.ny.gov/research/property/assess/manuals/vol4/pt1/sec4_01/sec487.htm

B.4.2 Purchase Types

Many homeowners choose to buy a solar PV system with cash, or by taking out a loan. As the system owners, they can apply for all applicable tax credits. Installation companies typically offer a 5 to 10-year warranty, and some manufacturers offer extended warranties. An increasing variety of loans are available to help customers finance the purchase of solar PV systems.

Leasing a solar PV system is another common option. With this model, a third-party company (often the installation contractor) is responsible for installing, operating and maintaining a solar PV system at the customer's site. Customers sign long-term leases (typically 20 years) and make monthly payments to the company that owns the solar PV system. In return, customers receive all electricity produced by the system. At the end of the lease term, the homeowner typically has the option of renewing the lease, purchasing the equipment at fair market value, or having the system owner remove the equipment. The company that owns the solar PV system receives most of the tax benefits.

A third option is a power purchase agreement (PPA). It is similar to a lease, but instead of paying a flat monthly fee, customers pay for the amount of electricity actually produced by the solar PV system.

B.5 Solar Terms

Alternating current: AC describes one type of electric charge flow. The AC stream of charges periodically reverses itself, whereas direct current (DC) describes a stream of electrons that moves in one direction only. AC is the standard electric current for power grids worldwide. Solar electric cells capture particles of light and convert them into DC electricity. An inverter translates DC into AC for consumers to use in their homes and businesses.

Ampere: Abbreviated as amp, this unit is used to measure electric current.

Balance-of-system: BOS costs refer to the costs of all aspects of a solar PV installation, except the cost of the modules and inverters. BOS costs include all wiring and miscellaneous materials, along with soft costs, such as time and administrative costs associated with selling and signing a contract, system design and permitting, installation labor costs, inspections, travel to and from the installation site, and other costs of doing business. These costs account for as much as 50 percent of the total solar PV system installation. New York State has focused on reducing BOS costs to reach its goal of producing 3 gigawatts of solar energy by 2023.

Direct current: DC describes the direct, constant flow of electricity. Unlike AC, DC does not periodically reverse direction. A solar PV system comes equipped with an inverter that converts DC into AC, the standard electric current for power grids in the United States.

Energy payback: Gauges how long it will take to recover the energy originally required to manufacture a solar PV system. Because most solar PV systems last 20 – 25 years, there is a pronounced net environmental benefit over the system's life span. The U.S. Department of Energy estimates an energy payback of 1-4 years for rooftop solar PV systems. The original energy used is often referred to as embedded energy.

Feed-in tariff: FITs are long-term generation contracts that have favorable terms designed to encourage the production of renewable energy by individuals and businesses. FITs are typically offered for long periods of time, such as 10, 15, or 20 years.

Inverter: A key component of any solar PV system that converts direct current (DC) electricity into alternating current (AC) electricity, which is the standard current in the United States.

Kilowatt: kW is a unit of measure that equals 1,000 Watts and is the main mechanism for measuring the size or capacity of a solar PV system. The Watt is named after Scottish inventor and mechanical engineer James Watt (1736 – 1819).

Kilowatt-hour: 1 kWh is equivalent to the electricity generated or consumed at a rate of 1,000 Watts over the period of one hour.

Net metering: A common feature of grid-connected solar PV systems whereby excess electricity produced by a solar array is fed back into the utility grid. System owners can earn credits on future energy bills for the excess electricity their systems generate. The credits can then be used later when homeowners need power from the local utility, such as at night or on cloudy days.

Power purchase agreement: PPAs are becoming a popular way for homeowners to take advantage of solar power without the financial responsibility associated with installation costs. Under the agreement, a third party installs the solar PV system and the homeowner agrees to buy the electricity (kWh) it generates, typically at a rate lower than what the utility offers.

Photovoltaic: PV technology converts solar energy into direct current electricity. The technology uses semiconducting materials that exhibit the photovoltaic effect, a naturally occurring phenomenon in which photons of light emitted from the sun knock electrons off their valence shell into a higher state of energy, creating electricity. A solar PV system uses solar panels, which are composed of a number of solar (PV) cells, to convert sunlight directly into electricity.

Photovoltaic cells: PV cells are thin layers of semiconducting material that are usually made of silicon. When the silicon is exposed to light, an electrical charge is generated. Solar (PV) cells form the basis of a solar PV panel, which together make up a solar PV system.

Remote net metering: A variation on net metering whereby a solar PV system's production is credited to an electricity consumer(s) located at a different physical site.

Solar photovoltaic (PV) systems: A technology that converts sunlight directly into electricity. A PV system is made up of solar modules (panels), which are made up of solar cells.

Solar thermal systems: A technology that uses sunlight to heat water or air. In contrast to a solar PV system, a solar thermal system uses mirrors to concentrate sunlight to produce heat.

Appendix C. Sample Photos

NYSERDA requires contractors participating in the NY-Sun program to provide construction photos. The photos in this chapter are illustrative examples only. Not all photos will apply to a given installation. Code enforcement officers may require construction photos from solar PV contractors to supplement or replace an in-person inspection. These example photos also help give a sense of solar PV system components and installation methods, and how they look when installed correctly.

REQUIRED CONSTRUCTION PHOTOS
NY-Sun Incentive Program

NEW YORK STATE OF OPPORTUNITY | NY-Sun

OVERVIEW PHOTOS:

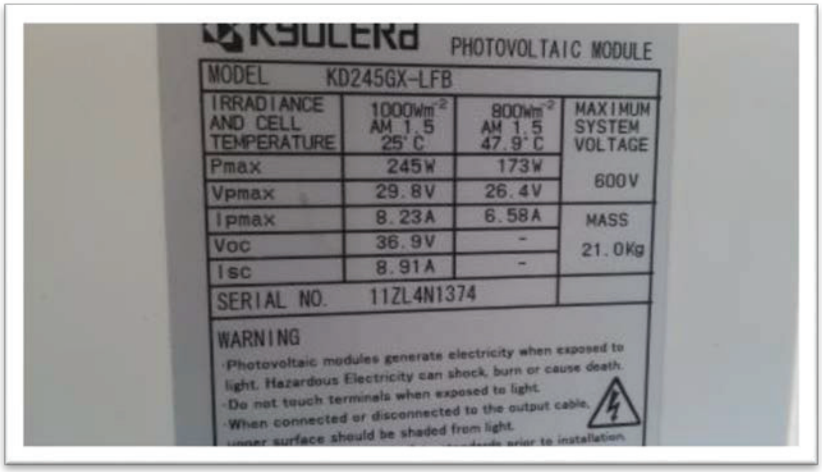
1. **Home Address Verification** – Must show street number and be taken from a street view.

2. **South Facing Horizon** – View of horizon facing South, taken from the array.

GENERAL ARRAY PHOTOS:

3. **Pull Back Image of Array** – Pull back photo of each array in system so that panel count can be verified. If more than one array comprises the system, please provide pull back photo of each array.

4. **Module Label Documentation** – Close up of module label, including make, model, serial number and Wattage. If multiple module models are used, please include a photo of each model used. If more than one array comprises the system, provide a label image of each array.



ARRAY RACKING PHOTOS:

5. **Module Racking System Documentation** – Photo demonstrating racking system used. If multiple arrays comprise the system, please provide a photo showing racking system of each array.

6. **Racking Roof Mounting System Documentation** – Photo demonstrating how racking system is mounted to the roof plane. If multiple arrays comprise the system, please provide a photo showing racking system mounting and anchors of each array.

7. **Racking End Clip Documentation** – Photo demonstrating that racking system includes end clips.

8. **Racking System Grounding** – Photo demonstrating the rail-grounding mechanism bonding rails north/south as well as across rail split.

MODULE INSTALLATION PHOTOS:

9. **Module Grounding** – Photo demonstrating the module grounding method.

10. **Wire Management of Modules** – Photo demonstrating the wire management of the modules.

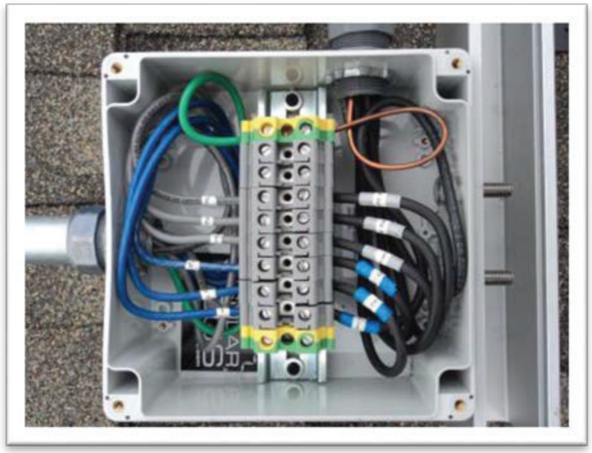
CONDUCTOR AND CONDUIT PHOTOS:

11. **Conductor Support and Management** – Photo demonstrating the wire management of the modules.

12. **Conduit Roof Top Penetrations** – Photo demonstrating the penetrations of any conduit supports.

JUNCTION/ COMBINER BOX PHOTOS:

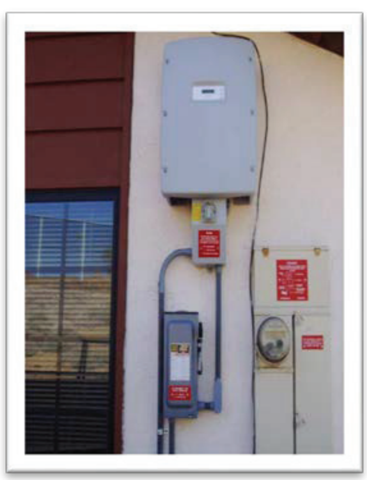
13. **Junction/ Combiner Box** –Junction/combiner box with the lid opened showing grounding and all conductors entering/exiting the box, and demonstrating strain relief



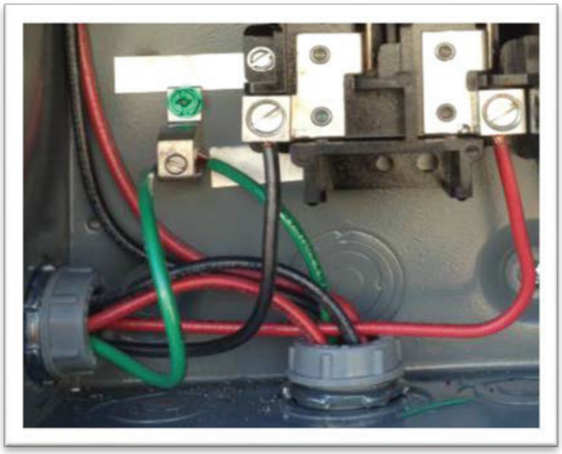
14. **Junction/ Combiner Box Mounting Method and Label** Overview photo showing exterior of box and method of support/ attachment and required labeling.

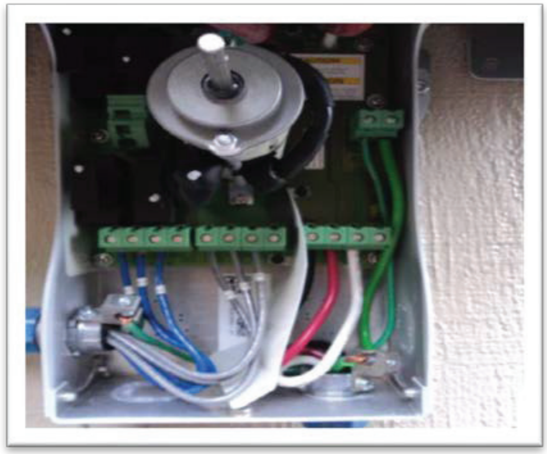
INVERTER PHOTOS:

15. **Inverter Outside View with lid on** –Photo demonstrating inverter box and labeling



16. **Inverter Internal Photo** – Inverter with cover off showing wiring and grounding



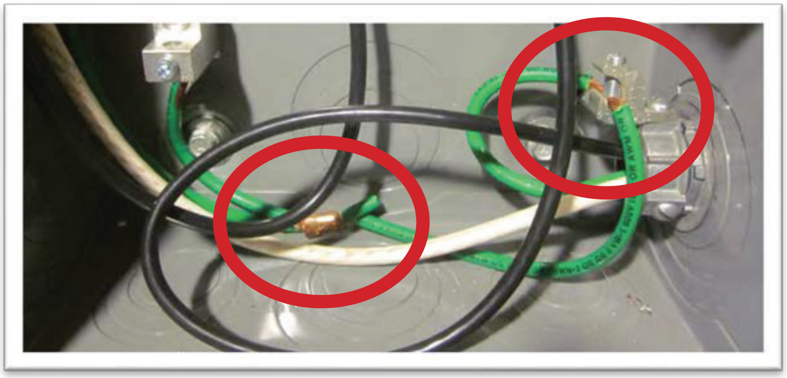


17. **Inverter Label Picture** –Close up photo clearly showing Inverter label with lettering legible.

BALANCE OF SYSTEM PHOTOS:

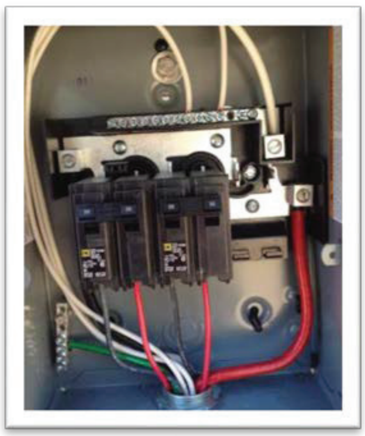
18. **Balance of System Wall Photos** – A pull-back photo showing the entire balance-of-systems equipment wall (may need multiple photos).

19. **GEC Path Photos** – Sequence of photos showing the path of the GEC from the inverter to the structure's grounding electrode, including any irreversible splices or taps (required for grounded inverters only).



A/C COMBINER PHOTOS:

20. **A/C Combiner Cover Removed** – A photo of the AC combiner with cover removed, showing interior of load center or panel, all breakers, and label and bus rating.



A/C DISCONNECT PHOTOS:

21. **A/C Disconnect Interior Photo** – Clear photo of interior of A/C Disconnect showing all wiring, grounding and overcurrent protection inside the AC disconnect.

22. **Exterior of A/C disconnect** – Exterior of the AC disconnect, showing manufacturer's label and NEMA rating as well as required safety labeling.

23. **Main Breaker Label Photo** – A close up photos showing labels of service panel.

MAIN PANEL TIE-IN PHOTOS:

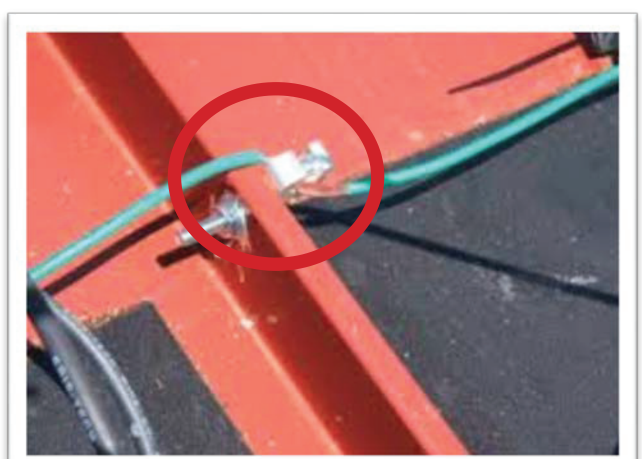
24. **Buss bar label** – A photo showing buss bar label.

25. **Interior of Main Service Panel** – Photo of main service panel with the front removed, showing any taps.

IF APPLICABLE PHOTOS:

26. **Ground Mounted Systems photo** – Photo of array, taken from behind, showing mounting and conductor protection.

27. **Metal roof Grounding** – Close up photo of grounding method used of metal roof.



28. **Battery Back-Up Photos** - Photo showing battery back-up system and racking.

Appendix D Sample Installation Errors

The following photos are examples of common yet serious installation errors. Each item presents a safety concern, a system performance issue, or both. For each of these installations, a certificate of completion had been issued by the AHJ.

Photo D1: Main service panel overloaded per NEC 705(D)(2)(3)(b). (100 amp main circuit breaker + 40 amps of PV) ÷ 100 amp bus rating >120%.

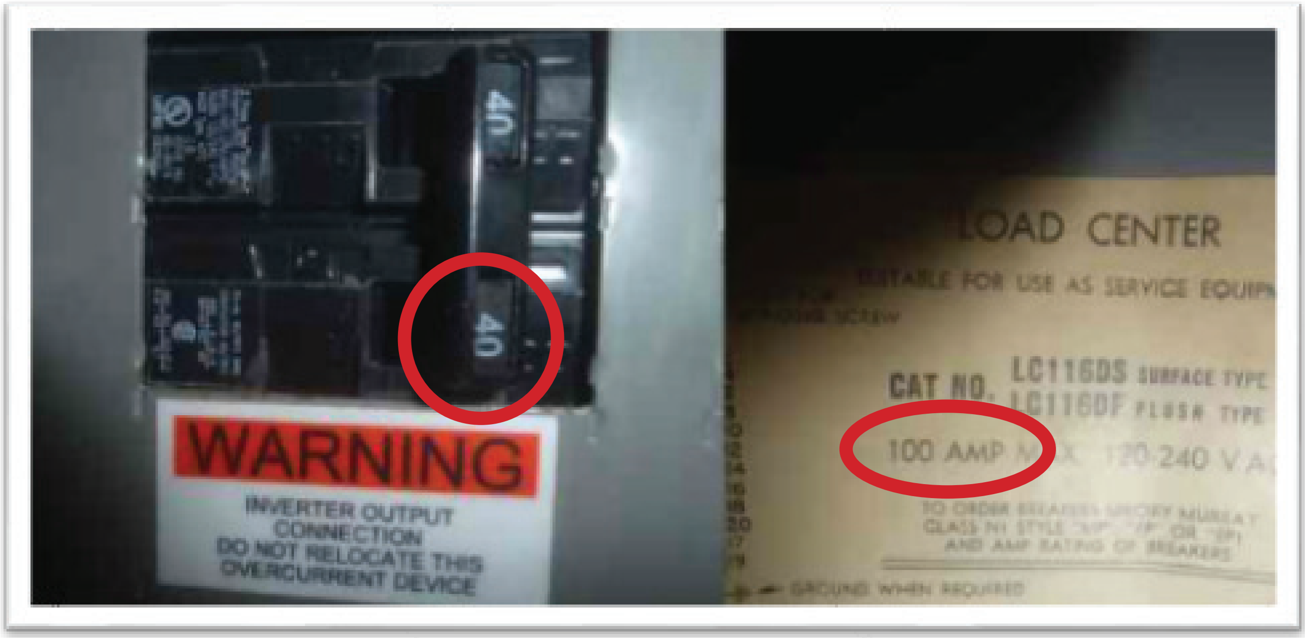


Photo D2: Backfed PV breaker not installed at opposite end of buss bar from main breaker: 2014 NEC690.12(D)(2)(3)(b)

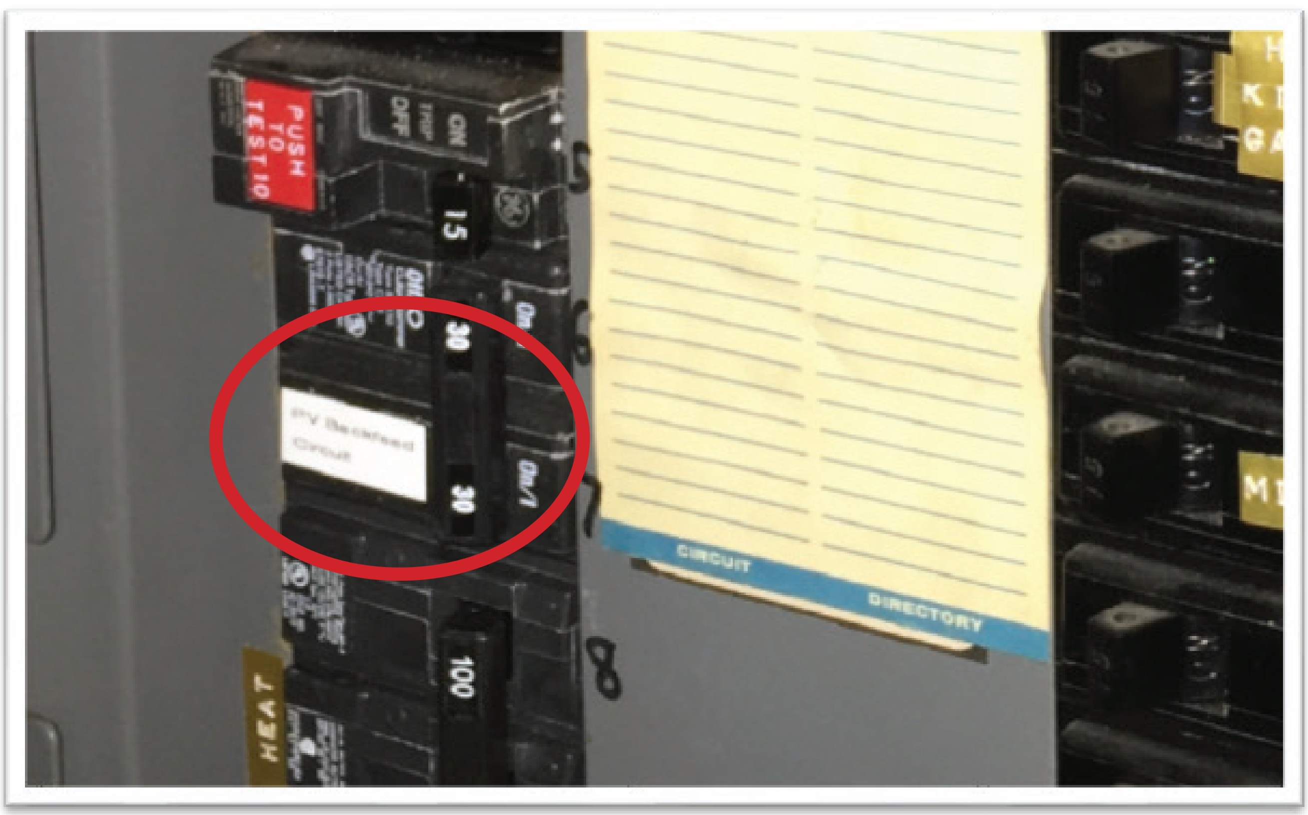


Photo D3: Working clearance not maintained: NEC 110.26

Photo D4: Equipment visibly damaged

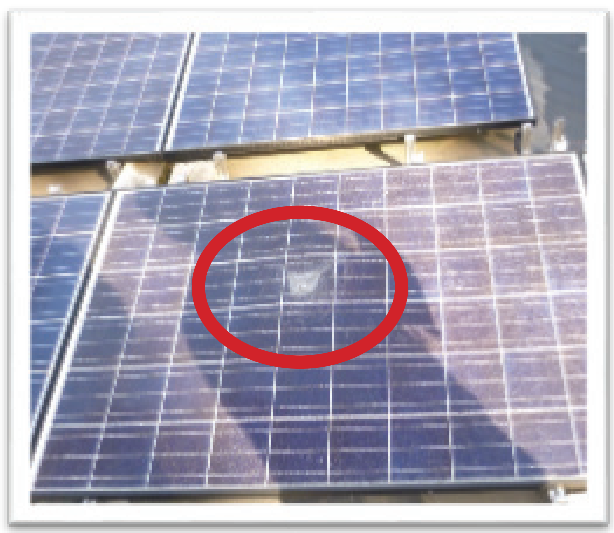


Photo D5 - Conductors over 30V not guarded, installed in raceway, or otherwise inaccessible: NEC 690.31(A)

Photo D6: Roof penetrations and anchors not flashed: International Building Code 1503.2, International Residential Code 903.2.

Photo D7: Where not protected from physical damage, equipment grounding conductor must be #6 or larger: NEC 690.46, 250.120(C). Conductors laying on asphalt shingles will become damaged and will not last a PV system's expected 30-year lifespan.

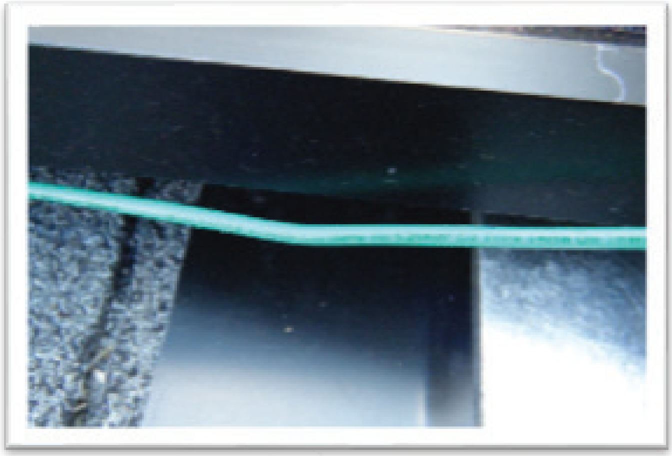


Photo D8: Source circuit conductors in contact with roof: NEC 338.10

Photo D9: Equipment is not rated for location. In this case, a non-GFCI outlet for PV monitoring equipment is located in a wet location: NEC 110.3(B), 210.8(A)(3)

Appendix E. Solar PV System Labeling Guidelines

Technical Bulletin: NYSERDA Solar Photovoltaic System Labeling Guidelines

Scope and Purpose

This document was prepared as part of NYSERDA's ongoing quality assurance (QA) for the NY-Sun Solar Photovoltaic (PV) program.

As part of this QA program, the Cadmus Group has performed approximately 3,000 inspections on solar PV systems installed in New York State since January 1, 2012. Many of these inspections have found issues related to incorrect, incomplete, or missing labels on installed equipment. The National Electrical Code® (NEC), OSHA and ANSI provide guidelines for required labels. However, these guidelines are not necessarily organized in an easy to use manner and make it difficult for system installers to get a clear picture of what is required labeling for solar PV systems.

The purpose of this document is to provide participating installers and other stakeholders with a summary of the required labels for the most common PV system configurations. While specific installations may have different labeling requirements, the labels included in this bulletin represent those required for solar PV systems under NYSERDA's QA program.

Unless otherwise noted, this bulletin is based on the 2014 edition of the National Electrical Code (NEC). The interpretations in this document are used by inspectors in the NY-Sun QA program.

Document Organization

This bulletin includes the following sections:

I. Label Construction, Placement, Color, and Marking

II. Label Descriptions and NEC References

- Arc-Flash Hazard Warning: NEC 110.16
- Directory/Identification of Power Sources: NEC 705.10, 225.37, 230.2(E), and 705.70
- Conductor Identification & Grouping: NEC 690.31(B), 200.6, 250.119, 310.110, and 690.31(B)
- Ground Fault Indication: NEC 690.5(C)
- Identification of PV Disconnects: NEC 690.13(B)
- Terminals Energized on Line & Load Sides of Disconnect in Open Position: NEC 690.17(E)
- Fuse servicing warning label: NEC 690.16(B)
- DC PV Source & Output Circuits Inside a Building: NEC 690.31(G) (3) & (4)
- Bipolar PV Systems: NEC 690.7(E)(3)
- Ungrounded (non-isolated) PV Systems: NEC 690.35(F)
- DC Photovoltaic Power Source: 690.53
- Identification of PV System Interconnection: NEC 690.54
- Batteries and Energy Storage Systems: NEC 690.5(C) 690.55, 690.71(H)5, 705.80
- Identification of Power Sources: NEC 690.56(B)
- Facilities with Rapid Shutdown: NEC 690.56(C)
- Point of Connection Identification: NEC 705.12(D) (2) (3) (b) & (c)
- Identification and warning of additional power source at the panel board: 690.12(D) (3)
- Identification of backfed breaker(s) NEC 408.4

Overview of Label Locations and Requirements

System Component	Required Labels	Notes
AC Combiner	PV Disconnect (NEC 690.13)	
	AC Characteristics (NEC 690.54)	
	Multiple Sources Present (NEC 705.12(D)(2)(3)(c)	
	Inverter Output Location (NEC 705.12(D)(2)(3)(b))	
	Circuits Identified (NEC 408.4)	
AC Disconnect	PV Disconnect (NEC 690.13)	
	AC Characteristics (NEC 690.54)	
Array	Connector Disconnect Warning (NEC 690.33(E))	
Battery Backup	Battery Characteristics (NEC 690.55 and 705.80) Battery disconnects (NEC 690.71(H)) Ground Fault warning (NEC 690.5(C))	Also note NYSFC 608.7.1 and 608.7.2 for additional fire code related requirements
DC Combiner	PV Disconnect (NEC 690.13)	
	Fuse Servicing Disconnect Directory (NEC 690.16(B))	Labels required for disconnects more than 6ft from fuses and/or not load-break rated
	DC characteristics (NEC 690.53)	
	Energized/ungrounded conductors (NEC 690.35(F))	
DC Disconnect	PV Disconnect (NEC 690.13)	
	Fuse Servicing Disconnect Directory (NEC 690.16(B))	Labels required for disconnects more than 6ft from fuses and/or not load-break rated
	Shock hazard (NEC 690.17(E) and 110.21(B))	
	DC characteristics (NEC 690.53)	
	Energized/ungrounded conductors (NEC 690.35(F))	
Junction & Combiner Boxes in Transformerless Systems	Energized/ungrounded conductors (NEC 690.35(F))	Not necessary on pull boxes where there are no splices
String Inverter	PV Disconnect (NEC 690.13)	For integrated disconnect only-be sure to indicate DC, AC, or dual rating
	GFDI (NEC 690.5(C))	
	DC characteristics (NEC 690.53)	
Transformerless (non-isolated) Inverter	PV Disconnect (NEC 690.13)	For integrated disconnect only-be sure to indicate DC, AC, or dual rating
	Energized/ungrounded conductors (NEC 690.35(F))	
	DC characteristics (NEC 690.53)	

Overview of Label Locations and Requirements (cont.)

System Component	Required Labels	Notes
Load Side Connection	Circuits Identified (NEC 408.4)	
	AC Characteristics (NEC 690.54)	
	Multiple Sources Present (NEC 705.12(D)(2)(3)(c)	
	Inverter Output Location (NEC 705.12(D)(2)(3)(b))	
	Power source directory (NEC 705.10)	
	Inverter directory (NEC 690.15(A) and 705.10)	
Subpanel	PV Disconnect (NEC 690.13)	Label applies to backfed breaker in subpanel
	AC Characteristics (NEC 690.54)	
	Multiple Sources Present (NEC 705.12(D)(2)(3)(c)	
	Inverter Output Location (NEC 705.12(D)(2)(3)(b))	
	Circuits Identified (NEC 408.4)	
Supply Side Connection	Power source directory (NEC 705.10)	Place at both main service disconnect and new PV system disconnect
	AC Characteristics (NEC 690.54)	
	PV Disconnect (NEC 690.13)	

I. Label Construction, Placement, Color, and Marking

Materials and Construction

Labeling used outdoors must be of durable construction and intended to withstand conditions including high temperatures, UV exposure, and moisture as required by NEC 110.21(B)(3). Heavy duty UV resistant vinyl, metal, or plastic may all be suitable materials, depending on the specific product ratings. Installers should also consider the label attachment method (e.g., adhesive) when considering longevity and are encouraged to review ANSI Z535.4-2011 for guidance on selecting the appropriate labeling and adhesive materials.

Placement

It is a violation of an enclosure's UL listing (and NEC 110.3(B)) to cover any existing manufacturer applied labels with installation specific labels, so this should be avoided. Additionally, it is highly recommended that the installer attach a label or magnet with the company name and contact information at the inverter or interconnection point for easy reference.

Colors

Label colors are chosen per OSHA 29 CFR 1910.145 direction that the requirements of ANSI Z535.4-2011 be used. NFPA 70 (The National Electrical Code) is driven by NFPA 1 (Fire Code) which provides specific colors and characteristics for certain labels as required by the NEC, so these requirements over rule the referenced ANSI standards in these cases, as noted in this Technical Bulletin and the text of the NEC.

Marking

Marking on labels for system specific values, such as short circuit current, shall not be hand-written and must be legible, as required by NEC 110.21(B)(2). Marking may be achieved by means of engraving or use of a long-lasting ink or paint as part of the printing process.

II. Label Descriptions and NEC References

There are various articles in the NEC that require labeling for PV systems. Many of the specific requirements are found in Article 690, Solar Photovoltaic Systems. Additional requirements are found in Article 110: Requirements for Electrical Installation; Article 200: Use and Identification of Grounded Conductors; Article 225: Outside Branch Circuits and Feeders; Article 230: Services; and Article 705: Interconnected Electric Power Production Sources.

Arc-Flash Hazard Warning

NEC 110.16 Flash Protection

Electrical equipment such as switchboards, panel boards, industrial control panels, meter socket enclosures, and motor control centers that are in other than dwelling occupancies and is likely to require examination, adjustment, servicing, or maintenance while energized shall be field marked or factory marked to warn qualified persons of potential electric arc flash hazards. The marking shall meet the requirements in 110.21(B) and be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

Figure 1

Note: does not apply to residential PV systems

Directory / Identification of Power Sources

A directory identifying the solar system and other power sources on site should be placed at service equipment and state the location of system disconnecting means. The NEC stipulates this requirement in the following articles:

NEC 705.10 Directory

A permanent plaque or directory, denoting all electric power sources on or in the premises, shall be installed at each service equipment location and at locations of all electric power production sources capable of being interconnected.

Exception: installations with large numbers of power production sources shall be permitted to be designated by groups.

Figure 2

NEC 230.2(E) Identification

Where a building or structure is supplied by more than one service, or any combination of branch circuits, feeders, and services, a permanent plaque or directory shall be installed at each service disconnect location denoting all other services, feeders, and branch circuits supplying that building or structure and the area served by each. Note that NEC 225.37 has similar requirements.

Figure 3

NEC 705.70 Utility-Interactive Inverters Mounted in Not-Readily-Accessible Locations

Utility-interactive inverters shall be permitted to be mounted on roofs or other exterior areas that are not readily accessible. In these cases, inverter location must be noted in the directory required by NEC 705.10, described above.

Conductor Identification & Grouping

NEC 310.110 Conductor Identification

This Article specifies the acceptable conductor marking methods for:

- Grounded conductors: NEC 200.6 (see below)
- Equipment grounding conductors: NEC 250.119 (see below)
- Ungrounded conductors: Shall be distinguishable from grounded and grounding conductors, with reference to NEC 310.120 for manufacturer-applied markings

NEC 690.31(B) Identification and Grouping

PV system conductors shall be identified and grouped as required by 690.4(B)(1) through (4). The means of identification shall be permitted by separate color coding, marking tape, tagging, or other approved means.

1. **PV Source Circuits.** PV source circuits shall be identified at all points of termination, connection, and splices.
2. **PV Output and Inverter Circuits.** The conductors of PV output circuits and inverter input and output circuits shall be identified at all points of termination, connection, and splices.
3. **Conductors of Multiple Systems.** Where the conductors of more than one PV system occupy the same junction box, raceway, or equipment, the conductors of each system shall be identified at all termination, connection, and splice points. Exception: Where the identification of the conductors is evident by spacing or arrangement, further identification is not required.
4. **Grouping.** Where the conductors of more than one PV system occupy the same junction box or raceway with a removable cover(s), the AC and DC conductors of each system shall be grouped separately by wire ties or similar means at least once, and then shall be grouped at intervals not to exceed 1.8 m (6 feet).
    - Exception: The requirement for grouping shall not apply if the circuit enters from a cable or raceway unique to the circuit that makes the grouping obvious.

NEC 690.31 (G) (1) Embedded in Building Surfaces

Where circuits are embedded in built-up, laminate, or membrane roofing materials in roof areas not covered by PV modules and associated equipment, the location of circuits shall be clearly marked using a marking protocol that is approved as being suitable for continuous exposure to sunlight and weather.

NEC 200.6 Means of Identifying Grounded Conductors

(A) **Sizes 6 AWG or Smaller.** An insulated grounded conductor 6 AWG or smaller shall be identified by one of the following means:

1. A continuous white outer finish.
2. A continuous gray outer finish.
3. Three continuous white stripes along the conductor’s entire length on other than green insulation.
4. Wires that have their outer covering finished to show a white or gray color but have colored tracer threads in the braid identifying the source of manufacture shall be considered as meeting the provisions of this section.

(B) **Sizes 4 or Larger.** An insulated grounded conductor 4 AWG or larger shall be identified by one of the following means:

1. A continuous white outer finish.
2. A continuous gray outer finish.
3. Three continuous white stripes along the conductor's entire length on other than green insulation.
4. At the time of installation, by a distinctive white or gray marking at its terminations. This marking shall encircle the conductor or insulation.

Note: Tape or similar marking means are only code-compliant on large (AWG 4 or larger) conductors. Smaller diameter conductors cannot be field –identified in this way.

NEC 200.7 Use of Insulation of a White or Gray Color or with Three Continuous White or Gray Stripes

The following shall be used only for the grounded circuit conductor, unless otherwise permitted:

1. A conductor with continuous white or gray covering
2. A conductor with three continuous white or gray stripes on other than green insulation
3. A marking of white or gray color at the termination

Note: PV systems utilizing transformerless (non-isolated) inverters do not ground either polarity of the PV array conductors. Therefore, conductors in these circuits cannot have insulation colored white or gray.

Figure 4

NEC 250.119 Identification of Equipment Grounding Conductors

Unless otherwise required, equipment grounding conductors shall be permitted to be bare, covered, or insulated. Individually covered or insulated equipment grounding conductors shall have a continuous outer finish that is either green or green with one or more yellow stripes. Conductors with these color schemes shall not be used for grounded or ungrounded circuit conductors.

Ground Fault Indication

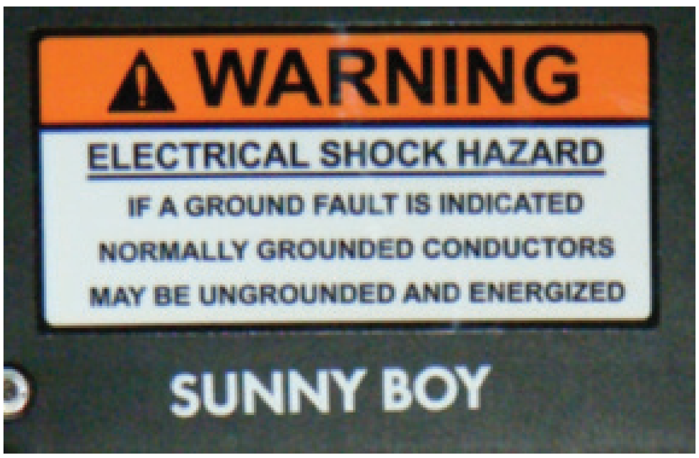
NEC 690.5(C) Labels and Markings

A warning label shall appear on the utility-interactive inverter or be applied by the installer near the ground-fault indicator at a visible location, stating the following:

WARNING
ELECTRIC SHOCK HAZARD
IF A GROUND FAULT IS INDICATED,
NORMALLY GROUNDED CONDUCTORS MAY
BE UNGROUNDED AND ENERGIZED

When the photovoltaic system also has batteries, the same warning is to be applied by the installer in a visible location at the battery bank.

Figure 5



Identification of PV Disconnects

NEC 690.13(B) Marking

Each PV system disconnecting means shall be permanently marked to identify it as a PV system disconnect.

Note: This requirement applies to both AC and DC disconnects. The International Fire Code (IFC) recommends labels that identify the main service disconnect or critical disconnects with reflective, red and white labels (IFC 605.11).

Figure 6

NEC 690.16(B) Fuse Servicing

Where the disconnecting means are located more than 1.8 m (6 ft.) from the overcurrent device, a directory showing the location of each disconnect shall be installed at the overcurrent device location. Non-load-break-rated disconnecting means shall be marked “Do not open under load”.

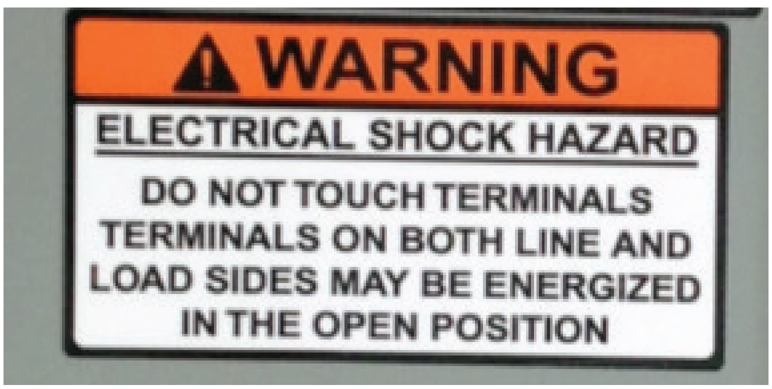
Terminals Energized on Line and Load Sides of Disconnect in Open Position

NEC 690.17 (E) Switch or Circuit Breaker

Where all terminals of the disconnecting means may be energized in the open position, a warning sign shall be mounted on or adjacent to the disconnecting means. The sign shall be clearly legible and have the following words or equivalent:

WARNING
ELECTRIC SHOCK HAZARD.
DO NOT TOUCH TERMINALS.
TERMINALS ON BOTH THE LINE AND LOAD SIDES
MAY BE ENERGIZED IN THE OPEN POSITION.

Figure 7



Note: This requirement does not apply to AC disconnects for any inverter Listed to UL 1741

DC PV Source and Output Circuits Inside a Building

NEC 690.31(G) (3) Marking and Labeling Required

The following wiring methods and enclosures that contain PV power source conductors shall be marked with the wording “WARNING: PHOTOVOLTAIC SOURCE” by means of permanently affixed labels or other approved permanent marking:

1. Exposed raceways, cable trays, and other wiring methods
2. Covers or enclosures of pull boxes and junction boxes
3. Conduit bodies in which any of the available conduit opening are unused

Figure 8

NEC 690.31 (G) (4) Marking and Labeling Methods and Locations

The labels or markings shall be visible after installation. The labels shall be reflective, and all letters shall be capitalized and shall be minimum height of 9.5mm (3/8in) in white on a red background. PV power circuit labels shall appear on every section of the wiring system that is separated by enclosures, walls, partitions, ceilings, or floors. Spacing between labels or makings, or between a label and a marking, shall not be more than 3 m (10 feet). Labels required by this section shall be suitable for the environment where they are installed.

Note: Although the ANSI standard directs that these types of labels have different coloring, the NEC has been driven by fire codes and thus specifies characteristics explicitly for these applications.

Figure 9

Bipolar PV Systems

NEC 690.7(E)(3) Bipolar Source and Output Circuits

WARNING
BIPOLAR PHOTOVOLTAIC ARRAY.
DISCONNECTION OF NEUTRAL OR GROUNDED CONDUCTORS
MAY RESULT IN OVERVOLTAGE ON ARRAY OR INVERTER.

The warning sign(s) or label(s) shall comply with 110.21(B).

Ungrounded (non-isolated, transformerless) PV Systems

NEC 690.35(F) Ungrounded PV Power Systems

The PV power source shall be labeled with the following warning at each junction box, combiner box, disconnect, and device where energized, ungrounded circuits may be exposed during service:

WARNING
ELECTRIC SHOCK HAZARD.
THE DC CONDUCTORS OF THIS PHOTOVOLTAIC SYSTEM
ARE UNGROUNDED AND MAY BE ENERGIZED.

Figure 10

Figure 11

DC Photovoltaic Power Source

NEC 690.53 Direct-Current Photovoltaic Power Source

A permanent label for the direct-current photovoltaic power source indicating items (1) through (5) provided by the installer at the photovoltaic disconnecting means:

1. Rated maximum power-point current
2. Rated maximum power-point voltage
3. Maximum system voltage

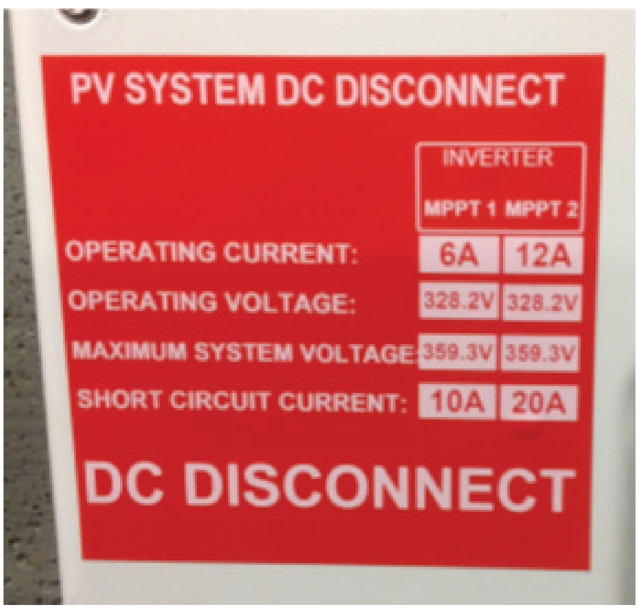
   Refer to § 690.7(A) for maximum PV system voltage.
4. Maximum circuit current. Where the PV power source has multiple outputs, 690.53(1) and (4) shall be specified for each output.

   Refer to § 690.8(A) for calculation of maximum circuit current.
5. Maximum rated output current of the charge controller (if installed).

   Informational Note: Reflecting systems used for irradiance enhancement may result in increased levels of output current and power.

Note: Inverters with multiple MPPT channels must be labeled per channel.

Figure 12



Identification of PV System Interconnection

NEC 690.54 Interactive System Point of Interconnection

All interactive system(s) points of interconnection with other sources shall be marked at an accessible location at the disconnecting means as a power source and with the rated AC output current and the nominal operating AC voltage.

Note: Examples of points of interconnection are AC combining panels, AC disconnects, backfed breakers at point of utility interconnection, etc. This requirement does not apply only to the point of common coupling for the PV system and the utility grid.

Figure 13

Batteries and Energy Storage Systems

NEC 690.55 PV Systems Employing Energy Storage

Photovoltaic power systems employing energy storage shall also be marked with the maximum operating voltage, including any equalization voltage and the polarity of the grounded circuit conductor.

Note: also refer to NEC 690.5(C), 480.6(D), 705.80, and 690.71(H)5

NEC 690.71 Storage Batteries

Section H describing disconnects and over current protection where energy storage device input and output terminals are more than 1.5 m (5 feet) from connected equipment, or where the circuits from these terminals pass through a wall or partition, the installation shall comply with the following:

(5) where the energy storage device disconnecting means is not within sight of the PV system AC and DC disconnecting means, records or directories shall be installed at the locations of all disconnecting means indicating the location of all disconnecting means.

Identification of Power Sources

NEC 690.56 Identification of Power Sources

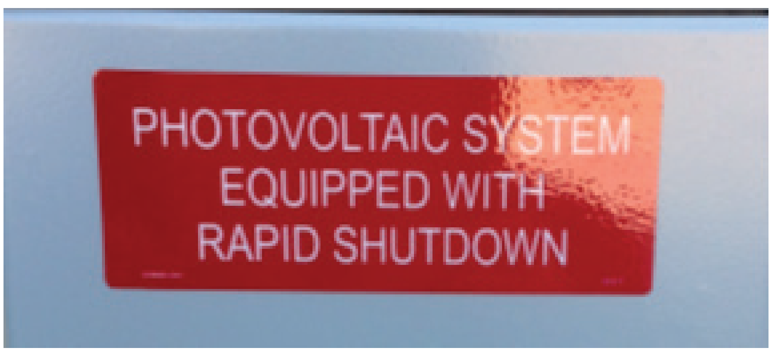
(A) Facilities with Stand-Alone Systems. Any structure or building with a PV power system that is not connected to a utility service source and is a stand-alone system shall have a permanent plaque or directory installed on the exterior of the building or structure at a readily visible location acceptable to the authority having jurisdiction. The plaque or directory shall indicate the location of system disconnecting means and that the structure contains a stand-alone electrical power system. The marking shall be in accordance with 690.31(G).

Note: (A) will not apply to NY-SUN funded systems

(B) Facilities with Utility Services and PV Systems. Buildings or structures with both utility service and a PV system shall have a permanent plaque or directory providing the location of the service disconnecting means and the PV system disconnecting means if not located at the same location. The warning sign(s) or label(s) shall comply with 110.21(B). Refer to figure 2.

(C) Facilities with Rapid Shutdown. Buildings or structures with both utility service and a PV system, complying with 690.12, shall have a permanent plaque or directory including the following wording: PHOTOVOLTAIC SYSTEM EQUIPPED WITH RAPID SHUTDOWN.

Figure 14



The plaque or directory shall be reflective, with all letters capitalized and having a minimum height of 9.5 mm (3/8 inch), in white on red background.

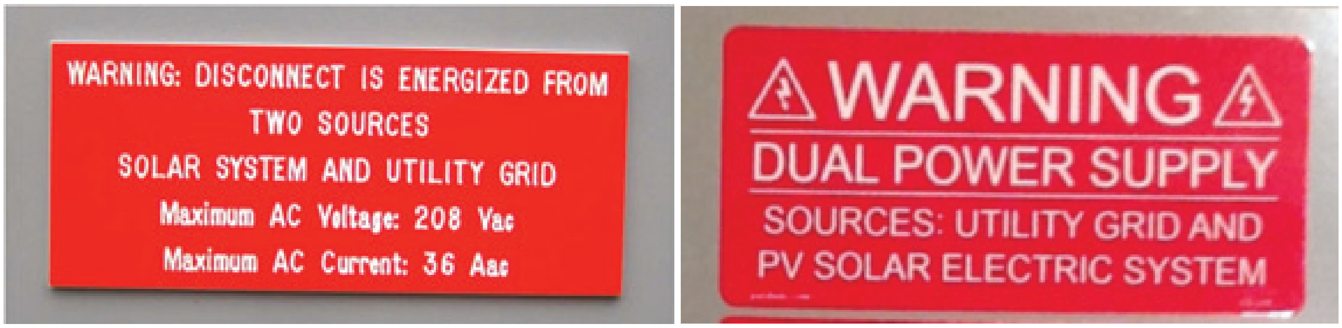
Note: Although the NEC does not explicitly define a location for this labeling, it is suggested that one be located at the main service disconnect for the utility, and one at the inverter location, or the location of the 'rapid shutdown' initiator if different.

Point of Connection Identification

NEC 705.12 (D) (3)

Equipment containing overcurrent devices in circuits supplying power to a buss bar or conductor supplied from multiple sources shall be marked to indicate the presence of all sources.

Figure 15



Identification and warning of additional power source at the panel board

705.12 (D) (2) (3) (b)

A permanent warning label shall be applied to the distribution equipment with the following or equivalent marking:

WARNING
INVERTER OUTPUT CONNECTION
DO NOT RELOCATE THIS OVERCURRENT DEVICE

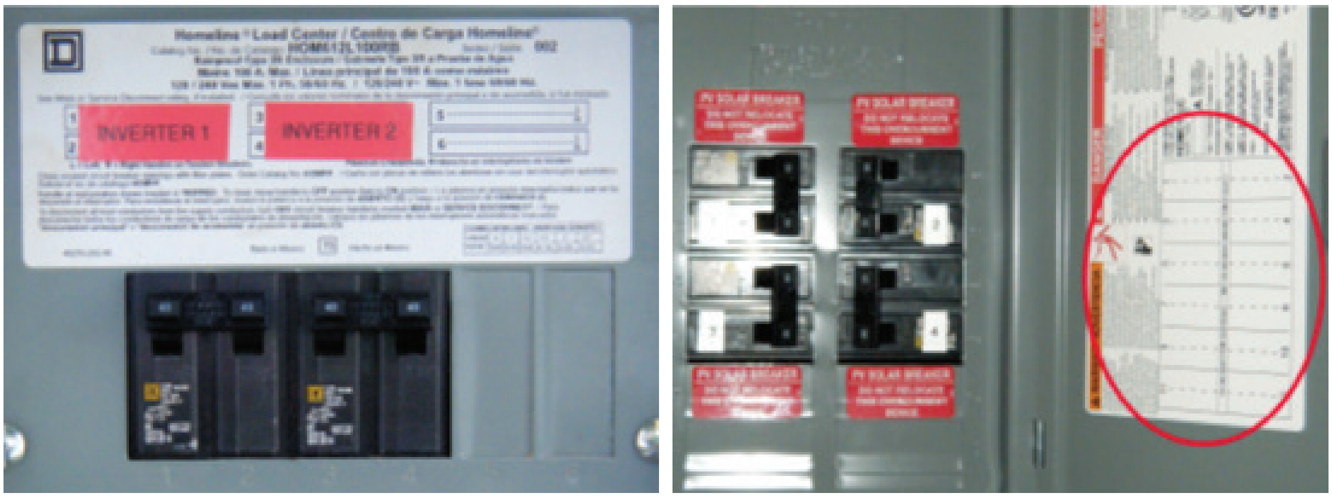
Figure 16

408.4 Field Identification Required

(A) Circuit Directory or Circuit Identification.

It is important to properly complete the circuit directory, as required by NEC 408.4(A). These directories are generally found on the inside of panelboard cover doors and if there is not one present prior to the PV installation, it is the installer's responsibility to add one and properly document the relevant PV system-associated breakers.

Figure 17

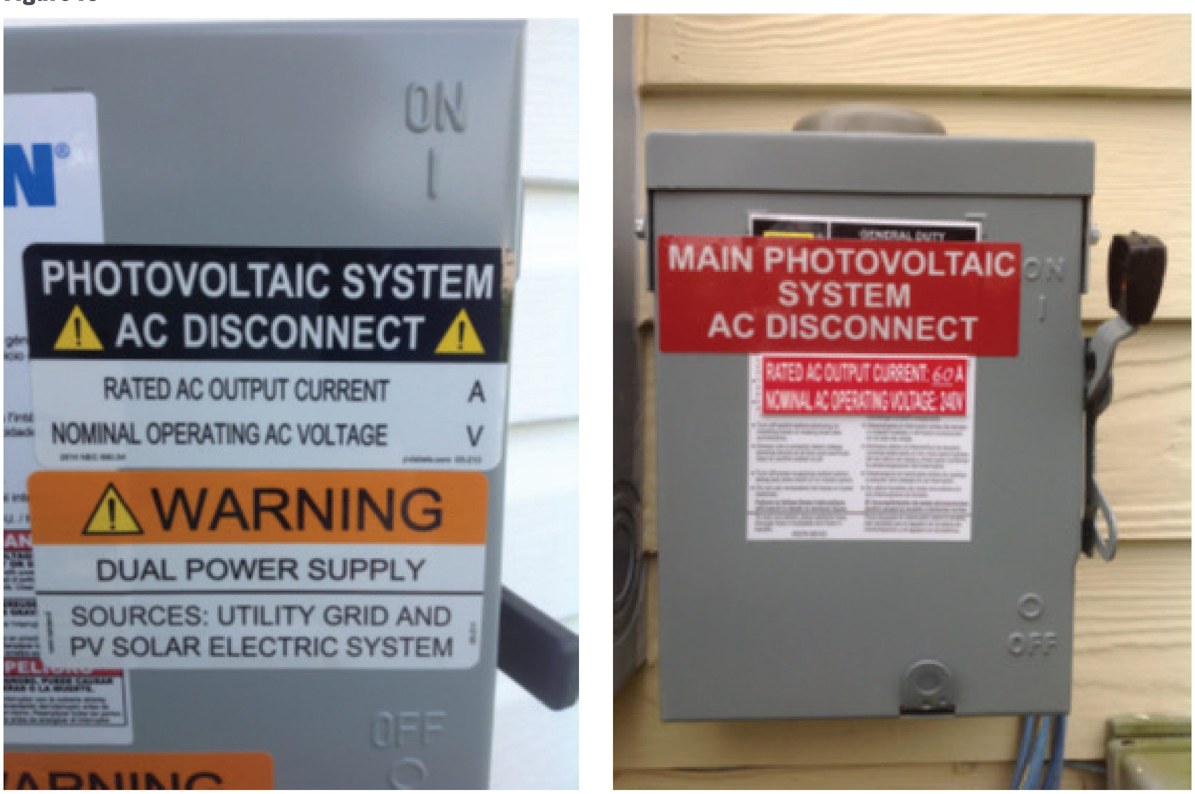


Common Labeling Mistakes to Avoid

Do not cover manufacturer's labeling with other labels.

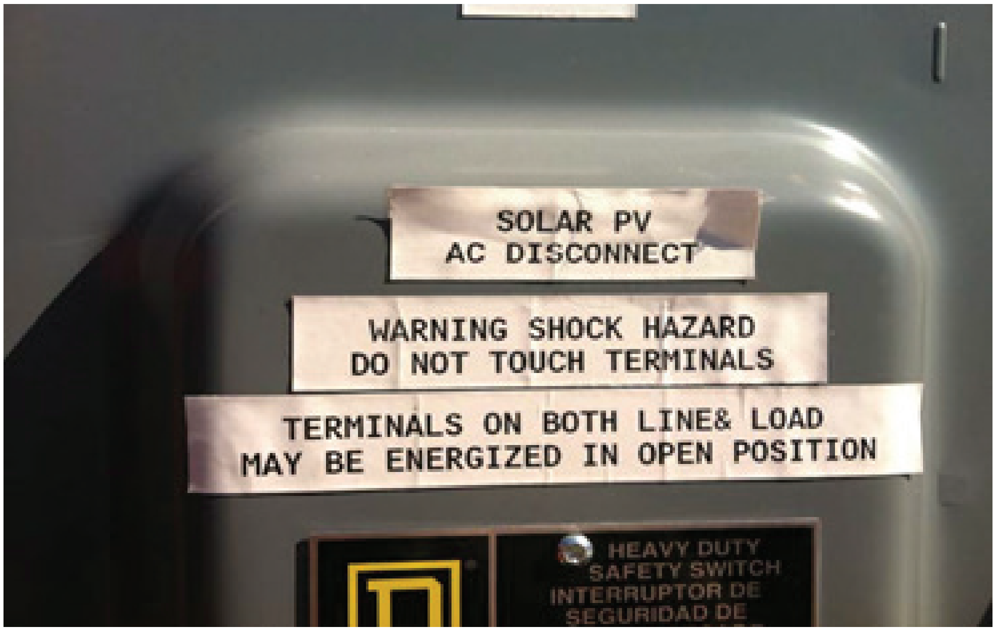
Figure 18

Figure 19



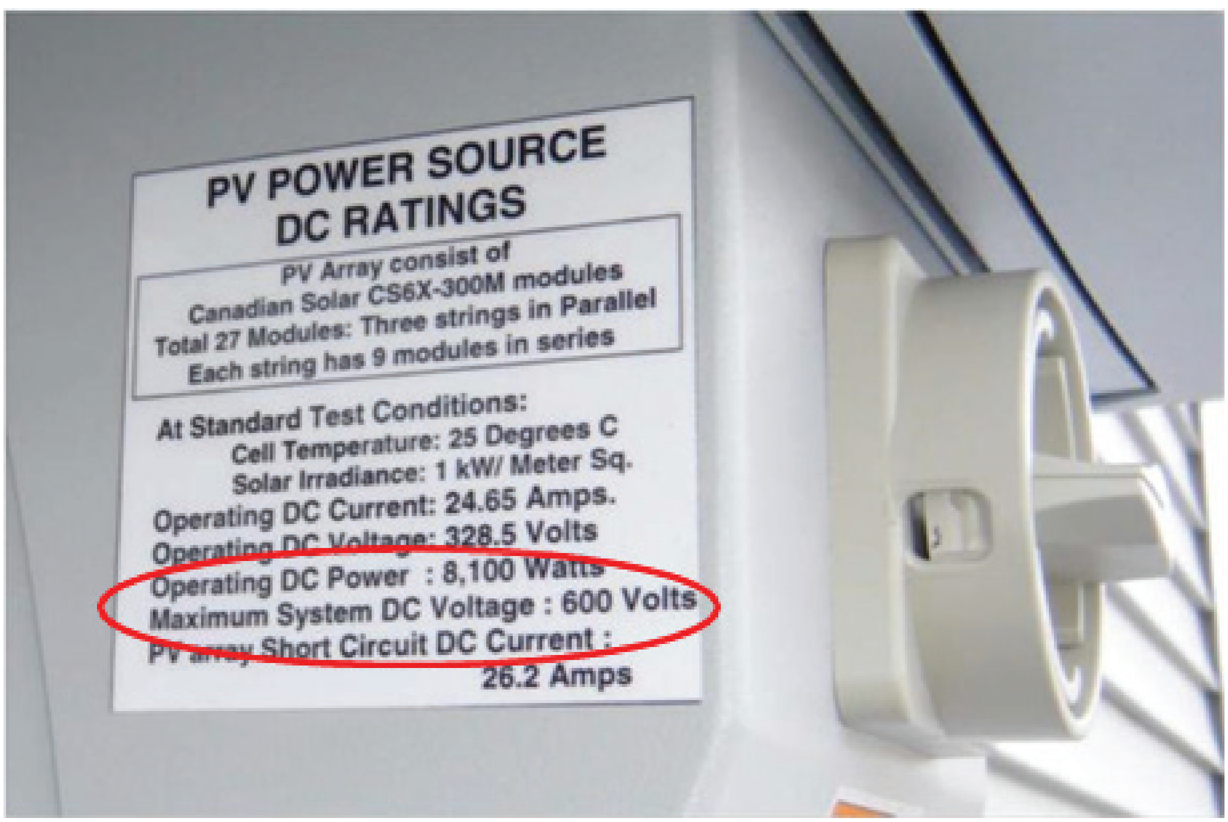
Make sure labels are permanent and suitable for use in the environment to which it will be exposed. In this example, these light duty adhesive labels will not withstand 20+ years of wind, sun and rain, and are in violation of 110.21.

Figure 20



Maximum System DC voltage is not 600VDC, it must be calculated per 690.7(A)

Figure 21



Label Not of Permanent Construction, nor conforming with 690.31(G)4.

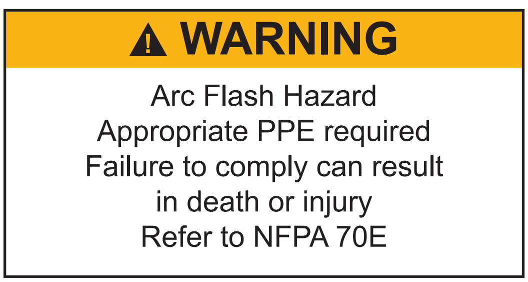
Figure 22

Appendix F: Example Labels

The following pages provide example NEC-compliant labels based on NEC required / recommended text as well as their related code articles. While the use of these labels on NY-Sun-funded solar PV projects is encouraged; final selection, preparation, and placement of labels in compliance with the NEC and other relevant codes is the responsibility of the installer.

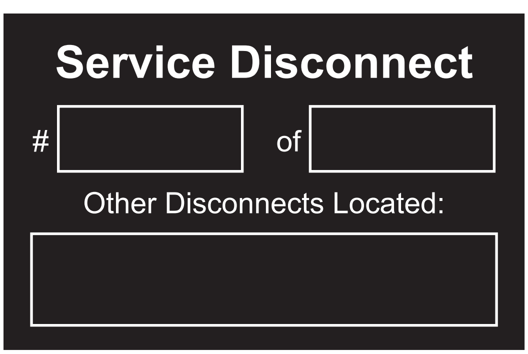
1) All labeling used outdoors must be engraved metal, UV stabilized engraved plastic or of a material sufficiently durable to withstand the environment involved. Values hand written or in written in marker are not acceptable per NEC 2014.
2) Labels used indoors may be made of durable vinyl or paper
3) Do not cover any existing manufacturer applied labels with installation specific labels
4) Label colors chosen per NFPA 70 2014 direction that ANSI Z535-2011 be used
5) Requirements comply with NEC 2014
6) Additionally, it is highly recommended that the installer attach a label with the company name and contact information at the inverter
7) All warning signs or labels shall comply with NEC 110.21(B)

Label #1
110.16



Label #2
225.37, 230.2(E)

 # 1 of 2 and 2 of 2 where utility is 1 and solar is 2, etc. Description of other disco location.



Label #3
225.37,
230.2(E),
705.12(D)3

This equipment is fed by multiple sources.
Source 1:
Utility Grid – main service panel in basement
Source 2:
Photovoltaic System – Disconnect on SE wall of house

Label #4
690.5(C)

⚠ WARNING

ELECTRIC SHOCK HAZARD
IF A GROUND FAULT IS INDICATED,
NORMALLY GROUNDED CONDUCTORS
MAY BE UNGROUNDED
AND ENERGIZED

Label #5
690.7(E)3

⚠ WARNING

BIPOLAR PHOTOVOLTAIC ARRAY.
DISCONNECTION OF NEUTRAL
OR GROUNDED CONDUCTORS MAY
RESULT IN OVERVOLTAGE ON
ARRAY OR INVERTER

Label #6
690.13(B)

PHOTOVOLTAIC SYSTEM DISCONNECT

Label #7
690.15(A)4,
690.56(B),
705.10

PARALLEL GENERATION SOURCE:
PHOTOVOLTAIC SYSTEM

UTILITY SERVICE DISCONNECT LOCATED:

PHOTOVOLTAIC SYSTEM DISCONNECT LOCATED:

Label #8
690.16(B)

Do not open under load

Label #9
690.17(E)

⚠ WARNING

ELECTRIC SHOCK HAZARD
DO NOT TOUCH TERMINALS.
TERMINALS ON BOTH THE LINE AND
LOAD SIDES MAY BE ENERGIZED
IN THE OPEN POSITION

Label #10
690.31(G)3 & 4,
690.31(G)1

Plaque or directory shall be reflective, with all letters capitalized and having a minimum height of 9.5mm (3/8 in.), in white on red background

WARNING: PHOTOVOLTAIC
POWER SOURCE

Label #11
690.35(F)

⚠ WARNING
ELECTRIC SHOCK HAZARD THE DC CONDUCTORS OF THIS PHOTOVOLTAIC SYSTEM ARE UNGROUNDED AND ENERGIZED

Label #12
690.53

PHOTOVOLTAIC DISCONNECT	
Rated maximum power-point current	A
Rated maximum power-point voltage	V
Maximum system voltage	V
Maximum circuit current	A

Label #13
690.53 - multiple MPPT channels

PHOTOVOLTAIC DISCONNECT	
Rated maximum power-point current	A
Rated maximum power-point voltage	V
Maximum system voltage	V
Maximum circuit current	A
Maximum rated output current of the charge controller	A

Label #14
690.55

⚠ WARNING	
Photovoltaic System Utilizing Energy Storage	
Nominal operating voltage	V
Maximum DC voltage	V
Grounded conductor is	NEGATIVE

Label #15
690.54

PHOTOVOLTAIC POWER SOURCE	
RATED AC OUTPUT CURRENT	A
NOMINAL OPERATING AC VOLTAGE	V

Label #16
690.56(C)

Plaque or directory shall be reflective, with all letters capitalized and having a minimum height of 9.5mm (3/8 in.), in white on red background

PHOTOVOLTAIC SYSTEM
EQUIPPED WITH RAPID
SHUTDOWN

Label #17
690.71(H)5

This building contains a battery backup storage system located:

Disconnects are located:

Label #18
705.12(D)2(3)b

⚠ WARNING

INVERTER OUTPUT CONNECTION
DO NOT RELOCATE THIS
OVERCURRENT DEVICE

Label #19
705.12(D)2(3)c

⚠ WARNING

THIS EQUIPMENT FED BY MULTIPLE SOURCES.
TOTAL RATING OF ALL OVERCURRENT DEVICES,
EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE,
SHALL NOT EXCEED AMPACITY OF BUSS BAR

Appendix G: Additional Resources

Adopting the NYS Unified Solar Permit Webinar
training.ny-sun.ny.gov/resources-5#pvtn-webinars-and-podcasts

Residential Solar Permitting Best Practices Explained
www.irecusa.org/wp-content/uploads/2013/09/expanded-best-practices.pdf

Expedited Permit Process for PV Systems
www.solarabcs.org/about/publications/reports/expedited-permit/pdfs/Expermitprocess.pdf

Other Resources for Municipal Inspectors and Code Officials
training.ny-sun.ny.gov/resources-5#for-inspectors-and-code-officials

NY-SUN

Understanding the **roof top access** and **ventilation** requirements as described in Section R324 of the 2015 International Residential Code

Introduction

This guide is meant to help you understand the *2015 International Residential Code* and Errata amendments as adopted by New York State.

We encourage you to have a discussion with your local code official to determine the specific requirements.

In New York State, it is the responsibility of the Local Authority Having Jurisdiction (AHJ) to interpret all codes and standards. ***Always consult with your local code official to determine code compliance.***

2015 IRC Code text is black.

NYS Errata changes are highlighted in yellow.

Additional commentary is blue.

call:
1-866-NYSERDA

visit:
nyserda.ny.gov/ny-sun

SECTION 324

SOLAR ENERGY SYSTEMS

"**R324.1 General** Solar energy systems shall comply with the provisions of this section."

"**R324.2 Solar thermal systems.** Solar thermal systems shall be designed and installed in accordance with Chapter 23 and the International Fire Code."

(This is a reference to the 2015 International Fire Code [IFC].)

"**R324.3 Photovoltaic systems.** Photovoltaic systems shall be designed and installed in accordance with Sections R324.3.1 through R324.7.7 and NFPA 70. Inverters shall be listed and labeled in accordance with UL 1741. Systems connected to the utility grid shall use inverters listed for utility interaction."

(NFPA 70 is also known as the 2014 National Electrical Code.)

"**R324.3.1 Equipment Listings.** Photovoltaic panels and modules shall be listed and labeled in accordance with UL1703.

"**R324.4 Rooftop-mounted photovoltaic systems.** Rooftop-mounted photovoltaic systems installed on or above the roof covering shall be designed and installed in accordance with Section R907"

(2015 IRC Code section "R907 Rooftop –Mounted Photovoltaic systems," is the section on "Roof Assemblies" and also contains references to R324, NFPA 70, wind loading R301, fire classification R902, and UL 1703, which are all related sections and standards.)

"**R324.4.1 Roof live load.** Roof structures that provide support for photovoltaic panel systems shall be designed for applicable roof live load. The design of the roof structures need not include roof live load in the areas covered by photovoltaic panel systems. Portions of the roof structures not covered by photovoltaic panels shall be designed for roof live load. Roof structures that provide support for photovoltaic panel systems shall be designed for live load, $\mathbf{L}_R$, for the load case where the photovoltaic panel system is not present."

(The adequacy of the roof structure should always be determined by a New York State Licensed Professional Engineer or Registered Architect)

"**R324.5 Building–integrated photovoltaic systems.** Building–integrated photovoltaic systems that serve as roof covering shall be designed and installed in accordance with Section R905"

"**R324.5.1 Photovoltaic shingles.** Photovoltaic shingles shall comply with Section R905.16"

(R905 is the 2015 IRC section for "Roof Assemblies".

R905.16 specifically addresses photovoltaic shingles, which references back to R324 and NFPA 70)

"**R324.6 Ground-mounted photovoltaic systems.** Ground-mounted photovoltaic systems shall be designed and installed in accordance with Section R301."

"**R324.6.1 Fire separation distances.** Ground-mounted photovoltaic systems shall be subject to the fire separation distance requirements determined by the local jurisdiction."

(R301 is the "Design Criteria" section of the 2015 IRC in the front under the title "Building Planning" which contains information on items such as winds load, snow loads, and design temperatures.

R324.6.1 reinforces the need to coordinate with the local authority having jurisdiction)

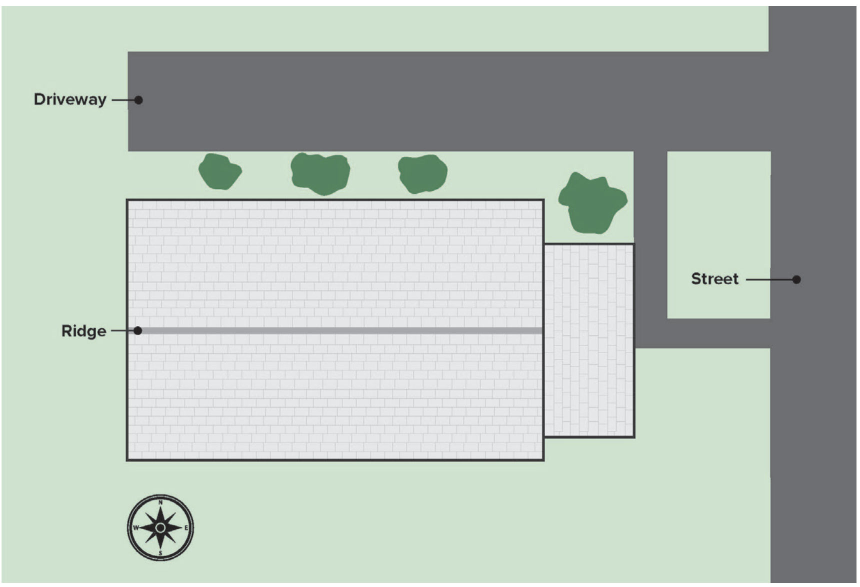
"**R324.7 Access and Pathways.** Roof access, pathways and spacing requirements for solar photovoltaic systems shall be provided in accordance with Sections R324.7.1 through R324.7.6

Exceptions:

1. Roof access, pathways and spacing need not be provided where an alternate ventilation method has been provided, or where vertical ventilation techniques will not be employed.

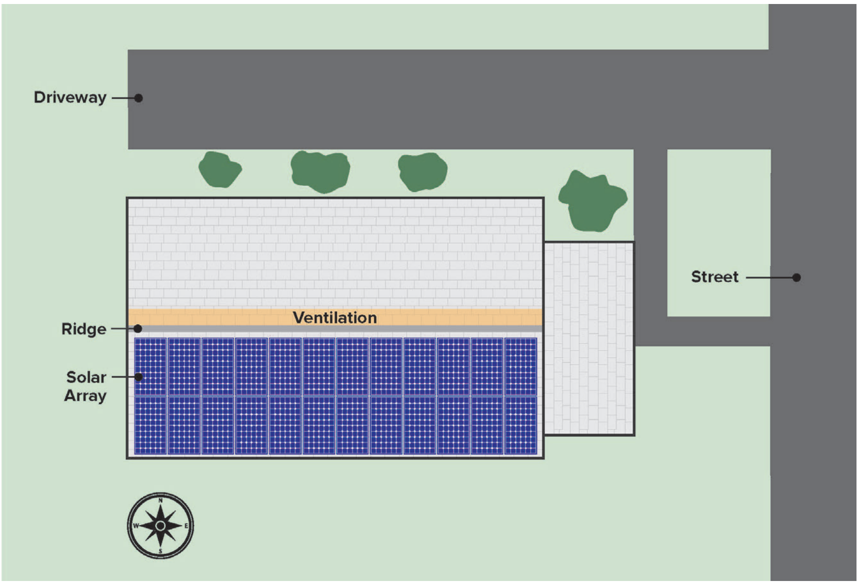
2. Detached garages and accessory structures."

Typical single ridge residence (Figure 1)



This is a typical residential single ridge residential structure. We will use this as an example to further evaluate and explain the various options.

Typical single ridge roof with alternative ventilation (Figure 2)



If ventilation is required it may be possible to propose an alternate ventilation location on roof slope opposite the array or the side wall of an attic space. Alternate locations should be coordinated and approved by the AHJ.

When proposing an alternate ventilation location, indicate the direction of the prevailing wind.

“**R324.7.1 Size of solar photovoltaic array.** Each array shall not exceed 150 feet (45 720mm) in any direction.”

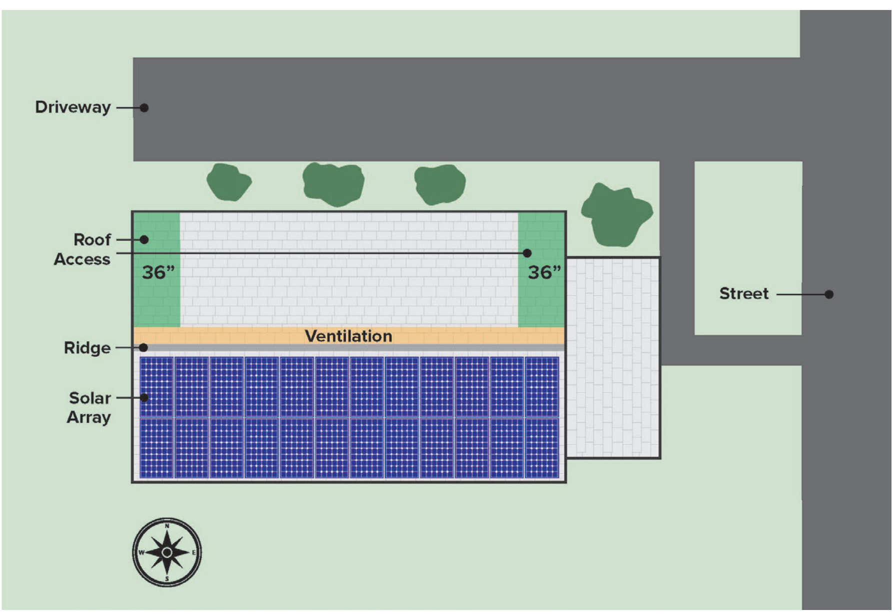
(Size 150 feet in any direction. 150’ X 150’ = 22,500 Square Feet. This should not be an issue for the vast majority of residences. Consult the “2015 International Building Code” for larger nonresidential structures.)

“**R324.7.2 Roof access points.** Roof access points shall be located:

1. In areas that establish access pathways which are independent of each other and as remote from each other as practicable so as to provide escape routes from all points along the roof;
2. In areas that do not require the placement of ground ladders over openings such as windows or doors or areas that may cause congestion or create other hazards;”
3. At strong points of building construction, such as corners, pilasters, hips, and valleys, and other areas capable of supporting the live load from emergency responders;
4. Where the roof access point does not conflict with overhead obstructions such as tree limbs, wires, signs;
5. Where the roof access point does not conflict with ground obstructions such as decks, fences, or landscaping; and
6. In areas that minimize roof tripping hazards such as vents, skylights, satellite dishes, antennas, or conduit runs.”

(Access and egress should always be available in two locations and cannot block widow and door access or emergency egress.)

Single ridge roof with alternate ventilation shown with two access points (Figure 3)



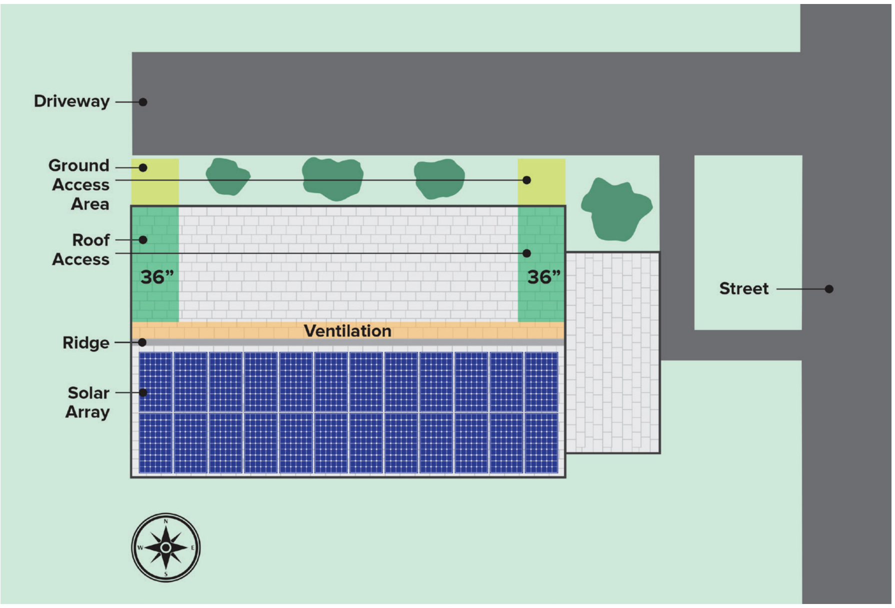
Looking back at the previous typical residential single ridge example, in order to maximize the southern facing roof it may be possible to propose an alternate ventilation on opposite roof slope and two roof access points on the opposite roof slope.

“**R342.7.3 Ground access areas.** Ground access areas shall be located directly beneath access roofs, and roof access points. The minimum width of the ground access area shall be the full width of the access roof or roof access point, measured at the eave. The minimum depth shall allow for safe placement of ground ladders for gaining entry to the access roof.”

(Ground access must align with roof access.)

“**R324.7.4 Single ridge roofs.** Panels, modules, or arrays installed on roofs with a single ridge shall be located in a manner that provides two 36 inches wide (914mm) access pathway extending from the roof access point to the ridge. Access pathways on opposing roof slopes shall not be located along the same plane as the truss, rafter, or other such framing system that supports the pathway.”

Single ridge roof indicating ground access in yellow (Figure 4)



Using the same example, you can see that the ground access aligns with roof access. Note that the two access points and 36” pathways allow two directions of access and egress and do not share a common truss of rafter. There is also adequate unobstructed ground access.

“**Exceptions:**

1. Roofs with slopes of 2 units vertical in 12 units horizontal (16.6 percent) and less.
2. Structures where an access roof fronts a street, driveway, or other area readily accessible to emergency responders.
3. One access pathway shall be required when the roof slope containing panels, modules or arrays is located not more than 24 inches (610 mm) vertically from an adjoining roof which contains an access roof.”

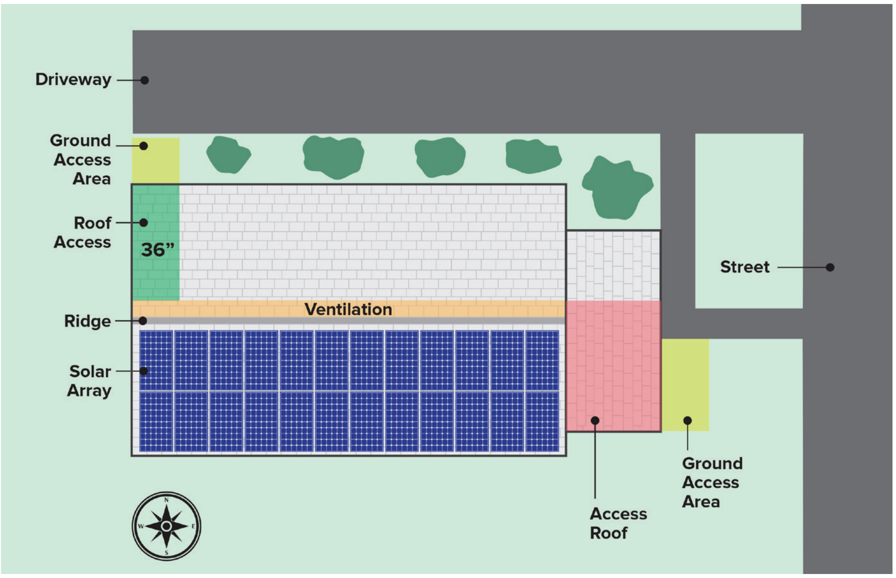
Single roof ridge exceptions:

1. Slope 2/12 or less.

2. Roof fronts a street, driveway, or readily accessible.

3. One pathway is required where roof containing modules is not more than 24” vertically from an adjoining roof that has an access roof.

Single ridge roof – single pathway with exception #3 adjoining roof within 24 Inches (Figure 5)

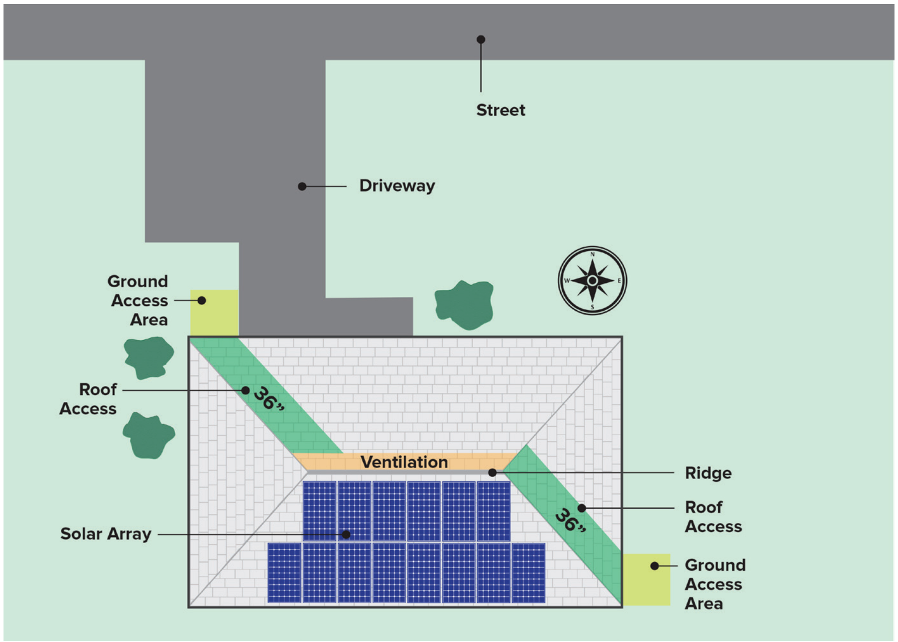


Again using the same example, with the adjoining roof within 24 inches of the array roof. Applying exception #3 you would only need a single access point and pathway on the main roof, as there is secondary access via an adjoining roof within 24 inches. This still allows two directions of egress, and does not share a common truss of rafter.

An access roof provides access to the ridge or peak of an adjoining roof surface containing solar panels, mosules, or arrays.

"**R324.7.5 Hip Roofs.** Panels, modules and arrays installed on dwellings with hip roofs shall be located in a manner that provides a clear access pathway not less than 36 inches wide (914 mm) extending from the roof access point to the ridge or peak, on each roof slope where panels, modules, or arrays are located."

Hip Roof – alternate venting with two roof pathways and ground access (Figure 6)



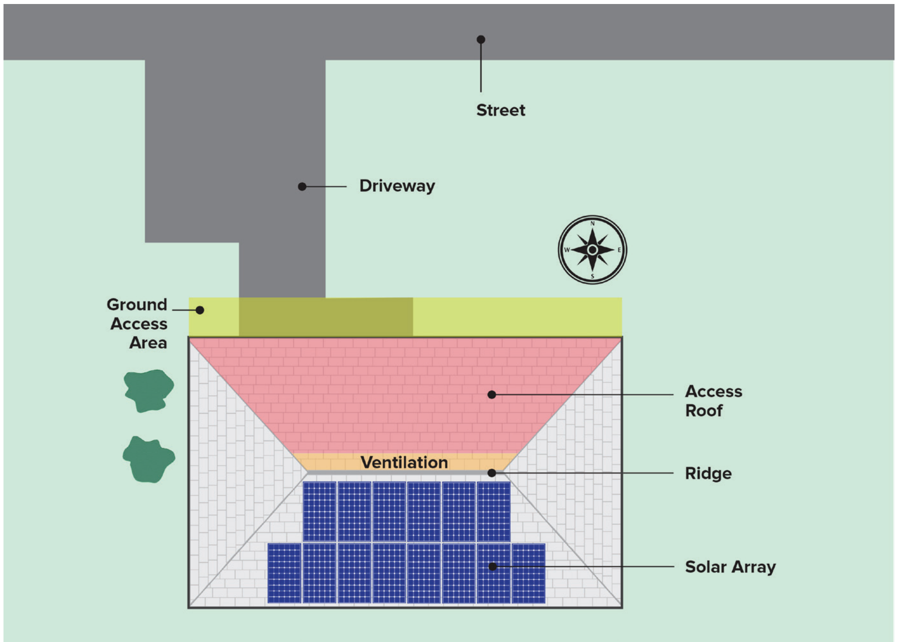
R324.7.5 Typical Hip Roof, showing alternate venting location and clear access pathway not less than 36 inches wide (914 mm) extending from the roof access point to the ridge or peak. Access and egress is from opposite sides and does not rely on the same roof truss or rafter and clear ground access.

"**Exceptions:**

1. Roofs with slopes of 2 units vertical in 12 units horizontal (16.6percent) and less.

2. Structures where an access roof fronts a street, driveway, or other area readily accessible to emergency responders."

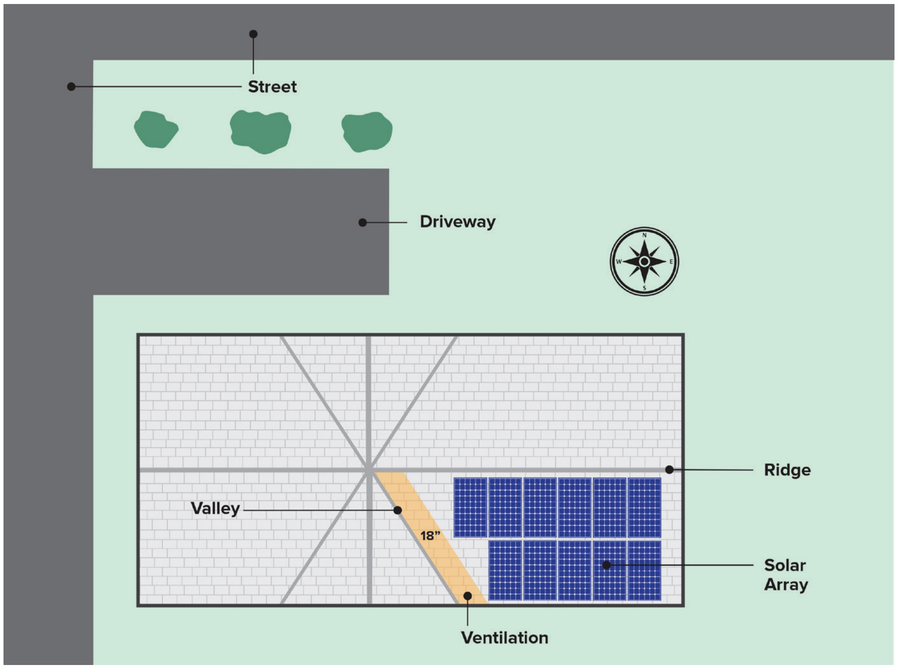
Hip Roof with exception #2 – access roof fronts a street or driveway (Figure 7)



Using the same HIP roof example, exception #2 would apply for all residential structures where an access roof fronts a street, driveway, or other area readily accessible to emergency responders.

"**R324.7.6 Roofs with valleys.** Panels and modules shall not be located less than 18 inches (457 mm) from a valley. Exception: Roofs with slopes of 2 units vertical in 12 units horizontal (16.6 percent) and less."

Valley Roof showing 18" clearance in yellow to the array (Figure 8)



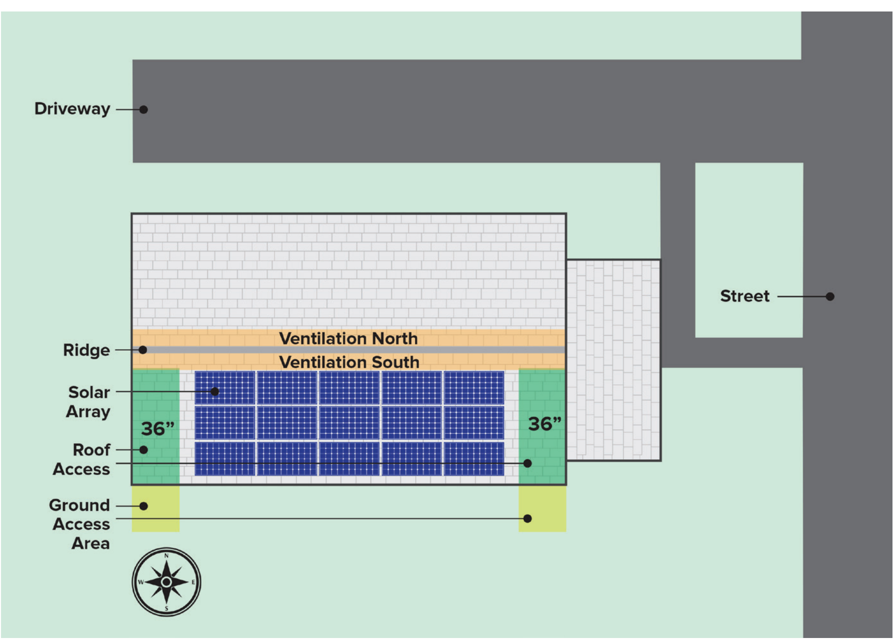
This image shows the 18 inch clear space from the valley to the array. The access and egress paths are not shown for clarity, nor is the venting location. There is street access to the front, and possible alternate venting on the opposite roof slope.

"**R324.7.7 Allowance for smoke ventilation operations**. Panels and modules shall not be less than 18 inches (457 mm) from a ridge or peak.

Exceptions:

1. Where an alternate ventilation method has been provided, or where vertical ventilation methods will not be employed between the upper most portion of the solar photovoltaic system and the ridge or peak.
2. Detached garages and accessory structures."

Single ridge roof showing a smaller array without any exceptions (Figure 9)



Using the original example, but now shown without any exceptions where vertical ventilation techniques will be employed would result in a smaller array. It's important to understand the exceptions and when they apply in order to maximize the available roof space.

NYSERDA's Conclusion

The residential building code as amended for New York State allows the designers of photovoltaic systems several options and alternatives. These illustrations are offered as possible examples. It is not possible to show every possible scenario. It is however up to the judgment of the local code official to determine final compliance with the code.

Contractors, design professionals, and AHJ's must consider many ventilation scenarios and consider that:

1. A fire can break out **anywhere** in a building. Alternate ventilation methods should consider fires occurring in less than ideal locations and during less than ideal conditions.
2. Emergency responders do not have x-ray vision. When approving an alternate ventilation method, AHJ's should consider the presence of attic storage atop a plywood base, finished attic space, or other such conditions that could deter ventilation operations
3. Contractors and AHJ must remember that the direction and magnitude of a prevailing wind can affect the location of the ventilation opening.

For example, a wind from the north places positive pressure on the northern roof slope and negative pressure on the southern slope. Under ideal conditions, a fire occurring in the northern portion of the building could necessitate a ventilation opening on the northern roof slope. A moderate wind from the north, however, could reduce the effectiveness of this opening due to positive wind pressures. In this case, it may be more effective to take advantage of the negative roof pressures and place the ventilation opening on the southern roof slope.

4. Design professionals, contractors, and AHJ must consider how the building is framed.

For example, a building with a cathedral ceiling and a dividing wall along its peak would appear to necessitate ventilation openings on both slopes to accommodate fires in less than ideal locations.

For more details and definitions, view the NYS Errata.
dos.ny.gov/dcea/pdf/2016%20DOS_UniformCodeSupplement_03212016.pdf

Additional Resources

Fire and Safety Considerations for Solar PV Webinar
training.ny-sun.ny.gov/resources-5#pvtn-webinars-and-podcasts

Fire Fighter Safety and Emergency Response for Solar Power Systems
sustainable-firengineering.ie/wp-content/uploads/2015/08/NFPA-FPRF_Firefighter-Tactics-Solar-Power_2013.pdf

Rooftop Solar PV & Firefighter Safety
solaroutreach.org/wp-content/uploads/2014/09/Rooftop-Solar-PV-Firefighter-Safety_Final.pdf

Solar Photovoltaic Installation Guideline
gov.ca.gov/docs/ec/CalFIRE_Solar_PV_guideline.pdf

The following is the access, ventilation, and setback portions of R324 for your reference.

R324.7 Access and Pathways. Roof access, pathways and spacing requirements for solar photovoltaic systems shall be provided in accordance with Sections R324.7.1 through R324.7.6

Exceptions:

1. Roof access, pathways and spacing need not be provided where an alternate ventilation method has been provided, or where vertical ventilation techniques will not be employed.
2. Detached garages and accessory structures.

R324.7.1 Size of solar photovoltaic array. Each array shall not exceed 150 feet (45 720mm) in any direction.

R324.7.2 Roof access points. Roof access points shall be located:

1. In areas that establish access pathways which are independent of each other and as remote from each other as practicable so as to provide escape routes from all points along the roof;
2. In areas that do not require the placement of ground ladders over openings such as windows or doors or areas that may cause congestion or create other hazards;"
3. At strong points of building construction, such as corners, pilasters, hips, and valleys, and other areas capable of supporting the live load from emergency responders;
4. Where the roof access point does not conflict with overhead obstructions such as tree limbs, wires, signs;
5. Where the roof access point does not conflict with ground obstructions such as decks, fences, or landscaping; and
6. In areas that minimize roof tripping hazards such as vents, skylights, satellite dishes, antennas, or conduit runs.

R342.7.3 Ground access areas. Ground access areas shall be located directly beneath access roofs, and roof access points. The minimum width of the ground access area shall be the full width of the access roof or roof access point, measured at the eave. The minimum depth shall allow for safe placement of ground ladders for gaining entry to the access roof.

R324.7.4 Single ridge roofs. Panels, modules, or arrays installed on roofs with a single ridge shall be located in a manner that provides 36 inches wide (914mm) access pathway extending from the roof access point to the ridge. Access pathways on opposing roof slopes shall not be located along the same plane as the truss, rafter, or other such framing system that supports the pathway.

Exceptions:

1. Roofs with slopes of 2 units vertical in 12 units horizontal (16.6 percent) and less.
2. Structures where an access roof fronts a street, driveway, or other area readily accessible to emergency responders.
3. One access pathway shall be required when the roof slope containing panels, modules or arrays is located not more than 24 inches (610 mm) vertically from an adjoining roof which contains an access roof.

R324.7.5 Hip Roofs. Panels, modules and arrays installed on dwellings with hip roofs shall be located in a manner that provides a clear access pathway not less than 36 inches wide (914 mm) extending from the roof access point to the ridge or peak, on each roof slope where panels, modules, or arrays are located.

Exceptions:

1. Roofs with slopes of 2 units vertical in 12 units horizontal (16.6percent) and less.
2. Structures where an access roof fronts a street, driveway, or other area readily accessible to emergency responders.

R324.7.6 Roofs with valleys. Panels and modules shall not be located less than 18 inches (457 mm) from a valley.

Exception: Roofs with slopes of 2 units vertical in 12 units horizontal (16.6 percent) and less.

R324.7.7 Allowance for smoke ventilation operations. Panels and modules shall not be less than 18 inches (457 mm) from a ridge or peak.

Exceptions:

1. Where an alternate ventilation method has been provided, or where vertical ventilation methods will not be employed between the upper most portion of the solar photovoltaic system and the ridge or peak.
2. Detached garages and accessory structures.

FACT SHEET

UNDERSTANDING NEW YORK STATE'S REAL PROPERTY TAX LAW § 487

NEW YORK STATE OF OPPORTUNITY. | NY-Sun

This fact sheet outlines important points for local governments that are considering opting out of RPTL § 487.

What is the Real Property Tax Law § 487?

This law provides a 15-year real property tax exemption for properties located in New York State with renewable energy systems, including solar electric systems. This law only applies to the value that a solar electric system adds to the overall value of the property; it does not mean that landowners with an installed renewable energy system are exempt from all property tax. A local government that does not opt out can still benefit financially through payment-in-lieu-of-taxes (PILOT) agreements.

In local governments that have taken no action one way or the other, the exemption is in effect. If a local law, ordinance, or resolution opting out of the exemption is adopted, a copy must be filed with the New York State Department of Taxation and Finance, and the New York State Energy Research and Development Authority (NYSERDA).

What is the local economic impact of solar?

New York State's solar market is one of the fastest growing solar markets in the country. Installations grew by 575 percent from 2012 to 2015. During the same time period, the U.S. as a whole saw a 146 percent increase. New York State ranked seventh nationwide for cumulative solar installed capacity in 2015.[1]

The solar industry is creating jobs across the State with more than 600 solar companies employing more than 8,250 people. In 2015, the solar industry added approximately 1,000 new jobs throughout the State, a 13.3 percent increase over 2014 job growth. The solar job market in the State is projected to grow another 11.6 percent in 2016, which means adding nearly 1,000 more jobs.

With an average wage of $22.02 per hour, the solar industry is responsible for creating thousands of living-wage jobs that allow workers to contribute to their local economies. Most jobs are local or regional and cannot be outsourced.[2]

Why would jurisdictions opt out of the RPTL § 487?

All local governments must offer the RPTL § 487 exemption unless they have opted out not to. Local governments can decide to opt out. As the solar market in New York continues to grow, many large-scale solar projects are being proposed throughout New York. Some local governments are opting out of RPTL § 487 so they can tax these multimillion-dollar projects and generate additional property tax revenue. However, these jurisdictions may find that they will not actually collect substantially more tax revenue from solar or other renewable energy systems because the systems may not be built if they are fully taxable. Property taxes can have a significant impact on the financial viability of solar electric projects, sometimes impacting project economics in a way that unintentionally prohibits solar electric development. Jurisdictions that opt out of RPTL § 487 may unintentionally prevent solar electric development at the local level. Activity in other states suggest there is less solar development in jurisdictions that opt out of the property tax exemption, with little to no additional tax revenue collected.[3]

Can jurisdictions opt out of RPTL§ 487 for large-scale solar only?

No. Under RPTL § 487, jurisdictions are not permitted to conditionally opt out of the property tax exemption. In other words, jurisdictions cannot choose to tax large systems but not small ones. A jurisdiction that opts out of RPTL § 487 to generate tax revenue from larger projects makes solar installations more expensive for homeowners and local businesses.

Can jurisdictions capture revenue from installations without opting out of RPTL§ 487?

Yes. The law allows jurisdictions that offer the RPTL § 487 exemption to negotiate payments in lieu of taxes (PILOTs). The purpose of a PILOT is to reduce the tax burden and tax rate uncertainty on the property and/or system owner, while preserving some of the forgone revenue that would have been paid in property taxes. PILOTs are often used for large-scale[4] renewable energy projects, including solar electric systems. They are annual payments commonly related to the system's size (often in dollars per megawatt [MW]) and cannot exceed the amount of taxes that would be owed without the exemption.

[1] NY-Sun, nyserda.ny.gov/All-Programs/Programs/NY-Sun
Solar Energy Industry Association (SEIA). "Top 10 Solar States 2015." www.seia.org/research-resources/top-10-solar-states

[2] The Solar Foundation. "New York Solar Jobs Census 2015." www.TSFcensus.org and SolarStates.org

[3] Barnes et al. 2013. "Property Taxes and Solar PV Systems: Policies, Practices, and Issues." https://nccleantech.ncsu.edu/wp-content/uploads/Property-Taxes-and-Solar-PV-Systems-2013.pdf

[4] In this fact sheet, large scale is considered solar electric projects that are in the megawatt range.

Each taxing jurisdiction (except the school districts of New York, Buffalo, Rochester, Syracuse, and Yonkers) that has not opted out of RPTL § 487 may require the owner of a solar installation to enter a PILOT. The PILOT may not exceed a 15-year term, but it cannot require payments that exceed the value of taxes that would be paid without the exemption provided by RPTL § 487.[5]

PILOT agreements can be an effective tool for jurisdictions to generate comparable revenue without making solar costs prohibitive for most homeowners and businesses.

Can a municipality that has opted out of RPTL § 487 opt back in?

Yes. The New York State Department of Taxation and Finance has stated that local governments can reinstate the RPTL § 487 exemption simply by repealing the local law, ordinance, or resolution that implemented the opt out. The final step to reinstate the exemption is to provide a copy of the new law, ordinance, or resolution to the New York State Department of Taxation and Finance and NYSERDA.[6]

Do other states have property tax exemptions for solar electric systems?

Yes. Thirty-three states offer some form of tax exemptions for renewable energy. Twenty-two of those states mandate property tax exemptions for 100 percent of the value of solar energy installations over 10 or more years.[7] These states include ones with significant solar development such as California, Massachusetts, and New Jersey, as well as states with minimal solar capacity such as South Dakota, Kansas, and Montana. The majority of states recognize the positive financial impact property tax exemptions can have on solar electric development and the local economic benefits of a robust solar industry.

Email info@training.ny-sun.ny.gov for more information about your municipality's individual situation.

More information about RPTL § 487

NYS Department of Taxation and Finance. "Recent Questions on the Real Property Tax Law and Solar Energy Systems." **www.tax.ny.gov/pdf/publications/orpts/legal/raq2.pdf?_ga=1.225179802.1031257166.1423842465**

New York Solar Energy Industry Association (NYSEIA). "Webinar: Understanding the Property Tax Exemption for Solar in New York," **www.youtube.com/watch?v=A3UrlI1-T0k**

Barnes et al. "Property Taxes and Solar PV Systems: Policies, Practices, and Issues." **nccleantech.ncsu.edu/wp-content/uploads/Property-Taxes-and-Solar-PV-Systems-2013.pdf**

NY-Sun, a dynamic public-private partnership, will drive growth in the solar industry and make solar technology more affordable for all New Yorkers. NY-Sun brings together and expands existing programs administered by the New York State Energy Research and Development Authority (NYSERDA), Long Island Power Authority (LIPA), PSEG Long Island, and the New York Power Authority (NYPA), to ensure a coordinated, well-supported solar energy expansion plan and a transition to a sustainable, self-sufficient solar industry.

[5] *New York State Department of Taxation and Finance. January 2016. "Recently Asked Questions About the Real Property Tax Law on the Topic of Solar Energy." Available at: https://www.tax.ny.gov/pdf/publications/orpts/legal/raq2.pdf?_ga=1.225179802.1031257166.1423842465*

[6] *New York State Department of Taxation and Finance, supra note 13.*

[7] *Solar Power Rocks. https://solarpowerrocks.com/new-york/*

FACT SHEET

LANDOWNER CONSIDERATIONS FOR SOLAR LAND LEASES

New York's solar market is growing fast–575% in the last four years alone–so demand for sites to install large-scale solar electric systems is high. Across New York State, solar developers are contacting farmers and landowners to secure long-term land leases for siting solar arrays. The amount of land desirable for a lease generally ranges from 10 to 30 acres, depending upon the size of the solar array.

Before considering such a lease or contract, you should know installing solar panels on farmland may trigger a "conversion penalty" and may increase the taxable value of the overall property. To fully understand the impact of these factors, landowners are urged to consult with an attorney and their municipal assessor before signing any documents.

What is shared solar?

NY-Sun, Governor Andrew M. Cuomo's initiative to add more than 3GW of installed solar capacity in New York State by 2023, encourages and supports the installation of solar arrays to generate clean and renewable energy statewide. Tens of thousands of New Yorkers have already put solar panels on their homes. Many buildings, however, are not suited for solar panels due to shading, roof condition, or other factors. New Yorkers now have the opportunity to subscribe to larger "shared solar" systems. Shared Solar provides opportunities for renters, homeowners, businesses, and municipalities to subscribe to a portion of shared solar energy projects. The siting of these systems is creating an even greater interest in the leasing of farmland.

Is solar right for your land?

The size of a solar installation is measured by its capacity to produce energy. A 1-megawatt (MW) installation will generate approximately 1,174,000 kilowatt hours (kWh is how electricity usage is measured on your utility bill) each year. A 1-MW system will generally require about six acres of land for 3,000 to 4,000 individual solar panels, and will cost $2 million to $3 million to build. Systems built on open land will connect directly to the electric grid and will have their own utility meter. Solar panels are typically warrantied for 25 years, but a system can last longer than that if panels are replaced over time.

What are the per acre lease rates?

Rates can vary. If you are approached by a developer or have interest in leasing your land, research the going rate for land leases in your area. Contact multiple solar developers to gauge interest in your land. Certain site characteristics are especially attractive for solar development, such as cleared land that is south-facing with road access and in close proximity to the substation. Do research online about solar lease rates in other areas and consider working with a real estate professional.

Prior to signing a lease with a solar developer, landowners should examine possible tax consequences and issues associated with the construction of roads, fencing, and electrical poles. Landowners should consider asking an attorney to carefully examine the land lease terms.

Do you receive an agricultural assessment on your property?

Under the Agriculture and Markets Law, if a landowner receives an agricultural assessment and converts the land to a nonagricultural use, the landowner may be subject to a monetary payment for converting the land. A conversion of land is "an outward or affirmative act changing the use of agricultural lands" (AML §301(8)).

Municipal assessors are responsible for tracking conversions when they occur. Landowners are also required to notify the assessor within 90 days whenever a parcel receiving an agricultural assessment is converted to a nonagricultural use. A fine of up to $1,000 can be levied against a landowner who fails to report the conversion.

Who is responsible for paying a conversion penalty?

The landowner on record is responsible for paying the conversion penalty. Your assessor can work with you to determine what the conversion penalty may cost. Make sure you know where the solar array will be placed on your property so that a comparative analysis of benefited acres versus total converted acres, by mineral, organic, and farm woodland soil groups can be determined.

Are solar panels considered real property and taxable?

Yes. A solar energy system is "real property" once it has been permanently affixed to land or a structure [Real Property Tax Law (RPTL) § 102(12)(b); 8 Op. Counsel SBEA No. 3]. The definition of "real property" also includes a "power generating apparatus" [RPTL §102(12)(f)]. As such, it is taxable unless it qualifies for an exemption (RPTL § 300).

Will the siting and construction of a solar array on my property affect other taxes?

Possibly. The assessor must determine the contributory value of the solar array to the value of your property. If the value of the converted acreage devoted to the solar array increases, it may affect your taxes. An increase in taxable value may affect your county, town, village, and school taxes as well as other taxes that may be levied, such as highway, fire, ambulance, library, lighting district, drainage district, and other taxes and levies. It may also affect special district taxes for municipal water and sewer districts if the land is no longer predominantly used for agricultural purposes.

Isn't there an exemption from the payment of school, county, town, and village taxes for solar arrays?

Possibly. There is an exemption statute in State Law that applies specifically to solar energy systems: Section 487 of the RPTL. Section 487, which also covers wind power systems and farm waste energy systems, provides a 15-year exemption from real property taxation for the increase in value resulting from the installation of a qualifying system. However, the statute allows municipalities and school districts to opt-out of this exemption. To find out if your county, town, village, and/or school district has opted out, talk to your local tax assessor.

Further information may be found on the following web sites:

tax.ny.gov/research/property/legal/localop/487opt.htm to read Frequently Asked Questions concerning the solar energy system exemption and statute.

New York State Taxation and Finance web page: **tax.ny.gov/pdf/publications/orpts/legal/raq2.pdf?_ga=1.190577835.1031257166.1423842465** (Note: to obtain updated information talk to your assessor.)

If my lease exceeds the 15-year exemption, what happens to my tax bill?

Leases beyond 15 years will likely have an effect on your tax liabilities going forward. Absent the exemption, the local government may seek to value the solar array at full value.

This assessment would again depend upon the contributory value of the solar array on your property at year 16. This question should be discussed with your local tax assessor.

What are other potential impacts that I should be aware of?

Solar arrays must be connected to the electrical grid, which may require the installation of power poles. Landowners should make sure that pole placement and the height of the wire will not interfere with their ability to farm the land. The same can be said concerning the siting of access roads. Make sure the access road is constructed so that it does not shed water onto your fields and that the finished grade does not interfere with normal drainage patterns. Also, ask about the material used to finish the surface of the access road. Will the size of the stone interfere with the operation of your equipment if some of it ends up in your field? See if the access road can be used by you and your farm equipment to access your property. Design the road so that it also serves both your needs and that of the solar company. Be sure to discuss these aspects of the construction of the solar project with the developer before you sign the lease.

Who is responsible for dismantling the solar array once the lease expires or is not renewed?

In the contract, make sure that there are provisions that determine who is responsible for dismantling the facility if the company is no longer in business or if the solar array ages out and is no longer viable, ensuring the property is returned to its pre-leased condiition.

What if I do not like the area of my property that the solar company has selected for their lease?

If you are interested in the possibility of a lease to a solar company, talk to them about the siting of the solar arrays on your property. Does it have to be placed on your best farmland (such as on Soil Groups 1-4)? Can the solar arrays be placed on land that is not suited for agricultural production, such as support land, sloping pasture, or underutilized areas of the farm? Can the land beneath the solar arrays be planted with crops or grazed by non-climbing animals? There are a number of possibilities that should be explored. Think about how the siting of a solar array on your property can benefit your farm operation and ask questions.

Does the town where I live have local laws that regulate the siting of solar facilities?

Possibly. Some municipalities have provisions in their zoning code to address the siting of solar arrays within the community. Other municipalities have placed a temporary freeze on the siting and installation of such facilities until they have decided on the best method to review and/or regulate the use within the town or village. Some municipalities are also in the process of drafting amendments to their zoning code to address this issue. Resources for local governments can be found at the NY-Sun PV Trainers Network website: **training.ny-sun.ny.gov**.

What can I do and how can I influence the local process?

Become or stay involved. If you do not participate in the local process, your point of view cannot be heard. Also, speak with your assessor to determine what impact the siting of a solar array may have on your farm or property and the bottom line (taxes versus lease payments).

NYSERDA

Agriculture and Markets

Visit NY-SUN.NY.GOV or call 1-866-NYSERDA to learn more about NY-Sun.

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FACT SHEET

DECOMMISSIONING SOLAR PANEL SYSTEMS

NEW YORK STATE OF OPPORTUNITY. | NY-Sun

This fact sheet provides information to local governments and landowners on decommissioning of large-scale solar panel systems.

As local governments develop solar regulations and landowners negotiate land leases, it is important to understand the options for decommissioning solar panel systems and restoring project sites to their original status.

From a land use perspective, solar panel systems are generally considered large-scale when they constitute the primary use of the land, and can range from less than one acre in urban areas to 10 or more acres in rural areas. Depending on where they are sited, large-scale solar projects can have habitat, farmland, and aesthetic impacts. As a result, large-scale systems must often adhere to specific development standards.

Abandonment and decommissioning defined

Abandonment occurs when a solar array is inactive for a certain period of time.

- Abandonment requires that solar panel systems be removed after a specified period of time if they are no longer in use. Local governments establish timeframes for the removal of abandoned systems based on aesthetics, system size and complexity, and location. For example, the Town of Geneva, NY, defines a solar panel system as abandoned if construction has not started within 18 months of site plan approval, or if the completed system has been nonoperational for more than one year.[1]
- Once a local government determines a solar panel system is abandoned, and has provided thirty (30) days prior written notice to the owner it can take enforcement actions, including imposing civil penalties/fines, and removing the system and imposing a lien on the property to recover associated costs.

Decommissioning is the process for removing an abandoned solar panel system and remediating the land.

- When describing requirements for decommissioning sites, it is possible to specifically require the removal of infrastructure, disposal of any components, and the stabilization and re-vegetation of the site.

What is a decommissioning plan?

Local governments may require to have a plan in place to remove solar panel systems at the end of their lifecycle, which is typically 20-40 years. A decommissioning plan outlines required steps to remove the system, dispose of or recycle its components, and restore the land to its original state. Plans may also include an estimated cost schedule and a form of decommissioning security (see Table 1).

What is the estimated cost of decommissioning?

Given the potential costs of decommissioning and land reclamation, it is reasonable for landowners and local governments to proactively consider system removal guarantees. A licensed professional engineer, preferably with solar development experience, can estimate decommissioning costs, which vary across the United States. Decommissioning costs will vary depending upon project size, location, and complexity. Table 1 provides an estimate of potential decommissioning costs for a ground-mounted 2-MW solar panel system. Figures are based on estimates from the Massachusetts solar market. Decommissioning costs for a New York solar installation may differ. Some materials from solar installations may be recycled, reused, or even sold resulting in no costs or compensation. Consider allowing a periodic reevaluation of decommissioning costs during the project's lifetime by a licensed professional engineer, as costs could decrease and the required payment should be reduced accordingly.

Table 1: Sample list of decommisioning tasks and estimated costs

Tasks	Estimated Cost ($)
Remove Rack Wiring	$2,459
Remove Panels	$2,450
Dismantle Racks	$12,350
Remove Electrical Equipment	$1,850
Breakup and Remove Concrete Pads or Ballasts	$1,500
Remove Racks	$7,800
Remove Cable	$6,500
Remove Ground Screws and Power Poles	$13,850
Remove Fence	$4,950
Grading	$4,000
Seed Disturbed Areas	$250
Truck to Recycling Center	$2,250
Current Total	$60,200
Total After 20 Years (2.5% inflation rate)	$98,900

[1] *Town of Geneva, N.Y. CODE § 130-4(D)(5) (2016):*

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

How can decommissioning be ensured?

Landowners and local governments can ensure appropriate decommissioning and reclamation by using financial and regulatory mechanisms. However, these mechanisms come with tradeoffs. Including decommissioning costs in the upfront price of solar projects increases overall project costs, which could discourage solar development. As a result, solar developers are sometimes hesitant to provide or require financial surety for decommissioning costs.

It is also important to note that many local governments choose to require a financial mechanism for decommissioning. Although similar to telecommunications installations, there is no specific authority to do so as part of a land use approval for solar projects (see Table 2). Therefore, a local government should consult their municipal attorney when evaluating financial mechanisms.

The various financial and regulatory mechanisms to decommission projects are detailed below.

Table 2: Relevant Provisions of General City, Town, and Village Laws Relating to Municipal Authority to Require Conditions, Waivers, and Financial Mechanisms

Site Plan Review	General City Law	Town Law	Village
Conditions	27-a (4)	274-a (4)	7-725-a (4)
Waivers	27-a (5)	274-a (5)	7-725-a (5)
Performance bond or other security	27-a (7)	274-a (7)	7-725-a (7)
Subdivision	**General City Law**	**Town Law**	**Village Law**
Waivers	33 (7)	277 (7)	7-730 (7)
Performance bond or other security	33 (8)	277 (9)	7-730 (9)
Special	**General City Law**	**Town Law**	**Village Law**
Conditions	27-b (4)	274-b (4)	7-725-b (4)
Waivers	27-b (5)	274-b (5)	7-725-b (5

Source: Referenced citations may be viewed using the NYS Laws of New York Online

Excerpts from these statutes are also contained within the "Guide to Planning and Zoning Laws of New York State," New York State Division of Local Governments Services, June 2011: **www.dos.ny.gov/lg/publications/Guide_to_planning_and_zoning_laws.pdf**

Financial mechanisms

Decommissioning Provisions in Land-Lease Agreements. If a decommission plan is required, public or private landowners should make sure a decommissioning clause is included in the land-lease agreement. This clause may depend on the decommissioning preferences of the landowner and the developer. The clause could require the solar project developer to remove all equipment and restore the land to its original condition after the end of the contract, or after generation drops below a certain level, or it could offer an option for the landowner to buy-out and continue to use the equipment to generate electricity. The decommissioning clause should also address abandonment and the possible failure of the developer to comply with the decommissioning plan. This clause could allow for the landowner to pay for removal of the system or pass the costs to the developer.

Decommissioning Trusts or Escrow Accounts. Solar developers can establish a cash account or trust fund for decommissioning purposes. The developer makes a series of payments during the project's lifecycle until the fund reaches the estimated cost of decommissioning. Landowners or third-party financial institutions can manage these accounts. Terms on individual payment amounts and frequency can be included in the land lease.

Removal or Surety Bonds. Solar developers can provide decommissioning security in the form of bonds to guarantee the availability of funds for system removal. The bond amount equals the decommissioning and reclamation costs for the entire system. The bond must remain valid until the decommissioning obligations have been met. Therefore, the bond must be renewed or replaced if necessary to account for any changes in the total decommissioning cost.

Letters of credit. A letter of credit is a document issued by a bank that assures landowners a payment up to a specified amount, given that certain conditions have been met. In the case that the project developer fails to remove the system, the landowner can claim the specified amount to cover decommissioning costs. A letter of credit should clearly state the conditions for payment, supporting documentation landowners must provide, and an expiration date. The document must be continuously renewed or replaced to remain effective until obligations under the decommissioning plan are met.[2]

Nonfinancial mechanisms

Local governments can establish nonfinancial decommissioning requirements as part of the law. Provisions for decommissioning large-scale solar panel systems are similar to those regulating telecommunications installations, such as cellular towers and antennas. The following options may be used separately or together.

- **Abandonment and Removal Clause.** Local governments can include in their zoning code an abandonment and removal clause for solar panel systems. These cases effectively become zoning enforcement matters where project owners can be mandated to remove the equipment via the imposition of civil penalties and fines, and/or by imposing a lien on the property to recover the associated costs. To be most effective, these regulations should be very specific about the length of time that constitutes abandonment. Establishing a timeframe for the removal of a solar panel system can be based on system aesthetics, size, location, and complexity. Local governments should include a high degree of specificity when defining "removal" to avoid ambiguity and potential conflicts.

[2] *See a letter of credit submitted to the Vermont Public Service Board by NextSun Energy, LLC.* ***http://psb.vermont.gov/sites/psb/files/docketsandprojects/Solar/Exhibit%20Petitioner%20JL-7%20(Revised%20326.14).pdf***

- **Special Permit Application.** A local government may also mandate through its zoning code that a decommissioning plan be submitted by the solar developer as part of a site plan or special permit application. Having such a plan in place allows the local government, in cases of noncompliance, to place a lien on the property to pay for the costs of removal and remediation.
- **Temporary Variance/Special Permit Process.** As an alternative to requiring a financial mechanism as part of a land use approval, local governments could employ a temporary variance/special permit process (effectively a re- licensing system). Under this system, the locality would issue a special permit or variance for the facility for a term of 20 or more years; once expired (and if not renewed), the site would no longer be in compliance with local zoning, and the locality could then use their regular zoning enforcement authority to require the removal of the facility.

What are some examples of abandonment and decommissioning provisions?

The New York State Model Solar Energy Law provides model language for abandonment and decommissioning provisions: **www.cuny.edu/about/resources/sustainability/reports/NYS_Model_Solar_Energy_LawToolkit_FINAL_final.pdf**

The following provide further examples that are intended to be illustrative and do not confer an endorsement of content:

- Town of Geneva, N.Y., § 130-4(D): **ecode360.com/28823382**
- Town of Olean, N.Y., § 10.25.5: **www.cityofolean.org/council/minutes/ccmin2015-04-14.pdf**

Is there a checklist for decommissioning plans?

The following items are often addressed in decommissioning plans requirements:[3]

- Defined conditions upon which decommissioning will be initiated (i.e., end of land lease, no operation for 12 months, prior written notice to facility owner, etc.).
- Removal of all nonutility owned equipment, conduit, structures, fencing, roads, and foundations.
- Restoration of property to condition prior to solar development.
- The timeframe for completion of decommissioning activities.
- Description of any agreement (e.g., lease) with landowner regarding decommissioning.
- The party responsible for decommissioning.
- Plans for updating the decommissioning plan.
- Before final electrical inspection, provide evidence that the decommissioning plan was recorded with the Register of Deeds.

Additional Resources

Template Solar Energy Development Ordinance for North Carolina (see Appendix G at pg. 21 for Sample Decommissioning Plan): **nccleantech.ncsu.edu/wp-content/uploads/Template-Solar-Ordinance_V1.0_12-18-13.pdf**

Land Use Planning for Solar: **training.ny-sun.ny.gov/images/PDFs/Land_Use_Planning_for_Solar_Energy.pdf**

Zoning Guide for Solar: **training.ny-sun.ny.gov/images/PDFs/Zoning_for_Solar_Energy_Resource_Guide.pdf**

Information on First Solar's recycling program for all of their modules: **www.firstsolar.com/en/Technologies-and-Capabilities/Recycling-Services**

PV Cycle: Europe's PV recycling program: **www.pvcycle.org/**

Solar Energy Industries Association (SEIA) information on solar panel recycling: **www.seia.org/policy/environment/pv-recycling**

Silicon Valley Toxics Coalition: **svtc.org/**

Silicon Valley Toxic Coalition Solar Scorecard: **www.solarscorecard.com/2015/2015-SVTC-Solar-Scorecard.pdf**

End-of-life PV: then what? - Recycling solar panels: **www.renewableenergyfocus.com/view/3005/end-of-life-pv-then-what-recycling-solar-pv-panels/**

NY-Sun, a dynamic public-private partnership, will drive growth in the solar industry and make solar technology more affordable for all New Yorkers. NY-Sun brings together and expands existing programs administered by the New York State Energy Research and Development Authority (NYSERDA), Long Island Power Authority (LIPA), PSEG Long Island, and the New York Power Authority (NYPA), to ensure a coordinated, well-supported solar energy expansion plan and a transition to a sustainable, self-sufficient solar industry.

[3] *North Carolina Solar Center, NC Sustainable Energy Center. December 2013. Template Solar Energy Development Ordinance for North Carolina.* ***https://nccleantech.ncsu.edu/wp-content/uploads/Template-Solar-Ordinance_V1.0_12-18-13.pdf***

Additional Resources

New York State Model Solar Energy Law and Toolkit
cuny.edu/about/resources/sustainability/reports/NYS_Model_Solar_Energy_LawToolkit_FINAL_final.pdf

Enabling Commercial PACE Financing in Your Community Webinar
training.ny-sun.ny.gov/resources-5#pvtn-webinars-and-podcasts

Climate Smart Communities
www.dec.ny.gov/energy/50845.html

Clean Energy Communities
nyserda.ny.gov/Clean-Energy-Communities

Energize New York
energizeny.org/

Land Use Planning Resource Guide
training.ny-sun.ny.gov/images/PDFs/Land_Use_Planning_for_Solar_Energy.pdf

Land Use and Policy for Solar Webinar
training.ny-sun.ny.gov/resources-5#pvtn-webinars-and-podcasts

Zoning for Solar Webinar
training.ny-sun.ny.gov/resources-5#pvtn-webinars-and-podcasts

Solar in Historic Districts Webinar
training.ny-sun.ny.gov/resources-5#pvtn-webinars-and-podcasts

Installing Municipal Solar Webinar
training.ny-sun.ny.gov/resources-5#pvtn-webinars-and-podcasts

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