Solar Basics and Frequently Asked Questions

Understanding the basics of solar energy technology, equipment, and terminology.

NEW YORK STATE | NYSERDA

Solar Guidebook for Local Governments
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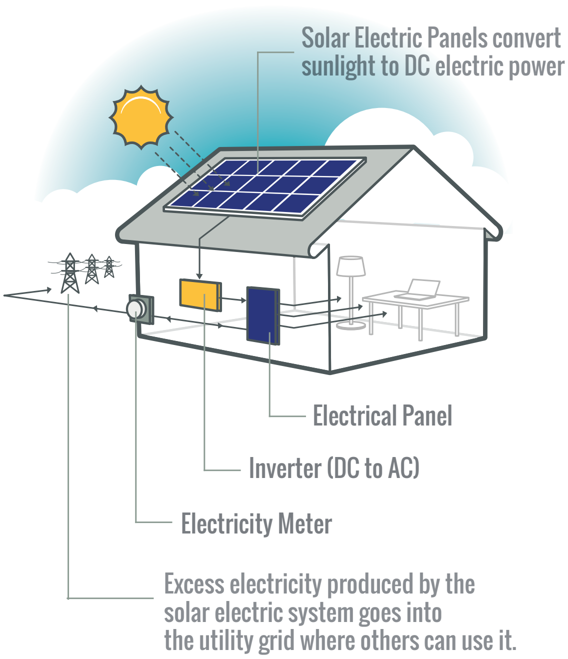
Section Contents

1. Solar Basics

An introduction to the common equipment and terminology used in solar technology. Topics of discussion include solar PV systems, solar terms, system components, net metering and financial considerations with regards to solar development.

1.1 Solar PV Systems



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.

1.2 Solar Terms

The following terms are frequently used when discussing solar energy and associated technologies.

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 installing 6 gigawatts of solar by 2025.

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.

1.3 System Components

1.3.1 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

1.3.2 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.

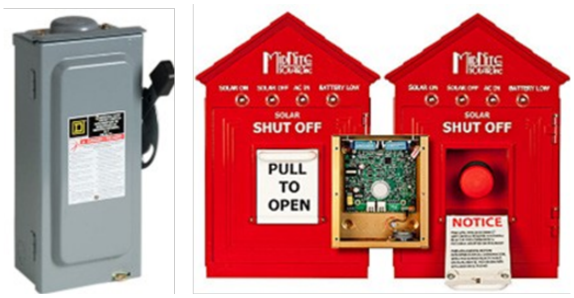
Most solar PV professionals describe system size in terms of module capacity (kilowatts DC), whereas most electric utilities refer to system size by inverter capacity (kilowatts AC).

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

1.3.3 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



1.3.4 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[1], 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

Detail of an L-Foot with a SnapNrack Flashing

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.

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

1.3.5 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.

1.3.6 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.

1.3.7 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.

1.4 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.

1.5 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.

1.5.1 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.[2] Visit the NY-Sun Program Site for the most up-to-date information regarding available incentives. For information regarding tax credits, we encourage you to speak with a tax accountant.

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.[3] 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.

1.5.2 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.

2. Frequently Asked Questions

2.1 Project Revenue

2.1.1 What is the difference between a “Large-Scale Renewable” project and a “Distributed Energy Resource” project?

Solar energy projects in New York State are divided into two general categories; large-scale renewables (LSR) and distributed energy resources (DER). LSR projects, also known as “utility-scale solar,” are typically larger than 5 MW_{ac}, and are built with the primary purpose of supplying wholesale electricity to the grid. A DER project is typically 5 MW_{ac} or less and must have a customer(s), known as the “offtaker,” to purchase the electricity. Most DER projects are community solar projects, residential/commercial rooftop solar projects, or small ground mounted solar.

[2] http://www.nyserda.ny.gov/All-Programs/Programs/NY-Sun
[3] https://www.tax.ny.gov/research/property/assess/manuals/vol4/pt1/sec4_01/sec487.htm

2.1.2 What are Renewable Energy Certificates? Do All Projects Qualify?

A renewable energy certificate (REC) is a certificate created by a tracking system, such as the New York Generation Attribute Tracking System (NYGATS), that represents the environmental attributes of one megawatt hour of electricity generated from a renewable source like solar or wind. A typical New York household requires about seven megawatt hours of electricity to be powered for a full year. RECs are used to substantiate environmental claims related to renewable energy use, such as for compliance with a State-mandated renewable compliance program, or for voluntary claims such as a climate action pledge. As such, RECs provide a tradable, traceable means for claiming the benefits of renewable electricity generation. In New York, under the Order Adopting the Clean Energy Standard, only eligible large-scale renewable facilities are able to generate Tier 1 RECs.[1] DER projects are compensated for environmental attributes under a separate compensation mechanism known as the environmental or "E" component of the VDER value stack.

2.1.3 How do large-scale solar projects make money?

Large-scale solar projects rely on two main streams of income to generate revenue and continue operations: 1. the sale of electricity generated by the renewable generator, typically either sold in the NYISO market (wholesale) or sold to an offtaker under a contract called a power purchase agreement, which compensate projects based on the power they generate, and 2. the sale of RECs to NYSERDA or another offtaker, which provides compensation for the project's environmental attributes. Through annual Renewable Energy Standard solicitations, NYSERDA seeks to purchase eligible RECs from renewable energy projects under long-term contracts to provide these projects with a predictable revenue stream via selling their RECs. Once a project is operational and transfers RECs to NYSERDA, they can then be sold to Load-Serving Entities, such as utilities, for compliance under the Clean Energy Standard. By providing a contract to renewable energy developers to purchase RECs from the projects they have built or plan to build, developers are granted financial security for their projects and, once operational, the RECs can be used by utilities to comply with environmental standards. It is important to note that projects do not receive payments from NYSERDA until they are operational and producing energy.[2]

2.1.4 What is the Investment Tax Credit?

Initially implemented in 2005, the Investment Tax Credit (ITC) is an important federal policy mechanism that has propelled the growth of solar across the United States. Section 48 of the Internal Revenue Code of 2006 (as amended) allows project owners or investors to be eligible for the federal business energy ITC for installing designated renewable energy generation equipment. The ITC allows project owners to apply a percentage of the project's engineering, procurement, and construction costs (such as the panels, inverters, and racking equipment) as a credit towards their income taxes. The ITC is a one-time dollar-for-dollar reduction, and does not cover interconnection or some other "soft" development and financing costs. The current ITC rate is set at 26% in 2020 and is scheduled to step down to 22% in 2021 and 10% in 2022. The ITC has been subject to frequent changes as energy policies have evolved. It is possible that the ITC may be modified or extended.

2.2 Local Benefits

2.2.1 What is RPTL §487?

New York State Real Property Tax Law (RPTL) Section §487 provides a 15-year exemption from real property taxation for renewable energy systems, including solar. This statute only applies to the value that a solar electric system adds to the overall value of the property; landowners with an installed renewable energy system continue to pay property tax on their homes and land. Property owners must also continue to pay special district taxes (such as a fire district tax payment, but could also include a library, sewer, water, or ambulance tax). The exemption has been a cornerstone of the State's efforts to meet its clean energy goals, providing essential economic incentives for solar. Local taxing jurisdictions do have the option to opt out of RPTL §487 and make the system fully taxable; however, projects may not be financially viable at full taxation. If a jurisdiction opts out of RPTL §487, it must opt out for systems of all sizes, not just large-scale, and must file copies of the local law opting out of RPTL §487 with both the New York Department of Taxation and Finance and NYSERDA.

[1] http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7B44C5D5B8-14C3-4F32-8399-F5487D6D8FE8%7D
[2] https://www.nyserda.ny.gov/All-Programs/Programs/Clean-Energy-Standard/REC-and-ZEC-Purchasers

2.2.2 What are PILOTs and Host Community Agreements?

If a taxing jurisdiction does not opt out of RPTL §487, it may enter into a payment-in-lieu-of-taxes (PILOT) agreement – an annual payment which replaces a portion of the property tax revenue a project would have otherwise generated. A PILOT cannot exceed the value of taxes that would be paid without the exemption. In order to negotiate a PILOT agreement, taxing jurisdictions must notify solar developers of their intent to require a PILOT within 60-days after being notified of the developer's intent to construct a project in their community. PILOT payments can also be paired with Host Community Agreements (HCAs), which provide certain benefits directly to the municipality hosting the project, and can be uniquely adapted for each municipality. Unlike PILOTs, which are typically distributed with constraints similar to tax revenue, HCAs are flexible and can be allocated as the host community sees fit.

2.2.3 Why should solar projects receive tax breaks?

Even while receiving an exemption under RPTL 487, a solar project can generate economic benefits in a community by growing the tax base, creating jobs, and generating supplemental income for farmers and landowners. Solar development can take place on existing or abandoned commercial sites, brownfields, landfills, agricultural lands, former industrial sites, and otherwise underutilized sites. Often, this land is generating minimal or no income for the municipality. By choosing to develop solar on this land, municipalities can turn underutilized sites into valuable and revenue-generating land, with the flexibility to direct PILOT payments or HCAs where the need is greatest. Full taxation typically discourages solar project development, and would cause communities to miss out on opportunities to fund local infrastructure and public services. Once installed, renewable energy systems do not create significant increased demands on municipal services or infrastructure, so PILOT payments usually provide a net benefit to the host community.

2.2.4 Is solar a good use of farmland?

While local governments can implement zoning laws to protect their most productive farmland, solar can be developed on farmland in a way that maintains the current economic benefits to the community and preserves prime farmland. In addition, solar projects can be designed with co-use in mind, as developers are more proactively designing project layouts that include fencing and water access for sheep, pollinator friendly landscaping for honey production, and compatible native vegetation for soil and water erosion prevention. When solar is developed on farmland, it often supplies the landowner with significantly higher income than they would have received without solar on the land, and can support the continuation of agricultural practices on farms with distressed economics, including ensuring that farms retain local ownership. As such, the local community benefits from PILOTs, HCAs, and land lease payments. These lease payments can provide farmers with 20 years or more of guaranteed financial security, diversifying their income while preserving the land for future use. Unlike alternative types of development, such as residential construction, after decommissioning at the end of a solar energy system's useful life, agricultural land can be returned to its original state and farming may resume.

In many instances, even while supporting solar, the land can continue to be used for agricultural operations such as livestock grazing, beekeeping, cultivation of certain crops, or planting of pollinator-friendly vegetation under and around the panels. New York has seen an emergence of solar projects that incorporate wildflowers and native plants to support bees, hummingbirds, and insects, and which may increase the future productivity of soil. Increasing the habitat for pollinators supports agricultural production and is great for New York's food supply.[3] Other options include planting shade-tolerant crops and elevating solar panels to allow farm equipment to pass safely underneath.[4]

2.2.5 My region is often overcast or cloudy. Does solar really make sense in New York?

Yes! It is a common misconception that solar only works well in climates where there is abundant sunshine. Solar panels do not require perfectly sunny weather to generate electricity, and modern solar resource datasets allow developers to accurately estimate the amount of sunshine at a given location. Solar photovoltaic (PV) technology continues to become more efficient, enabling solar projects to generate in the absence of strong, direct sunlight, and increasing the viability of project locations throughout New York. Additionally, the cooler temperatures in New York actually make panels more efficient. Combined with the strong demand for renewable energy throughout New York, availability of suitable land, and supportive policies, solar makes sense in most areas of New York State.[5]

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[3] "New York State's First Pollinator-Friendly Solar Farm." Cypress Creek Renewables, ccrenew.com/news/jefferson-solar-ribbon-cutting/.

[4] "Overview of Opportunities for Co-Location of Solar Energy Technologies and Vegetation." National Renewable Energy Laboratory, www.nrel.gov/docs/fy14osti/60240.pdf.

[5] Bobby Magill Follow "Rooftops in Cloudy Places Could Be Solar Gold Mines." Climate Central, 15 Apr. 2016, http://www.climatecentral.org/news/cloudy-places-could-be-solar-gold-mines-20253.

2.3 Safety

2.3.1 Are solar panels toxic?

Solar panels largely consist of widely-used and non-toxic components, including an aluminum frame, tempered glass, and various common plastics. The most common type of solar panel consists of crystalline silicon PV cells which generate electricity when exposed to light. These non-toxic crystalline silicon cells consist almost entirely of silicon, one of the most common elements in the Earth's crust.[6]

Cadmium-based thin-film solar panels are the second most common type of panel (accounting for less than 15% worldwide), however NYSERDA is not aware of any of these installations currently in New York.[7,8] While cadmium is toxic, the form of cadmium used in these types of solar panels is cadmium telluride (CdTe), which has 1/100th the toxicity of elemental cadmium. When a CdTe panel is exposed to fire, the glass panels absorb the cadmium such that more than 99.9% of the cadmium is stored in the glass itself and not released into the environment. CdTe panels have also passed the EPA's Toxic Characteristic Leaching Procedure test, which tests the potential for crushed panels in a landfill to leach hazardous substances into groundwater.

Some minor system components, including solder, may contain toxic chemicals at extremely low concentrations. Analysis performed by the North Carolina Clean Energy Technology Center did not find a potential toxicity threat from leaching, even in worst case scenarios (hurricane, fire, tornado, etc.), indicating an insignificant threat to human health and the environment.

Release of toxic chemicals from other solar system equipment including inverters, racking, and cabling is also unlikely as solar installations must conform to state fire safety and electric codes, and they pose little or no risk of contaminating the soil or ground water.

2.3.2 Can solar panels break and release toxic materials?

The most common solar panel failure modes include glass breakage and various failures of internal electrical connections, neither of which would typically result in the release of any materials to the environment. Solar panels are constructed primarily of silicon or cadmium telluride, tempered glass, and metals. Similar to a car windshield, when solar panels experience a catastrophic event, the panels typically stay fully intact, thus not releasing any materials into the environment.

Additionally, reputable solar panel manufacturers will ensure that their equipment is certified to applicable performance and safety standards including those established by the International Electrotechnical Commission (IEC) and Underwriters Laboratory (UL).

2.3.3 Do solar panels affect water runoff at the site?

Federal, state, and local rules are in place to ensure that solar arrays are installed in ways that protect public water supplies, wetlands, and other water resources. Rooftop solar systems have little to no effects on the direction or flow of water. Ground-mounted systems will be designed to manage runoff using deep-rooted vegetation such as "pollinator-friendly" grasses and wildflowers, pervious pavement, or topographical features such as berms, swales, or retention ponds, which can provide a net water quality benefit.

Various state agencies also maintain requirements and relevant guidance on this topic:

- The Department of Environmental Conservation's State Pollutant Discharge Elimination System (SPDES) website details permit requirements for stormwater discharge.[9]
- The Department of Agriculture and Markets' Guidelines for Solar Energy Projects includes guidance related to drainage for solar installations on agricultural lands.[10]

[6] "Health and Safety Impacts of Solar Photovoltaics." NC Clean Energy Technology Center, May 2017, ncsolarcen-prod.s3.amazonaws.com/wp-content/uploads/2017/10/Health-and-Safety-Impacts-of-Solar-Photovoltaics-2017_white-paper-1.pdf.
[7] https://data.ny.gov/Energy-Environment/Solar-Electric-Programs-Reported-by-NYSERDA-Beginn/3x8r-34rs
[8] "Crystalline Silicon Photovoltaics Research." Energy.gov, https://www.energy.gov/eere/solar/crystalline-silicon-photovoltaics-research
[9] State Pollutant Discharge Elimination System (SPDES) website https://www.dec.ny.gov/chemical/43133.html
[10] https://agriculture.ny.gov/system/files/documents/2019/10/solar_energy_guidelines.pdf

2.3.4 Should we be worried about electromagnetic fields (EMF) associated with solar?

There are two kinds of EMF; “ionizing fields,” which are high level and harmful, and “non-ionizing,” which are low-level and generally harmless. Non-ionizing radiation comes from computers, appliances, cell phones, and wireless routers, whereas ionizing radiation comes from harmful sources such as UV lights or X-rays. EMF from solar systems are non-ionizing, similar to that of your household appliances. Studies show that the exposure level within the array or at the fenced boundary of a system falls well below recommended exposure limits. This exposure level decreases even more as you move away from the system, and is nonexistent at night when the system is not producing energy. Ultimately, EMF from solar systems is extremely insignificant and cannot be associated with a health effect.[11]

2.3.5 Do solar panels create glare? I’m worried about the visual impacts for my town and aviation.

Solar panels are designed to be dark colors, usually black or blue, that absorb the sunlight to create electricity. If panels were reflecting the sun, or creating glare, they would not be effective. PV panels are designed with anti-reflective coating to increase panel efficiency and keep the level of reflected light around 2% - less than the reflectivity of water. Airports around the world have been installing PV arrays to provide onsite generation, and studies show that glare from the solar arrays is a negligible issue.[12]

2.3.6 Do solar panels create high ambient temperatures in their surroundings?

The theory that a functioning solar PV array increases the ambient temperature of its surroundings is known as the “heat island” effect. The “heat island” effect proposes that solar panels create a darker landscape that reflects less light, and therefore creates a localized area of increased heat. Few studies have been conducted on the subject, but it has been generally concluded that the area surrounding a large-scale solar array is unlikely to experience a net heating change from the panels. It is, however, possible to see some heating occur under the panels themselves. This can be mitigated with proper implementation of vegetative cover instead of gravel.[13] With any PV array, the significance of the heating depends on the location of the array, time of the year, and surrounding environment.[14, 15]

2.3.7 Does the fire department need special equipment to handle solar panel fires?

No special equipment is needed to handle solar panel fires, just proper training. Solar panels, like any electrical device, can be a fire hazard themselves or act as a physical barrier that hinders the ability of firefighters to put out an unrelated fire. Project developers and municipalities must ensure the local fire department is aware of the installation and informed about the procedures for de-electrifying the system and responding to incidents. In addition, the New York State Fire Code directly addresses solar PV installations, requiring clear labeling, instructions, setbacks, and safety features.

2.3.8 Are solar panels recyclable?

Solar panel recycling and disposal is not yet a major consideration in New York State, as most installations are newly operational and have a minimum 25-year expected useful life. It is, however, important to plan for the disposal of solar systems at the end of their useful life. Currently, there are no regulations requiring the recycling of solar panels in New York State, but it is best practice to reuse or recycle system components. Solar panels are classified as “general waste,” which means that they can be placed in a landfill. Solar panels can contain small amounts of toxic materials, but research shows that they generally do not pose a threat in landfills.[16]

Some solar energy system components, such as metal racking, can readily be reused or salvaged. Solar PV recycling is still in its infancy, though the ultimate goal is to recycle solar panels and recover any materials that may be reused or sold. At present, this is costly, but the industry is advancing; a 2016 study by the International Renewable Energy Agency (IRENA) estimates that recyclable materials in old solar modules will be worth $15 billion in recoverable assets by the year 2050.[17] Some examples of recycling opportunities in the United States include: Cascade Eco Minerals, Cleanlites, Echo Environmental, and First Solar.

2.3.9 Do solar PV systems generate noise?

Solar panels are noise-free, and residential solar inverters are quieter than a refrigerator. Large-scale, ground-mounted systems may have minor noise associated with the transformers and inverters within the array as well as the electrical equipment used as required for utility interconnection. Any system noise is typically at background levels at a distance of 50 to 150 feet from the site boundary.

2.3.10 How are endangered species protected?

Endangered species are accounted for and protected throughout the life of a large-scale solar project. First, solar projects must conduct an initial screening with the U.S. Fish and Wildlife Service to identify if endangered species are present in the area. In consultation with the New York State Department of Environmental Conservation (DEC) and U.S. Fish and Wildlife, developers must identify potential impacts to endangered or threatened species from facility construction, operation, or maintenance, and work with the DEC to mitigate impacts. Issues related to direct and indirect habitat loss, mortality, breeding, and wintering and migration patterns of bird and bats are all addressed during the process through which solar projects obtain their permits to construct, and inform the final design of the project and mitigation measures. Examples of potential mitigation measures include construction buffers around known bald eagle nests, avoiding disturbing sensitive habitat, and developing conservation funds to offset any unavoidable impacts.

2.3.11 Do solar panels contribute to bird loss?

The misconception that solar projects are a major contributor to bird loss has stemmed from issues with "concentrated solar thermal." This type of solar system, which constitutes a small percentage of US solar capacity and is located almost exclusively in the Southwest, uses mirrors to focus solar energy in order to power a steam generator. Bird loss in this situation occurs when birds fly through concentrated light reflection. Solar projects in New York, which use solar panels to convert sunlight into energy, do not reflect light or act as a mirrors. Due to this major design difference, there is a minimal impact on avian species.[19]

Questions?

If you have any questions regarding solar basics, please email questions to cleanenergyhelp@nyserda.ny.gov or request free technical assistance at nyserda.ny.gov/SolarGuidebook. The NYSERDA team looks forward to partnering with communities across the state to help them meet their solar energy goals.

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