



Solar 101



The rundown on photovoltaic systems

Photovoltaic (PV) systems absorb sunlight and use the energy to displace electrons, creating a flow of electricity.

- *Sunlight has energy, which is absorbed by semiconductor materials in PV panels and transferred to negatively charged particles, electrons, within the cell.*
- *The electrons begin to flow through the grid-like conductor materials on the panel as a current, creating electricity.*
- *This electricity can be channeled and used to power our homes, businesses, infrastructure, and more.*



“How Does Solar Work?” Energy.gov, Solar Energy Technology Office,
www.energy.gov/eere/solar/how-does-solar-work.

Emissions-free electricity

Solar energy does NOT produce harmful emissions and has several health benefits when compared to fossil fuels.

- *Widespread solar adoption would significantly reduce emissions of harmful gases released by burning fossil fuels, including Carbon Dioxide (CO₂), Nitrogen Oxide (NO_x), and Sulphur Dioxide (SO₂).*
- *Reducing these emissions deters a wide variety of human health issues and decreases the formation of smog and haze.*
- *Solar power results in fewer cases of chronic bronchitis, respiratory and cardiovascular problems, and lost workdays related to health issues.*

Grover, S. National Renewable Energy Laboratory, *Energy, Economic, and Environmental Benefits of the Solar America Initiative*, www.nrel.gov/docs/fy07osti/41998.pdf.



Diversifying our energy market

Relying on multiple forms of electricity ensures reliability and cost effectiveness.

- *More types of energy available mean ensured electric power 24-7-365.*
- *A diverse grid offers a safety net during extreme weather or other circumstances.*
- *Regional Transmission Operators deploy energy resources in least-cost order until the demand is met.*
 - *Wind and solar are chosen first because they're zero-fuel-cost sources.*



“The Diversity of Our Energy Market.” *Sustainable Energy Fund*, 17 June 2020, www.thesef.org/diversity-of-energy-market/.
Singh, Hardika. “Utility-Scale Solar Could Provide Significant Economic Impacts to Ohio, Study Finds.” *OHIO News*, Ohio University, 7 Oct. 2020, www.ohio.edu/news/2020/10/utility-scale-solar-could-provide-significant-economic-impacts-ohio-study-finds. “Lazard’s Levelized Cost of Energy Analysis—VERSION 12.” Lazard, Nov. 2018, www.lazard.com/media/450784/lazards-levelized-cost-of-energy-version-120-vfinal.pdf.

Use of Prime farmland

Prime farmland is used for many different purposes and is sometimes needed to site solar projects.

- *Prime farmland is “land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses.” (NRCS)*
- *Solar is a cash crop with a small footprint; 1 MW of solar requires only 7-10 acres of land.*
- *64% of prime farmland is cropland, which is used for:*
- *Limiting use of prime farmland jeopardizes private property rights and hinders development of projects that are vital to our economy and communities.*



Ethanol



Urban Sprawl



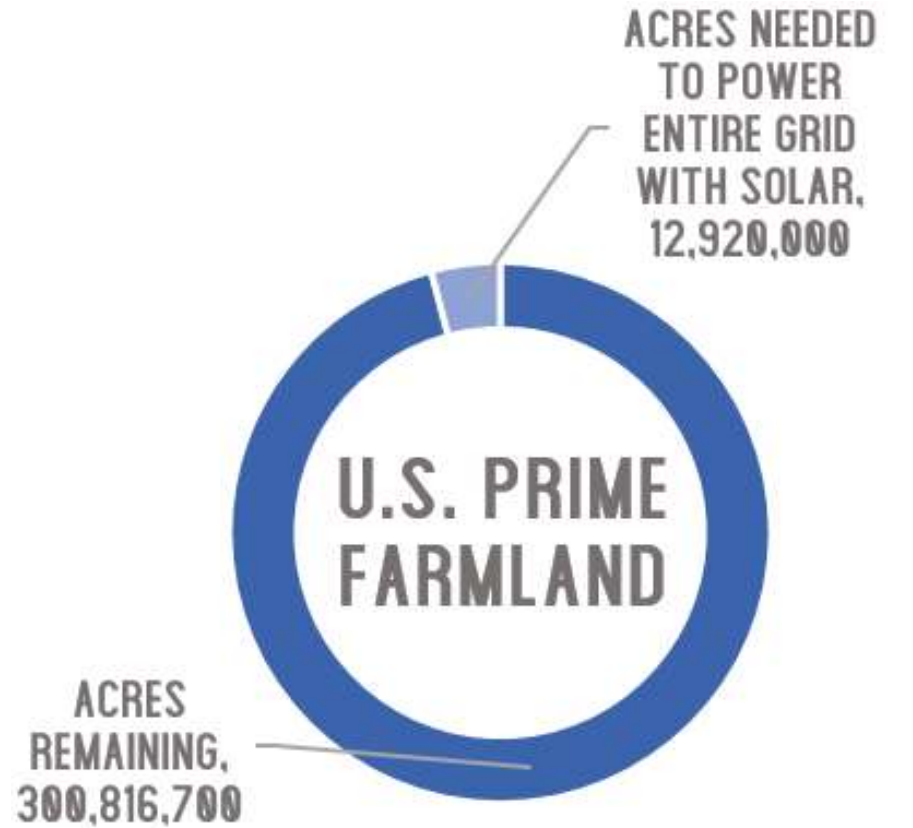
Rural Transport

U.S. Department of Agriculture. 2020. Summary Report: 2017 National Resources Inventory, Natural Resources Conservation Service, Washington, DC, and Center for Survey Statistics and Methodology, Iowa State University, Ames, Iowa. <https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/nri/results/> “Prime Farmland ‘Top Ten’ States.” *National Resources Conservation Service*, National Resources Inventory, 1997, Dec. 2000, www.nrcs.usda.gov/wps/portal/nrcs/detail/null/?cid=nrcs143_014052. Ong, Sean, et al. NREL - National Renewable Energy Laboratory, 2013, p. V, Land-Use Requirements for Solar Power Plants in the United States.



Land use in perspective:

Powering the entire US Grid with solar would use a maximum of only 4.9% of all US Prime Farmland.

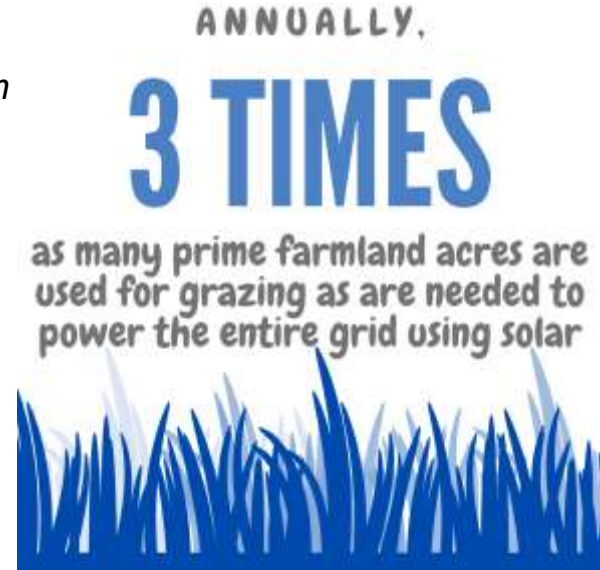


NREL, EIA, National Resources Inventory 2017

Conservation planning

Solar and wind can coexist with a variety of conservation efforts.

- *Pair beehives with pollinator-friendly native plants and flowers in and around the project area.*
- *Manage vegetation using sheep and goats instead of mowing, leading to:*
 - *healthier soil*
 - *improved water storage and filtration*
 - *sequestration of carbon, erosion reduction*
 - *habitat preservation*
 - *lower local energy costs*



Benage, Megan, et al. "Guidance for Developing a Vegetation Establishment and Management Plan for Solar Facilities." *Environmental Review of Energy Projects*, MN Commerce Department; Division of Energy Resources, Mar. 2021, <https://apps.commerce.state.mn.us/eera/web/page/home> "U.S. Energy Information Administration - Eia - Independent Statistics and Analysis." Use of Electricity - U.S. Energy Information Administration (EIA), 7 Apr. 2021, www.eia.gov/energyexplained/electricity/use-of-electricity.php.

Landowner and community benefits

Solar projects generate tax revenue that can be invested into rural communities.

- *Millions of dollars of taxes paid by solar projects can be reinvested into local projects such as:*



Schools



Hospitals



Infrastructure

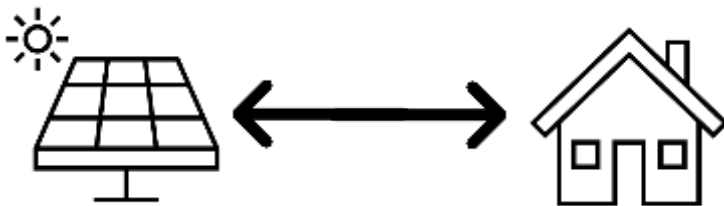
- *This revenue keeps property taxes low for all residents.*
- *Landowners receive land-lease payments for the life of the project.*
- *More money in the community creates a ripple-effect of economic development.*

Brookshire, Daniel, et al. NC Sustainable Energy Association, 2020, *Increased North Carolina County Tax Revenue from Solar Development - 2020 Update*.

Safety and security: Solar setbacks

Solar setbacks are distancing requirements that separate solar projects from residences and private property.

- *Solar setbacks establish the distance a solar installation must be sited away from nearby residences.*
- *Ground-mounted solar projects must be set back from homes to ensure visibility and access, traffic safety, ventilation, and vegetation management.*
- *Setbacks are typically determined locally, allowing communities to determine the best practices for their area and landscape.*



“Solar Energy: SolSmart's Toolkit for Local Governments. Planning, Zoning, & Development.” *SolSmart*, U.S. Department of Energy Solar Energy Technologies Office, <https://solsmart.org/solar-energy-a-toolkit-for-local-governments/planning-zoning-development/>.

Stormwater and Drainage

Solar systems are regulated to ensure healthy stormwater management and drainage.

- *According to the National Renewable Energy Laboratory (NREL) projects such as the Photovoltaic Stormwater Management Research and Testing (PV-SMaRT) address these concerns by:*
 - *Communicating with experts on water quality*
 - *Conducting field research on stormwater infiltration and runoff at five ground-mounted PV sites in five states: Minnesota, New York, Oregon, Colorado, and Georgia*
 - *Validating models to predict stormwater runoff for a range of site conditions and PV designs*
 - *Developing best practices for stormwater management and water quality at ground-mounted PV sites, based on research findings*
- *The EPA requires construction projects that disturb more than one acre of land to obtain stormwater permits, protecting water quality and wildlife.*
 - *Permits ensure plans are made to prevent erosion and discharge of sediments.*

Daw, Jennifer. "Photovoltaic Stormwater Management Research and Testing." NREL.gov, 2020, www.nrel.gov/solar/pv-smart.html.
"Stormwater Discharges from Construction Activities." EPA, Environmental Protection Agency, www.epa.gov/npdes/stormwater-discharges-construction-activities.

Built To last: Solar panels and severe weather

Solar panels are tested for durability to ensure they can withstand hurricanes and severe hail.

- *Before installation, solar panels are required to withstand tests that simulate severe storms.*
- *Manufacturers are held accountable by organizations such as the International PV Quality Assurance Taskforce, which develops standardized tests to assure that solar panels can survive the following and more:*
 - *Mechanical stressors (hail, being walked on, etc.)*
 - *Excessive cold or heat*
 - *Humidity*



“Hail No! National Lab's Solar Panels Survive Severe Storm.” *Energy.gov*, Office of Energy Efficiency & Renewable Energy, 15 May 2017, www.energy.gov/eere/articles/hail-no-national-labs-solar-panels-survive-severe-storm.

PV systems at the end of their assigned life

There are several ways to retire a solar farm, including extension, refurbishment, repowering, or decommissioning.

- *Landowners may extend the life of a solar farm at the end of its 20–30-year lifespan, maintaining the existing structures to continue electricity production.*
- *The solar plant may be refurbished or repowered, whereby the panels are replaced with newer/updated technology that is also likely more efficient.*
- *Solar panels can be completely dismantled. This is called decommissioning. When this happens, the land can be reverted to its original purpose or altered for other infrastructure or development.*
- *Solar installations are a great way to preserve the land for future farming. It gives the soil time to rest and regenerate.*

Curtis, Taylor, Garvin Heath, Andy Walker, Jal Desai, Edward Settle, and Cesar Barbosa. 2021. Best Practices at the End of the Photovoltaic System Performance Period. National Renewable Energy Laboratory. NREL/TP-5D00-78678. www.nrel.gov/docs/fy21osti/78678.pdf.

Frequently asked Questions



Do solar panels work on cloudy days or at night?

Yes, solar panels can still function in the absence of direct sunlight.

- *Solar panels can absorb both direct and indirect sunlight to produce electricity.*
- *When there is less sunlight available, there is less for the PV cells to absorb, and therefore less electricity can be produced.*
- *Solar panels do not produce electricity at night, but solutions such as battery storage and net metering allow users to access electricity previously produced or electricity from other sources on the grid to meet their energy needs.*

“What Happens to Solar Panels When It's Cloudy or Raining?” SEIA - Solar Energy Industries Association, www.seia.org/initiatives/what-happens-solar-panels-when-its-cloudy-or-raining.

Do solar panels release chemicals into the environment?

No; the materials used to make solar panels are sealed and contained so they do not affect the surrounding area.

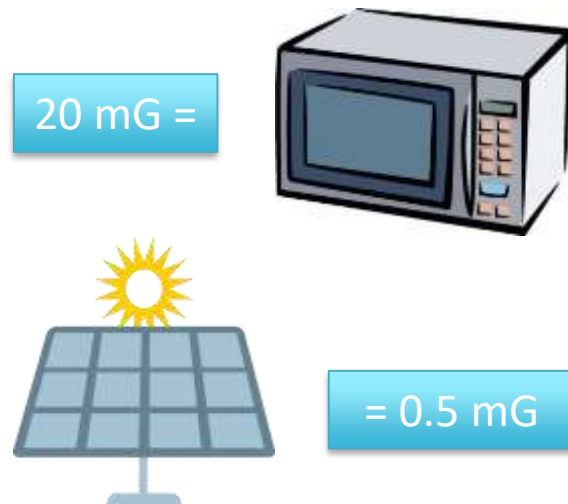
- *Solar panels contain a variety of materials, including silicon and different types of metals.*
- *All components are laminated and enclosed to prevent external factors damaging the functionality of the system; the materials within the panels cannot evaporate or mix with water to leak into the surrounding environment.*
- *The only risk that could allow these materials out is through large fires at extremely high temperatures. With proper maintenance of solar arrays this is largely preventable.*

Clean Energy Results, 2015, *Questions & Answers Ground-Mounted Solar Photovoltaic Systems*, www.mass.gov/doc/ground-mounted-pv-guide/download.

What is EMF and how is it related to solar?

Electromagnetic Fields (EMFs) are produced by solar panels at levels similar to those created by household appliances.

- *Solar panels generate non-ionizing electromagnetic fields (EMF), which is different from the ionizing radiation produced by x-rays.*
 - *Non-ionizing radiation makes enough energy to heat things, but not displace electrons from their atoms and molecules or damage DNA.*
- *Off-site exposure levels to these frequencies are low: about 0.5 mG (milligauss – the unit used to measure EMF strength) at site boundaries.*
 - *In comparison, standing within four feet of your microwave while in use can result in up to 20 mG of EMF exposure.*



“Radiation Studies - CDC: Non-Ionizing Radiation.” *Centers for Disease Control and Prevention*, 7 Dec. 2015, www.cdc.gov/nceh/radiation/nonionizing_radiation.html.

“Electric & Magnetic Fields.” *National Institute of Environmental Health Sciences*, U.S. Department of Health and Human Services, 14 May 2020, www.niehs.nih.gov/health/topics/agents/emf/index.cfm

Will solar decrease my property value?

No; Large solar projects often have no negative impact on property values. In some cases, they may even have tangible positive effects.

- *Large-scale solar arrays often have no measurable decrease on the value of adjacent properties, and in some cases may even have positive effects.*
- *Proximity to solar farms does not negatively impact the sales of agricultural or residential land or deter its purchase.*
- *On residential properties, installation of rooftop solar panels can drive the value of a home up to 4.1% higher than it would have been without the project.*

“Solar & Property Value.” SEIA - Solar Energy Industries Association, July 2019, www.seia.org/research-resources/solar-property-value

Mikhitarian, Sarah. “Homes With Solar Panels Sell for 4.1% More.” Zillow Research, Zillow, 16 Apr. 2019, www.zillow.com/research/solar-panels-house-sell-more-23798/

Do solar panels cause fires?

Fires from solar projects are very rare, but also very preventable.

- *As with any electric device, poorly maintained wiring and connections can pose a fire risk.*
- *It is important to ensure that all solar projects are appropriately serviced and cared for to prevent fires.*
- **Four key ways** to prevent fires, according to Luke Magon, Owner and Managing Director of ScanPro, Asset and Infrastructure Monitoring:
 - *1) Manage the surrounding environment through vegetation control,*
 - *2) Manage all energized equipment and ensure proper sealing,*
 - *3) Document maintenance through visual inspection,*
 - *4) Address future expectations and changes to be made.*

Magon, Luke. "Mitigating the Risk of Fire on Utility Scale Solar Facilities." *LinkedIn*, 11 Feb. 2020, www.linkedin.com/pulse/mitigating-risk-fire-utility-scale-solar-facilities-luke-magon/.

Do solar Panels cause glare?

No; solar panels are designed to absorb light, not reflect it, and cause less glare than home window glass.

- *Solar panels cause less glare than that of standard home windows, snow, white concrete, and energy-efficient white rooftops.*
- *Even though solar panels are somewhat shiny, they are designed to absorb light rather than reflect it.*
- *Any reflected light cannot be converted into electricity, so the creators of PV solar modules have worked hard to ensure minimal reflection.*

“The Truth about Photovoltaic Panels and Glare: IWS.” *Intermountain Wind & Solar*, www.intermtnwindandsolar.com/the-truth-about-photovoltaic-panels-and-glare/.

Day, Megan, and Benjamin Mow. “Research and Analysis Demonstrate the Lack of Impacts of Glare from Photovoltaic Modules.” NREL - National Renewable Energy Laboratory, U.S. Department of Energy, 31 July 2018, www.nrel.gov/state-local-tribal/blog/posts/research-and-analysis-demonstrate-the-lack-of-impacts-of-glare-from-photovoltaic-modules.html.

Is solar disruptive?

No; solar panels are effectively silent and landscaping techniques can minimize visibility to onlookers.

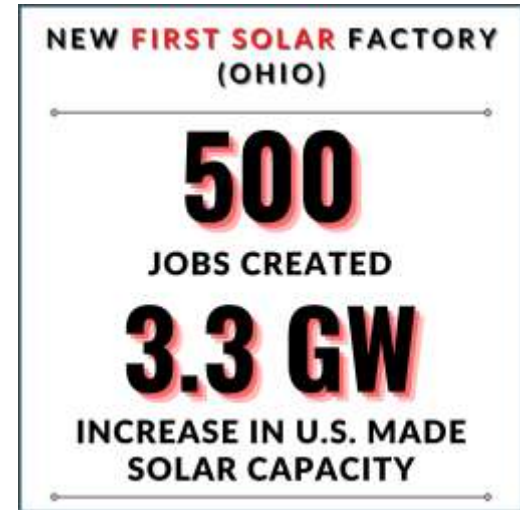
- *Though tracking motors and inverters may make a soft humming sound, this noise is not typically audible from outside the solar enclosure.*
- *Noise associated with solar panels is limited to their construction and removal, which are brief moments over the course of a solar farm's life.*
- *Hedges, bushes, and trees are all viable and effective landscaping solutions that can act as screens to guise the visibility of solar farms in action.*
- *Landscaping contributes to the health and wellbeing of the earth; plants remove Carbon Dioxide (CO₂) from the atmosphere through photosynthesis, helping to combat global warming.*

“Solar & Property Value.” SEIA - Solar Energy Industries Association, www.seia.org/research-resources/solar-property-value. National Geographic Society. “Photosynthesis.” National Geographic Society, 5 Sept. 2019, www.nationalgeographic.org/encyclopedia/photosynthesis/

Where are solar panels manufactured?

Solar panels and cells are increasingly being manufactured in the United States, but most are still produced internationally.

- *As of 2020, there were more than 24 companies with solar panels made in the U.S. with a generation capacity of about 12.4 GW*
- *The utility-scale solar industry employs 120,000 Americans across all 50 states.*
- *A 2018 tariff imposed on all solar cell and panel imports has led U.S. solar companies to open new factories, manufacturing more of their materials domestically.*



Matasci, Sara. "American Made Solar Panels: List of U.S. Manufacturers." *Solar News*, EnergySage, 4 June 2019,

<https://news.energysage.com/u-s-solar-panel-manufacturers-list-american-made-solar-panels/>

"U.S. Solar Panel Manufacturers." *Solar Power World*, 3 Aug. 2021, www.solarpowerworldonline.com/u-s-solar-panel-manufacturers/.

What happens to decommissioned solar panels?

Solar panels that are removed from use can be disassembled and recycled for use in other products or refurbished and resold.

- *Silicon PV modules are primarily made of glass, aluminum, and plastic, which can all be easily recycled.*
- *The glass content of panels is increasing over time in efforts to maximize efficiency in energy absorption, a process that allows for even more simple recycling processes.*
- *Some solar panels contain metals such as cadmium, gallium arsenide, or chromium, which must be treated as hazardous waste and handled accordingly.*
- *Decommissioned solar panels can be repurposed and resold, which is more cost effective and sustainable than recycling.*

IRENA and IEA-PVPS (2016), “End-of-Life Management: Solar Photovoltaic Panels,” International Renewable Energy Agency and International Energy Agency Photovoltaic Power Systems, www.irena.org/publications/2016/Jun/End-of-life-management-Solar-Photovoltaic-Panels

“Shining Some Light on Solar Panels.” South Carolina Department of Health and Environmental Control , Apr. 2018, www.scdhec.gov/sites/default/files/Library/OR-1695.pdf



THANK YOU



ADDRESS

570 Asbury Street, Suite 201, St. Paul, MN 55104

OFFICE

651.644.3400

WEB

CleanGridAlliance.org



@CGA_Midwest



@cleangridalliance



@clean-grid-alliance