JOINT STATE GOVERNMENT COMMISSION

General Assembly of the Commonwealth of Pennsylvania

Agrivoltaic Farming in Pennsylvania

Report of the Advisory Committee

May 2025

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REPORT

House Resolution 224 (2023)
Agrivoltaic Farming in Pennsylvania

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The report is available at http://jsg.legis.state.pa.us

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JOINT STATE GOVERNMENT COMMISSION

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The Joint State Government Commission was created in 1937 as the primary and central non-partisan, bicameral research and policy development agency for the General Assembly of Pennsylvania.[1]

A fourteen-member Executive Committee comprised of the leadership of both the House of Representatives and the Senate oversees the Commission. The seven Executive Committee members from the House of Representatives are the Speaker, the Majority and Minority Leaders, the Majority and Minority Whips, and the Majority and Minority Caucus Chairs. The seven Executive Committee members from the Senate are the President Pro Tempore, the Majority and Minority Leaders, the Majority and Minority Whips, and the Majority and Minority Caucus Chairs. By statute, the Executive Committee selects a chairman of the Commission from among the members of the General Assembly. Historically, the Executive Committee has also selected a Vice-Chair or Treasurer, or both, for the Commission.

The studies conducted by the Commission are authorized by statute or by a simple or joint resolution. In general, the Commission has the power to conduct investigations, study issues, and gather information as directed by the General Assembly. The Commission provides in-depth research on a variety of topics, crafts recommendations to improve public policy and statutory law, and works closely with legislators and their staff.

A Commission study may involve the appointment of a legislative task force, composed of a specified number of legislators from the House of Representatives or the Senate, or both, as set forth in the enabling statute or resolution. In addition to following the progress of a particular study, the principal role of a task force is to determine whether to authorize the publication of any report resulting from the study and the introduction of any proposed legislation contained in the report. However, task force authorization does not necessarily reflect endorsement of all the findings and recommendations contained in a report.

Some studies involve an appointed advisory committee of professionals or interested parties from across the Commonwealth with expertise in a particular topic; others are managed exclusively by Commission staff with the informal involvement of representatives of those entities that can provide insight and information regarding the particular topic. When a study involves an advisory committee, the Commission seeks consensus among the members.[2] Although an advisory committee member may represent a particular department, agency, association, or group, such representation does not necessarily reflect the endorsement of the department, agency, association, or group of all the findings and recommendations contained in a study report.

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[1] Act of July 1, 1937 (P.L.2460, No.459); 46 P.S. §§ 65–69.

[2] Consensus does not necessarily reflect unanimity among the advisory committee members on each individual policy or legislative recommendation. At a minimum, it reflects the views of a substantial majority of the advisory committee, gained after lengthy review and discussion.

Over the years, nearly one thousand individuals from across the Commonwealth have served as members of the Commission's numerous advisory committees or have assisted the Commission with its studies. Members of advisory committees bring a wide range of knowledge and experience to deliberations involving a particular study. Individuals from countless backgrounds have contributed to the work of the Commission, such as attorneys, judges, professors and other educators, state and local officials, physicians and other health care professionals, business and community leaders, service providers, administrators and other professionals, law enforcement personnel, and concerned citizens. In addition, members of advisory committees donate their time to serve the public good; they are not compensated for their service as members. Consequently, the Commonwealth receives the financial benefit of such volunteerism, along with their shared expertise in developing statutory language and public policy recommendations to improve the law in Pennsylvania.

The Commission periodically reports its findings and recommendations, along with any proposed legislation, to the General Assembly. Certain studies have specific timelines for the publication of a report, as in the case of a discrete or timely topic; other studies, given their complex or considerable nature, are ongoing and involve the publication of periodic reports. Completion of a study, or a particular aspect of an ongoing study, generally results in the publication of a report setting forth background material, policy recommendations, and proposed legislation. However, the release of a report by the Commission does not necessarily reflect the endorsement by the members of the Executive Committee, or the Chair or Vice-Chair of the Commission, of all the findings, recommendations, or conclusions contained in the report. A report containing proposed legislation may also contain official comments, which may be used to construe or apply its provisions.[3]

Since its inception, the Commission has published over 450 reports on a sweeping range of topics, including administrative law and procedure; agriculture; athletics and sports; banks and banking; commerce and trade; the commercial code; crimes and offenses; decedents, estates, and fiduciaries; detectives and private police; domestic relations; education; elections; eminent domain; environmental resources; escheats; fish; forests, waters, and state parks; game; health and safety; historical sites and museums; insolvency and assignments; insurance; the judiciary and judicial procedure; labor; law and justice; the legislature; liquor; mechanics' liens; mental health; military affairs; mines and mining; municipalities; prisons and parole; procurement; state-licensed professions and occupations; public utilities; public welfare; real and personal property; state government; taxation and fiscal affairs; transportation; vehicles; and workers' compensation.

Following the completion of a report, subsequent action on the part of the Commission may be required, and, as necessary, the Commission will draft legislation and statutory amendments, update research, track legislation through the legislative process, attend hearings, and answer questions from legislators, legislative staff, interest groups, and constituents.

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[3] 1 Pa.C.S. § 1939.

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May 2025

To the Members of the General Assembly of Pennsylvania:

We are pleased to release Agrivoltaic Farming in Pennsylvania in response to House Resolution 224, Pr.'s No. 2061 (2023), which directed the Joint State Government Commission to conduct a study of agrivoltaic farming in Pennsylvania. Agrivoltaic farming combines farming with the collection of solar energy and contributes to Pennsylvania's energy independence.

The Commission was directed to appoint an advisory committee composed of stakeholders in the agricultural sector to assist in the study of how solar energy is produced and the federal and state regulatory climate that governs it. The report presents the current state of farmland preservation in Pennsylvania and how it impacts potential solar development. The report examines the interplay of agricultural production and solar energy production and how the two can co-exist in the field of agrivoltaics.

The report concludes with findings and recommendations on legislative solutions to preserve and boost Pennsylvania farms, suggestions to stabilize rising costs for farmers, and methods to facilitate the complementary nature of agrivoltaics farming and solar energy production.

The report may be found at our website, https://jsg.legis.state.pa.us.

Respectfully submitted,

Glenn J. Pasewicz
Executive Director

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INTRODUCTION

Despite the best efforts of Benjamin Franklin and Nikola Tesla, no one has successfully harnessed the raw electricity generated in nature to any kind of reliable degree. Instead, electricity must be generated from the conversion of other sources, such as water, wind, or fossil fuels like coal and natural gas. More recently, geothermal, solar, biomass, and methane have been developed as alternative sources of energy. Concerns over diminishing fossil fuel reserves, the costs of retrieving increasingly inaccessible stores of those fuels, and dependence on international suppliers have all contributed to a growing interest in the development of alternative energy sources. Many of these alternative sources, such as solar, wind and geothermal, are attractive to some policymakers as a potentially unlimited, "homegrown" resource. All these alternative energy resources require land for infrastructure, and for solar energy in particular, the land that is most convenient for solar development is frequently under agricultural use.

Agriculture has been a major industry in Pennsylvania since its earliest days. When William Penn traveled in 1677 to the southwestern region of what is now modern Germany, he issued a twofold invitation to would-be immigrants to his lands in the New World: Come for the religious freedom and the cheap, fertile farmland. And they came in droves. By 1790, first generation Germans and their descendants comprised approximately one-third of the total population of Pennsylvania. Farms of all sizes were spread across the colony, with smaller farms in the eastern part of the state and larger ones west beyond the Susquehanna River.[4] Nearly 350 years later, agriculture remains a significant sector of the state economy. With more than 25 percent of the acreage of the state devoted to farmland, agriculture contributes $132.5 billion to the state economy and supports more than 593,000 jobs. Agriculture supports one in ten jobs in Pennsylvania, and 6.25 percent of the gross state product.[5] However, Pennsylvania has been losing farms and farmlands for at least 15 years.[6]

[4] John G. Gagliardo, "Germans and Agriculture in Colonial Pennsylvania," *The Pennsylvania Magazine of History and Biography,* The Historical Society of Pennsylvania, Vol. 83, No. 2, April 1959. https://journals.psu.edu/pmhb/article/view/41466#.

[5] Commonwealth of Pennsylvania, Department of Agriculture, "About The Pennsylvania Department of Agriculture," https://www.pa.gov/en/agencies/pda/about-pda.html

[6] See Peter Wulfhorst, "Mitigating the Impact of Declining Farms in Pennsylvania, *Penn State Extension,* July 13, 2022, https://extension.psu.edu/mitigating-the-impact-of-declining-farms-in-pennsylvania and Rachel Wagoner, "Ohio and Pennsylvania continue to lose farms, farmland,", *Farm and Dairy,* February 23, 2024, https://www.farmanddairy.com/news/ohio-and-pennsylvania-continue-to-lose-farms-farmland/813342.html

By far, the biggest threat to farmland is low-density residential development, followed by urban high-density development (warehouse and fulfillment center complexes in particular),[7] but solar energy production is also a potential source of farmland loss. At least since the OPEC oil embargo of 1973, the need for the United States to be energy independent has continued to grow. Both the federal government and Pennsylvania's governor and lawmakers have sought to increase energy production in the Commonwealth. Solar energy has the potential to increase that independence, but unfortunately, solar energy collection frequently comes at the expense of the best farmland. In the interests of combining those two uses, House Resolution 224, Printer's No. 2061 (2023) directed the Joint State Government Commission to conduct a study of agrivoltaic farming in Pennsylvania. Agrivoltaic farming provides for the simultaneous use of farmland for agricultural production and solar energy harvesting, consequently protecting farming interests while increasing energy independence.

The Commission was directed to form an advisory committee composed of various stakeholders in the agricultural sector to assist in the study and to report findings and recommendations on:

1) A comprehensive accounting of which state, county and local agencies utilize or would benefit from agrivoltaics farming systems;
2) Legislative solutions to boost agricultural productivity;
3) Suggestions to stabilize rising input costs for farmers; and
4) Methods to facilitate the complementary nature of agrivoltaics farming and solar energy production.

While the recommendations reproduced in this report are the consensus of the members of the advisory committee, it should not be assumed by the reader that agreement was unanimous. Some provisions were the subject of much debate and concerns are noted in context.

This report will examine how solar energy is produced, and the federal and state regulatory climate it is governed by. The report then looks at the current state of farmland preservation in Pennsylvania and how it impacts potential solar development. Ultimately, this report looks at the interplay of agricultural production and solar energy production, and how they can co-exist in the field of agrivoltaics.

[7] "Farms Under Threat: The State of the States," American Farmland Trust, https://farmland.org/project/farms-under-threat/. See also, Philip Gruber, Stephanie Speicher, and Tom Venesky, "Huge Warehouses Threaten Pennsylvania Farmland. Where Can They Be Built?", *Lancaster Farming,* November 2, 2023, https://www.lancasterfarming.com/farming-news/ag-business/huge-warehouses-threaten-pennsylvania-farmland-where-can-they-be-built/article_943bad36-77fd-11ee-8a56-1f55cac5779e.html. See also Wolfhurst, *Penn State Extension.*

Note on Terminology:

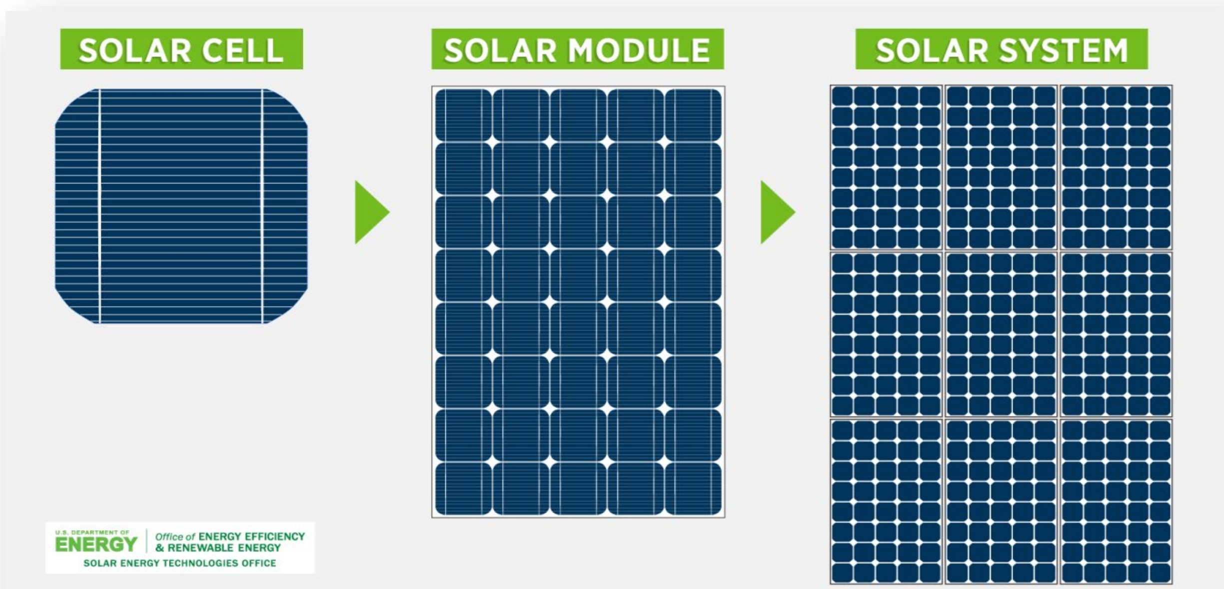
Throughout this report, the term "agrivoltaics" is used to describe the collocation of solar panels and agricultural activities. Some of the sources reviewed in this study refer to the practice of "agrisolar" and occasional references may be seen to this term. In the Europe, "agrivoltaics" is more heavily regulated, and country-approved definitions of practices must be met to qualify for European Union subsidies for agrivoltaics projects. Many of these countries use a narrower definition of agrivoltaics that tends to exclude solar panels on barns or other farm buildings, and pollinator habitats. To distinguish between these types of activities, the broader term of "agrisolar" has been used in Europe to identify all projects that combine agriculture with solar power. The term "agrisolar" does not seem to be in significant use in the United States. Additionally, the United States Department of Energy's National Renewable Energy Lab (NREL) uses the term "agrivoltaics" and includes pollinator habitat under that rubric. Accordingly, this report uses the term "agrivoltaics" unless the term "agrisolar" is part of a quotation or is in a citation.

This chapter will review how solar energy is typically produced, and the federal and Pennsylvania energy laws impacting solar energy development.

Solar Photovoltaic (PV) Energy Production

The type of solar energy which chiefly concerns this report is photovoltaics (PV), more often known to the public as solar panels. These panels are composed of cells made of ultrathin semi-conducting materials, such as silicone, which absorbs sunlight and creates electricity.[8] These delicate PV cells are encased in layers of plastic and glass to protect them against outside elements. While individual PV cells may be able to produce one to two watts of power, when many cells are chained together in a panel (sometimes called a module) they can produce between 250 to 400 watts.[9] When many solar panels are configured together, they are called solar arrays.

Figure 1
Typical Residential Rooftop Solar System
2019



Source: U.S. Dept. of Energy, "PV Cells 101: A Primer on the Solar Photovoltaic Cell."

[8] U.S. Dept. of Energy, "Solar Photovoltaic Technology Basics," Energy.gov, accessed January 7, 2025. https://www.energy.gov/eere/solar/solar-photovoltaic-technology-basics
[9] U.S. Dept. of Energy, "Solar Photovoltaic Technology Basics."

In addition to solar arrays, there are other components in a solar energy system. Mounting structures attach modules to either ground, a roof, or support scaffolding. Solar systems also need converters to change the direct current of electricity generated into alternating current. PV technology is still improving and over the last two decades panels have become cheaper, tougher, and more efficient at converting sunlight into electricity.

Photovoltaics convert sunlight into direct current (DC) electricity. Briefly:

> PV cells generate direct current (DC) electricity. DC electricity can be used to charge batteries that power devices that use DC electricity. Nearly all electricity is supplied as alternating current (AC) in electricity transmission and distribution systems. Devices called inverters are used on PV panels or in PV arrays to convert the DC electricity to AC electricity.
>
> PV cells and panels produce the most electricity when they are directly facing the sun. PV panels and arrays can use tracking systems to keep the panels facing the sun, but these systems are expensive. Most PV systems have panels in a fixed position that are usually facing directly south in the northern hemisphere—or directly north in the southern hemisphere—at an angle that optimizes the physical and economic performance of the system.[10]

The use of photovoltaics in solar energy production is covered by broad federal and state energy law and policy.

Distribution of Solar Energy

The size of photovoltaic arrays and how much energy they produce affects how those who own the panels use this electricity and supply it to others. Government policies determine how energy produced by solar arrays is used at individual, community, and grid scales.

Given the history of PV in the Commonwealth, the current disquiet about recent solar development throughout Pennsylvania must be placed in context. PV solar is a very scalable source of electricity generation. The larger the plant, the cheaper the energy produced, which incentivizes the creation of large solar projects. The largest PV solar plant in the U.S. is Solar Star in California, which produces 579 MW of electricity across two sites,[11] which is enough to power 255,000 homes. For reference the average size of a residential solar system in Pennsylvania between five to eight kW, a thousand times smaller.[12]

[10] U.S. Energy Information Administration," Solar Explained: Photovoltaics and Electricity," accessed November 19, 2024. https://www.eia.gov/energyexplained/solar/photovoltaics-and-electricity.php
[11] "Solar Star Projects, Antelope Valley, California, USA," NS Energy, February 7, 2020. https://www.nsenergybusiness.com/projects/solar-star-projects-california/
[12] "Frequently Asked Questions," The Pennsylvania Solar Center, October 3, 2022. https://pasolarcenter.org/get-solar/frequently-asked-questions/https://pasolarcenter.org/get-solar/frequently-asked-questions/

Off-Grid Systems

One of the main considerations for PV systems is whether they are connected to the wider energy grid or not. Typically, only the smallest solar systems are not connected to a grid and therefore rely on batteries to provide a constant flow of power to a location when the system is not producing electricity from sunlight. Off-grid solar systems may require back-up sources of energy, such as from gas powered generators.[13] This report focuses on solar systems tied into electricity grids.

Net Metering

In a typical grid-tied solar system where residences or businesses with a solar system produce more energy than a location consumes, the excess electricity flows into the grid. Both the electricity consumed and produced by a location is recorded in an electric utility's meter and the excess electricity is recorded as credits to the solar-producer's bill. The billing practice is referred to as net metering, a term is frequently applied generally to the system and billing. This is also called customer generation or a distributed energy resource.[14] Excess credit is rolled over and applied to a subsequent month's bill allowing customer generators to save money on months when they produce less electricity due to seasonal variations in the weather. At the end of the billing year customer generators with excess money are paid the excess in a retail cost of the electricity minus transmitting the energy. This is called "price to compare."[15] According to the Pennsylvania Public Utility Commission, there are a total of 73,181 customer generators with solar panels participating in net metering as of 2024.[16] These customer-generators have a total generational nameplate capacity of 738,665 kW.[17] This the upper limit of what these customer-generators could produce.

As of 2023, Pennsylvania was one of 34 states that mandated net metering be available through utility providers.[18] Rural electric cooperatives are not currently required by Pennsylvania law to provide net metering but may choose to do so. [19]

Pennsylvania state policy has set the limit for residential net metering credits to the equivalent of 50 kilowatts, which is the amount of electricity produced by approximately 100 solar panels costing $135,000.[20]

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[13] Sara Wolf, "Grid-Tied vs. Off-Grid Solar Systems," Paradise Energy (blog), August 15, 2024. https://www.paradisesolarenergy.com/blog/grid-tied-solar-vs-off-grid-solar-systems

[14] Gary Musgrave, "The Origins and Meaning of Net Metering," Penn State Extension, March 9, 2023. https://extension.psu.edu/the-origins-and-meaning-of-net-metering

[15] Solar United Neighbors, "Net Metering in Pennsylvania," July 12, 2024. https://solarunitedneighbors.org/resources/net-metering-in-pennsylvania/

[16] Pennsylvania Public Utility Commission, "Interconnection Requests and Interconnection Capacity Analysis Report," p. 6, 2024, https://www.puc.pa.gov/media/3263/net-metering-interconnection-report-2022-2024-final.pdf.

[17] Pennsylvania Public Utility Commission, "Interconnection Requests and Interconnection Capacity Analysis Report," report, p. 9, https://www.puc.pa.gov/media/3263/net-metering-interconnection-report-2022-2024-final.pdf.

[18] Solar Energy Industries Association, (SEIA), "Net Metering," September 5, 2024. https://seia.org/net-metering/

[19] § 8 of the AEPS Act.

[20] Emily Walker, "Pennsylvania Solar Panel Cost: Oct. 2024 Prices and Savings," EnergySage, December 17, 2024. https://www.energysage.com/local-data/solar-panel-cost/pa/

Non-residential systems, such as those at businesses, have a net metering limit of 3 MW, which require 12 to 18 acres of land to produce. Solar systems that allow their energy to be used as micro-grids or tapped into emergency systems have a higher 5 MW net metering limit within the state, which would require between 20 to 30 acres.[21]

Net metering restrictions vary from state to state. Delaware limits net meters to eight percent of its peak subscribers with a 25 kW limit for residential generators and 500-2,000 for commercial generators, depending on utility requirements, compensated at a retail rate.[22] New Jersey limits net metering maximum to the previous year's energy consumption and provides compensation for solar at retail rate. Washington DC has a 1 MW limit.

While the advisory committee did not weigh in on the appropriateness of net metering rates because of the scope of the study, there are other alternatives to the practice being explored. New York has had net metering since 1997 but has recently begun to transition away from the practice to avoid straining the grid. The state uses a Value of Distributed Energy Resources (VDER), which reduces the benefits of solar compensation to try to prevent these households from shifting the costs of maintaining the grid to non-solar households. Starting in 2022 solar operators had to pay customer benefit contribution charges per kW; charges varied based on utility company.[23]

Merchant Generators

One of the more recent trends which has changed how net metering impacts Pennsylvania's solar generation capabilities are merchant generators. These wholesale market generators represent up to 3 MW solar installations which use the state's net metering policies with the intention to sell almost all the energy produced instead of consuming it on site. This practice has proven to be controversial because it was not the intended use of net metering and rates are more advantageous than selling wholesale electricity because they avoid certain taxes and transmission costs.

While the Pennsylvania Public Utility Commission (PUC) initially formed rules preventing small commercial installations from exporting the majority of the energy produced, the ban was overturned in a 2020 Commonwealth Court case that was affirmed per curiam by the Pennsylvania Supreme Court in 2021.[24] The future of merchant generators is still undecided as the practice is opposed by representatives from larger utilities who argue that the merchant generators raise costs for consumers because they are not paying for the cost of transmitting energy unlike larger utilities. Supporters of these projects believe this work-around encourages the growth of solar energy in the state, avoids regulatory queues to become approved for the grid, and brings additional flexible siting requirements due to their smaller size.[25]

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[21] Solar United Neighbors, "Net Metering in Pennsylvania."
[22] "Net Metering," DSire.org, December 11, 2023. https://programs.dsireusa.org/system/program/detail/43
[23] Catherine Lane, "Complete Guide to New York Net Metering," SolarReviews.com, December 2024. https://www.solarreviews.com/blog/new-york-net-metering
[24] Hommrich v. PUC, 231 A.3d 1027 (Pa. Cmwlth. 5/12/2020), affirmed per curiam at 664 Pa. 567 (2/17/2021).
[25] Philip Gruber, "Solar Companies Go Small in Pennsylvania, to the Annoyance of Utility Companies," Lancaster Farming, June 26, 2024. https://www.lancasterfarming.com/farming-news/ag-business/solar-companies-go-small-in-pennsylvania-to-the-annoyance-of-utility-companies/article_124fbef2-3224-11ef-9aca-8b10069f133e.html

Grid Scale Solar

Increasingly, Pennsylvania contains large scale solar projects which can generate electricity at a much lower cost than solar installed on residential or commercial rooftops. Grid-scale solar projects are often sited on dozens of acres of leased land with the goal of selling electricity to electric utilities under long-term contracts or through wholesale markets. In Pennsylvania, grid-scale, also known as utility scale, is defined as solar projects above 5 MW of installed capacity that have gone through Pennsylvania regulatory approval process.[26] Frequently these projects are scaled to 10 MW or more.

Solar operations at this scale currently offer the highest annual lease payment to landowners as compared to other types of solar generation, with annual lease payments spanning between $300 to $2,400 per acre.[27] This makes signing grid-scale solar leases an attractive option for farmers with marginal or underutilized land. With lease terms that range between twenty to thirty years, grid-scale solar offers famers a means of financial stability. Because the operation and maintenance of the solar project is the responsibility of the solar company and access to the area is limited while under lease, these leases minimally impact landowner's time or resources. Large solar projects have been noted to temporarily create construction jobs and may also increase local tax revenue, which can have indirect benefits to rural communities.[28]

Despite the benefits, leasing land for grid-scale solar also has drawbacks for many farmers because it removes control over what they can do with their land for decades. After signing, lessors do not have input in how the solar installation is operated and managed. Furthermore, the land has been removed from agricultural use as its primary purpose becomes energy production. This use has the potential to reduce the amount of food and other agricultural products produced in the state. For more insight into the implication of grid-scale solar on Pennsylvania farmland please see a recent Center for Rural PA report.[29]

Grid-scale solar frequently faces opposition from communities who are concerned with the aesthetic of solar energy production and believe it negatively affects the rural culture. The financial and energy benefits primarily flow to utility companies and investors, with relatively less local reinvestment compared to community solar. There is some evidence that incorporating dual use solar practices can decrease negative perceptions of solar.

Both the Pennsylvania Department of Agriculture and the Pennsylvania Department of Environmental Protection have issued similar guidance for siting grid-scale solar systems, with the PUC providing guidance on farmland in particular. These include a preference for use of previously impacted lands rather than agricultural and forested lands, respect for local decision

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[26] 52 Pa. Code §§ 75.11-75.17, issued under the Public Utility Code (Title 66 of the Pennsylvania Consolidated Statutes and the AEPS Act.

[27] Beresnyak, "Grid-Scale Solar 'Basics.'"

[28] Beresnyak, "Grid-Scale Solar 'Basics.'"

[29] Zachery Goldberg et al., "Understanding and Addressing the Impact of Solar Development on Pennsylvania Farmland," Center for Rural Pennsylvania," August 29, 2024.
https://www.rural.pa.gov/download.cfm?file=Resources/reports/assets/262/Impact%20of%20Solar%20Development%20on%20Pennsylvania%20Farmland%20Report%20Web.pdf

making, and use of informed project planning that includes decommissioning and site restoration.[30]

Community Solar

Sitting in between the models of residential net metering and grid-scale solar are community solar projects, which include individuals, businesses, or municipalities that collectively subscribe to (or sometimes own) a solar energy system. While the exact mechanism may depend on how the policy is established in each state, typically the electricity generated is sold to participants, who receive credits on their utility bills for their share of the energy produced. Pennsylvania is one of seven states that does not currently authorize community solar projects.[31] If the practice was authorized, some of the necessary groundwork has already been laid. Virtual net metering, where an address receiving credits is allowed to be in a different location from the energy generation, is needed for community solar projects, and is already allowed in Pennsylvania.

According to the NREL, community solar is one of the fastest growing segments of the U.S. photovoltaic market. The level of MW produced by community PV doubled each year between 2010 and 2021.[32] As of 2024, there were 7.87 GW of community solar projects operating throughout the country.[33] Many of these projects were located in Florida, New York, Massachusetts, and Minnesota. While approximately 73 percent of the market is concentrated in those four states, another 20 states, as well as the District of Columbia and Puerto Rico have been identified as enacting community solar legislation. Despite the size of its market share, community solar in Florida is on a voluntary basis without legislative endorsement.[34]

Community solar models frequently include multiple partners playing distinct roles:

- Host owns the location where a project is sited.
- Sponsor manages subscriptions and utility interactions.
- Utility measures energy produced and distributes it.
- Subscribers who are individuals, businesses, nonprofits, and governments that purchase the energy.[35]

In some situations, a host and a sponsor may be the same entity.

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[30] Pennsylvania Department of Environmental Protection, "Commonwealth of Pennsylvania Grid-Scale Solar Siting Policy," accessed December 17, 2024. https://www.pa.gov/agencies/dep/residents/solar-energy-resource-hub/solar-siting-policy.html; and Pennsylvania Department of Agriculture, "Farmland Considerations for Siting Grid-Scale Solar Panels," December 12, 2022. https://bloximages.newyork1.vip.townnews.com/lancasterfarming.com/content/tncms/assets/v3/editorial/b/39/b39853c2-8849-11ed-9735-e355d2682f4d/63aeee45f34d4.pdf.pdf

[31] U.S. Dept. of Energy, "Community Solar Market Trends," Energy.gov, accessed March 10, 2025. https://www.energy.gov/communitysolar/community-solar-market-trends

[32] NREL, "Community Solar: Overview, Ownership Models, and the Benefits of Locally-owned Community Solar Projects," Slide show, June 2023. https://www.nrel.gov/docs/fy23osti/86210.pdf

[33] U.S. Dept. of Energy, "Community Solar Market Trends."

[34] United States Environmental Protection Agency, "Shared Renewables," accessed March 31, 2025. https://www.epa.gov/green-power-markets/shared-renewables and NREL, Community Solar: Market Status, June 2024. https://www2.nrel.gov/state-local-tribal/community-solar

[35] NREL, "Community Solar: Overview, Ownership Models, and the Benefits of Locally-Owned Community Solar Projects."

Ownership arrangements may differ from project to project, Community solar projects can be owned by communities, utility companies, or third-party solar developers. One study found that locally owned community solar created three times as many jobs and had a larger impact on the local economy than did other types.[36] Other community solar projects provide a social benefit by offering a portion of their shares to low-income families.

One of the main benefits of community solar is it allows subscribers to purchase electricity from an array without having the infrastructure on their own houses. Not everyone has the necessary rooftop or money to install their own solar systems. It is estimated nationally, that 42 to 44 percent of households and businesses cannot adopt "behind the meter" solar.[37] Further, residential rooftop solar can be less efficient than other scaled up solar installations. However, with community solar, all partners can benefit from the project. Hosts may receive government incentives, utilities have access to inexpensive power, and subscribers can support clean energy initiatives. Solstice Power Technologies, a community solar developer, has reported that subscribers to its projects saw 5 to 15 percent savings on their electricity bill.[38] While community solar may not be desired by all community members, it is opt-in.

Community solar is not without risks, as enough subscribers must sign up to secure financing and be able to pay off the infrastructure. To mitigate this, community solar can partner with anchor institutions, large and dependable electricity consumers, that help ensure a project's stability. Anchor institutions can take the form of large businesses, municipal buildings, or nonprofits.

If adopted within Pennsylvania, the community solar model could be implemented alongside agrivoltaic systems, where communities decide that such a system is within their best interests. While an agrivoltaic community solar system could be more expensive than alternatives, it might support other local priorities such as farmland preservation, protecting pollinator habitat, or encouraging local agricultural products. To some communities, these benefits may be important enough to communities to offset the higher cost of the project. Jack's Solar Garden in Colorado is perhaps the best well known community solar garden in the U.S. at the time of this report.[39]

[36] John Farrell and Katie Kienbaum, "Advantage Local: Why Local Energy Ownership Matters," *Institute for Local Self-Reliance*, June 2023. https://ilsr.org/wp-content/uploads/2023/06/ILSR-Advantage-Local-Report-2023.pdf
[37] NREL, "Community Solar," accessed March 10, 2025, https://www.nrel.gov/state-local-tribal/community-solar.html.
[38] Forrest Watkins, "What Is Community Solar?," Solstice, September 25, 2023. https://solstice.us/solstice-blog/what-is-community-solar/
[39] NREL, "The Future of Agriculture Combined With Renewable Energy Finds Success at Jack's Solar Garden," September 10, 2021. https://www.nrel.gov/news/program/2021/future-of-agriculture-combined-with-renewable-energy-finds-success-at-jacks-solar-garden.html

The Coalition for Community Solar Access has proposed model legislation for community solar programs,[40] and the U.S. Department of Energy's Lawrence Berkeley National Laboratory produced a guide for developing community solar models in states that do not have statutes explicitly authorizing their formation.[41]

Federal Energy Law and Policy

Thomas Edison developed direct current (DC) in the 1880s and established the first electric generating plant in the United States in 1882 at New York City's Pearl Street Station.[42] Early electricity generation plants served limited areas and were isolated from one another. Nicola Tesla developed alternating current (AC), and for many years, Tesla and Edison were at odds in promoting their respective sources. The biggest drawback of DC is that it is harder to convert to different voltages, making it less universally adaptable.[43] After the contract for electricity for the 1893 Chicago Exposition was granted to Westinghouse, who was using AC and the Niagara Falls Power Company was licensed to generate AC electricity from the falls in 1896, Tesla's AC became the standard in the U.S. In 1920, the Federal Water Power Act was enacted to promote and regulate hydroelectric projects and dams through the Federal Power Commission.[44]

By the 1930s, it became apparent that connections between multiple plants were crucial to expansion and reliability. The Federal Power Act of 1935 amended the 1920 act and expanded it to include licensing and oversight of hydroelectric public utilities (sellers of electricity) and transmitting utilities selling electricity at wholesale in interstate commerce.[45] Under the 1935 act, the Commission

> is empowered and directed to divide the country into regional districts for the voluntary interconnection and coordination of facilities for the generation, transmission, and sale of electric energy, . . . and it may at any time thereafter, upon its own motion or upon application, make such modifications thereof as in its judgment will promote the public interest. Each such district embraces an area which, in the judgment of the Commission, can economically be served by interconnection and coordinated electric facilities. It is the duty of the Commission to promote and encourage interconnection and coordination within each such district and between districts.[46]

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[40] "Model Legislation for a Balanced and Effective Community Solar Program," Coalition for Community Solar Access, June 2024. https://communitysolaraccess.org/wp-content/uploads/Model-Legislation-for-a-Balanced-and-Effective-Community-Solar-Program.pdf

[41] Anthony Sandonato, Bentham Paulos, and Greg Leventis, "Community Solar for Opportunity States," Lawrence Berkley National Laboratory, U.S. Department of Energy Solar Energy Technologies Office, June 2024. https://www.energy.gov/sites/default/files/2024-07/Opportunity%20States_EMP_tech-brief_06.26.2024.pdf

[42] Abraham Parrish, "Lighting America: The Early Adoption of Electric Light," Library of Congress Blogs, October 18, 2024. https://blogs.loc.gov/maps/2024/10/lighting-america-the-early-adoption-of-electric-light/

[43] "The War of the Currents," U.S. Department of Energy, November 18, 2014. https://www.energy.gov/articles/war-currents-ac-vs-dc-power

[44] The Act of June 10, 1920, Chapter 285 of the 66th Congress.

[45] 16 U.S.C. § 791a et seq.; § 796(22) and (23).

[46] 16 U.S.C. § 824a(a).

Additionally, the Commission "may by order direct a public utility (if the Commission finds that no undue burden will be placed upon such public utility thereby) to establish physical connection of its transmission facilities with the facilities of one or more other persons engaged in the transmission or sale of electric energy, to sell energy to or exchange energy with such persons."[47]

By 1935 over 90 percent of urban areas in America had access to electricity, but the reverse was true in rural locations, where only ten percent of farms had power.[48] To expand electricity to America's farms, President Franklin Roosevelt issued an executive order in 1935 establishing the Rural Electrification Administration (REA). As results from federal efforts to electrify were slow, focus shifted to empowering member-owned co-ops.

The Rural Electrification Act of 1936 established the REA as a permanent agency.[49] A provision of the law provided for loans for "wiring on the premises or persons in rural areas and the acquisition and installation of electrical and plumbing appliances and equipment" and for "construction and operation of generating plants, electric transmission and distribution lines or systems for the furnishing of electric energy to persons in rural areas who are not receiving central station service."[50]

REA federal loans had low interest rates tied to a schedule.[51] Priority was given to local governments, nonprofit groups and co-ops, but private sector companies could also apply for the loans if they met the terms. There was debate over whether the power companies would be excluded from this offer, but ultimately it was agreed to in the interest of expanding electricity to the nation as quickly as possible.[52] Private power companies made up only of four percent of the loans given out in the program's first year.[53] The program was successful in bringing electricity to rural America. By 1939, up to 25 percent of rural areas had power, and by 1945, 90 percent of American farms were estimated to have electricity.[54] Currently, there are 13 rural electric cooperatives in Pennsylvania.[55]

Local grids initially developed as a natural extension of utilities working together as power pools from the 1890s forward in time. These transmission networks of interconnected local power companies evolved into larger regional interconnections: the Eastern Interconnection, the Western Interconnection and the Texas Interconnected System. Historically, these three interconnections operated independently, with efforts begun to further connect each area during the 1960s.[56]

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[47] 16 U.S.C. § 824a(b).

[48] "Rural Electrification Administration," Roosevelt Institute, last modified February 25, 2011. https://rooseveltinstitute.org/rural-electrification-administration/

[49] Paul Anderson, "Sam Rayburn and Rural Electrification," *East Texas History*, accessed June 23, 2020. https://easttexashistory.org/items/show/73

[50] Rural Electrification Act of 1936, Pub. L. 74–605, May 20, 1936.

[51] Rural Electrification Act of 1936.

[52] Paul Anderson, "Sam Rayburn and Rural Electrification."

[53] Thomas McCraw, *TVA and the Power Fight, 1933-1939* (Philadelphia: Lippincott, 1971), 87.

[54] "Rural Electrification Administration," *Roosevelt Institute*.

[55] Pennsylvania Rural Electric Association, About Us, accessed November 26, 2024. https://www.prea.com/about-us

[56] Pratima Garg, "Explainer: What Are Grid Interconnections And What Complicates Them?," *Yale Clean Energy Forum,* March 9, 2022. https://cleanenergyforum.yale.edu/2022/03/09/explainer-what-are-grid-interconnections-and-what-complicates-them

The U.S. Department of Energy (DOE) was created in 1977, primarily in response to the OPEC oil embargo and ensuing oil crisis of 1973. Among the Congressional findings cited in the Department of Energy Organization Act was that "a strong national energy program is needed to meet the present and future energy needs of the Nation consistent with overall national economic, environmental and social goals;" and that the then existing fragmentation of energy policy, regulation, research, development, and demonstration "does not allow for the comprehensive, centralized focus necessary for effective coordination of energy supply and conservation programs," thereby justifying a consolidation of major Federal energy functions into one integrated executive branch department.[57] The DOE has authority within 35 different federal laws, including the Federal Power Act.[58] The Federal Power Commission was renamed the Federal Energy Regulatory Commission (FERC) under the 1977 DOE Organization Act and its authority specifically identified as regulation of wholesale sales of electricity and transmission of electricity in interstate commerce.[59] Subsequent amendments and other energy statutes have added natural gas pipelines and storage facilities, liquified natural gas, and oil pipelines (all operating in interstate commerce)."[60] FERC continues to maintain authority over the interconnection of electricity providers and the transmission of electricity in interstate commerce, including the interconnections that compose the U.S. electric grid.

Interconnection Regions

Within the three interconnection regions, smaller groups of suppliers are connected to one another as either independent system operators (ISO)[61] or regional transmission organizations (RTO).[62] There are 10 ISOs and RTOs operating in the U.S. and Pennsylvania is a member of the RTO called the PJM Interconnection.[63] One of the earliest power pools, PJM was created in 1927 and has grown to cover all of Pennsylvania, and all or part of 12 other states: Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Tennessee, Virginia, and West Virginia.[64]

Within the interconnections, the ISOs, and the RTOs are four principal actors in energy generation and transmission. **Electric generation suppliers** are the entities that sell electricity to end-users (direct purchasers of electric power), known as retail electric customers. **Electric distribution companies** are public utilities that provide transmission and distribution of electricity to retail customers. In other words, the suppliers generate and sell electricity and distribution companies provide the routing to individual customers. The fourth player is a **customer-generator**, or a retail customer that also generates its own electricity. Customer-generators operate a net metered system. "Net metering" measures the difference between the electricity supplied by

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[57] 42 U.S.C. § 7111.
[58] https://www.energy.gov/gc/laws-doe-administers
[59] 42 U.S.C. §§ 7172.
[60] Lawrence R. Greenfield, "An Overview of the Federal Energy Regulatory Commission and Federal Regulation of Public Utilities," June 2018. https://www.ferc.gov/sites/default/files/2020-07/ferc101.pdf
[61] FERC Orders No. 888/889, 18 CFR Part 37, April 24,1996.
[62] FERC Order No. 2000, 18 CFR Part 35, December 20, 1999.
[63] FERC, "Electric: Power Sales and Markets: RTOs and ISOs," accessed November 20, 2024. https://www.ferc.gov/power-sales-and-markets/rtos-and-isos
[64] FERC, "Electric: Electric Power Markets: PJM," accessed November 20, 2024. https://www.ferc.gov/industries-data/electric/electric-power-markets/pjm

an electric utility and the electricity generated by a customer-generator's own means. Any portion of the electricity generated by the alternative energy generating system that is used to offset part or all the customer-generator's requirements for electricity is credited back to the customer-generator. These terms are statutorily defined as:

> **"Customer-generator."** A nonutility owner or operator of a net metered distributed generation system with a nameplate capacity of not greater than 50 kilowatts of installed at a residential service or not larger than 3,000 kilowatts at other customer service locations, except for customers whose systems are above three megawatts and up to five megawatts who make their systems available to operate in parallel with the electric utility during grid emergencies as defined by the regional transmission organization or where a microgrid is in place for the primary or secondary purpose of maintaining critical infrastructure, such as homeland security assignments, emergency services facilities, hospitals, traffic signals, wastewater treatment plants or telecommunications facilities, provided that technical rules for operating generators interconnected with facilities of an electric distribution company, electric cooperative or municipal electric system have been promulgated by the Institute of Electrical and Electronic Engineers and the Pennsylvania Public Utility Commission.[65]
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> **"Electric distribution company."** The public utility providing facilities for the jurisdictional transmission and distribution of electricity to retail customers, except building or facility owners/operators that manage the internal distribution system serving such building or facility and that supply electric power and other related electric power services to occupants of the building or facility.[66]
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> **"Electric generation supplier"** or **"electricity supplier."** A person or corporation, including municipal corporations which choose to provide service outside their municipal limits except to the extent provided prior to the effective date of this chapter, brokers and marketers, aggregators or any other entities, that sells to end-use customers electricity or related services utilizing the jurisdictional transmission or distribution facilities of an electric distribution company or that purchases, brokers, arranges or markets electricity or related services for sale to end-use customers utilizing the jurisdictional transmission and distribution facilities of an electric distribution company. The term excludes building or facility owner/operators that manage the internal distribution system serving such building or facility and that supply electric power and other related power services to occupants of the building or facility. The term excludes electric cooperative corporations except as provided in 15 Pa.C.S. Ch. 74 (relating to generation choice for customers of electric cooperatives).[67]

[65] AEPS Act.
[66] 66 Pa.C.S. § 2803.
[67] 66 Pa.C.S. § 2803.

> **"Retail electric customer."** A direct purchaser of electric power. The term excludes an occupant of a building or facility where the owners/operators manage the internal distribution system serving such building or facility and supply electric power and other related power services to occupants of the building or facility; where such owners/operators are direct purchasers of electric power; and where the occupants are not direct purchasers.[68]

Pennsylvania has 11 electric distribution companies,[69] 126 electric generation suppliers, and 225 broker/marketers, which are entities that act as agents or intermediaries in the sale and purchase of electric energy but do not take title to electric energy.[70]

Numerous media reports have indicated that grid capacity is being strained, for a variety of reasons. Efforts to move from fossil fuels to renewable energy sources and carbon emission restrictions have been identified as contributing to decreasing energy production overall. This impact is exacerbated by increasing demands for electricity in fields like transportation and technology. Data centers (essentially the memory banks for computers using artificial intelligence) are heavy electricity consumers. Additionally, even if supply and demand would equalize at a higher level than currently exists, distribution systems and transmission lines are already near maximum capacity.[71] These strains on the U.S. grid have been under scrutiny by the state and federal authorities and various efforts are underway to expand the national grid.

System Capacity

The North American Electric Reliability Corporation (NERC) was established in 1968 as a non-profit organization designed to ensure reliability of the U.S. electricity grid and strengthening utility interconnections.[72] The Energy Policy Act of 2005 directed the designation of an electric reliability organization to develop and enforce mandatory standards for the reliable operation and planning of the U.S. power grid.[73] NERC was designated as that entity in 2006. [74]

In its 2023 long-term reliability assessment, NERC identified multiple areas of the country that are projected to be at high or elevated risk for inadequate capacity. Fortunately for Pennsylvanians, PJM is projected to be at normal risk.[75] In announcing the release of its 2024

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[68] 66 Pa.C.S. § 2803.
[69] Pa. Public Utility Commission, "Electric Companies and Suppliers," accessed November 19, 2024. https://www.puc.pa.gov/electricity/electric-companies-suppliers/
[70] Pa. PUC, "Electric Generation Suppliers," accessed November 19, 2024. Licensed Suppliers, PA PUC
[71] Taylor Millard, PA Grid Operator Pays 700% More to Buy Power, Warns Price Hikes Will Follow," Delaware Valley Journal, August 22, 2024. https://delawarevalleyjournal.com/pa-grid-operator-pays-700-more-to-buy-power-warns-price-hikes-will-follow/
[72] David Nevius, "The History of the North American Electric Reliability Corporation, 2nd Ed. March 2020. https://www.nerc.com/AboutNERC/Resource%20Documents/NERCHistoryBook.pdf
[73] Public Law 109-58, 119 Stat. 594, § 1211, August 5, 2005. https://www.congress.gov/109/plaws/publ58/PLAW-109publ58.pdf
[74] FERC. "Order Certifying North American Electric Reliability Corporation As The Electric Reliability Organization and Ordering Compliance Filing, 116 FERC Paragraph 61,062. https://www.ferc.gov/sites/default/files/2020-04/E-5_12.pdf
[75] NERC, 2023 Long-Term Reliability Assessment, December 2023. https://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/NERC_LTRA_2023.pdf

long-term forecast, PJM's website described the organization's expected growth in the next 15 years:

> PJM, Pennsylvania's regional grid operator Total annual energy use throughout the PJM footprint is expected to increase nearly 40% by 2039, from 800,000 gigawatt-hours (GWh) to about 1.1 million GWh. . . . Through its Ensuring a Reliable Energy Transition initiative and related research, PJM has noted that increased electricity demand, combined with accelerated generator retirements and the slow pace of replacement generation, will challenge reliability in the PJM footprint by 2030 if not addressed. Rising energy demand in the region PJM serves is increasingly driven by the development of data centers throughout the PJM footprint, combined with the accelerating electrification of transportation and industry.[76]

PJM's annual Regional Transmission Expansion Plan (RTEP) anticipates future demand. It forms the basis of its responses to requests for approval of new and expanded electric facilities access to the grid.[77] The process for a facility to put in a request for permission to access the grid is lengthy, and usually takes between two to two-and-a-half years.[78] The requests have traditionally been handled by a "first come, first served," process in which developers apply for consideration before all regulatory steps have been completed. This queue has grown substantially, in large part due to federal and state energy policy that has actively encouraged solar energy development. In 2024, there were 46 solar power plants in Pennsylvania. Nationwide, 48 states have at least one solar power plant (North Dakota and West Virginia have none), with Pennsylvania tied for 25th place with Wisconsin in order of total number of plants. A dozen of Pennsylvania's plants are large facilities, producing 10.0+ MW of electricity.[79] This number is expected to grow significantly, as there was a total of 425 active solar projects are in the planning queue as of April 2024.[80]

In response to an influx of new interconnection requests and a growing backlog in the queue, PJM filed and received approval from FERC to implement new, hopefully more efficient, rules for new service requests in April 2022. One of the changes is from a first-come, first-served queue to a first-ready, first-served queue. Part of the FERC request and approval was a two-year pause in the review and potential approval of approximately 1,200 projects. PJM began

[76] "PJM Publishes 2024 Long-Term Load Forecast," *PJM Inside Lines,* January 8, 2024. https://insidelines.pjm.com/pjm-publishes-2024-long-term-load-forecast/
[77] PJM, "Regional Transmission Expansion Planning," accessed December 10, 2024. https://learn.pjm.com/three-priorities/planning-for-the-future/rtep.aspx
[78] PJM, "Connecting to the Grid FAQs," accessed December 10, 2024. https://learn.pjm.com/three-priorities/planning-for-the-future/connecting-grid
[79] "Solar Power Plants in Pennsylvania, by Megawatt, 2024," and "Solar Power Plants by State, 2024," prepared by the Center for Rural Pennsylvania webinar entitled "Utility-Scale Solar Energy in Pennsylvania: Key Findings from Recent Research," held on September 19, 2024. Data source cited: U.S. Energy Atlas, Energy Information Administration, U.S. Department of Energy.
[80] Zachery Goldberg et al., "Understanding and Addressing the Impact of Solar Development on Pennsylvania Farmland," Center for Rural Pennsylvania," August 29, 2024. https://www.rural.pa.gov/download.cfm?file=Resources/reports/assets/262/Impact%20of%20Solar%20Development%20on%20Pennsylvania%20Farmland%20Report%20Web.pdf

transitioning to the process in July 2023 and expects have full implementation complete by 2026.[81] FERC issued Order No. 2023 on July 28, 2023, to address interconnection queue backlogs nationwide, and revised its rules to streamline the process, including switching to the first-ready, first-served process first requested by PJM.[82] Other orders by FERC include a DOE road map of potential solutions and additional efforts to reduce the grid backlogs.[83]

The concerns about capacity in the central and western part of the country have spurred further efforts to expand the grid. In May 2024, DOE released a list of 10 potential national interest electric transmission corridors to accelerate projects that expand access to the national grids. One of these projects borders southwestern Pennsylvania along the West Virginia border and the other is along Lake Erie.[84] Additionally, in August 2024, DOE announced $2.2 billion in grants for eight projects across 18 states to further improve the grid. None of these projects are in Pennsylvania.[85]

While the impetus to move to renewable energy sources may have found its origins in the 1973 oil embargo, interest has grown internationally. In 2016, the Obama administration announced the formation of the Clean Energy Savings For All Initiative, a collaboration between the Departments of Energy, Housing and Urban Development, Agriculture, Health and Human Services, Veterans Affairs, and the Environmental Protection Agency "to increase access to solar energy and promote energy efficiency across the United States and, in particular in low- and moderate- income communities."[86] Additionally, the Obama administration dedicated over $11 billion to finance international clean energy. The issue moved to the forefront of the national energy debate when the Obama administration to assisted developing nations in the global transition to zero and low-carbon energy resources.[87] With the inauguration of the Biden administration, the U.S. federal government support for developing renewable energy sources sprang into overdrive. Among the goals set by the Biden administration was a move by the federal government to 100

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[81] PJM, "Generation Interconnection," January 3, 2024. https://learn.pjm.com/-/media/about-pjm/newsroom/fact-sheets/generation-interconnection-fact-sheet.ashx. See also, James Bruggers, "The Largest U.S. Grid Operator Puts 1,200 Mostly Solar Projects on Hold for Two Years," *Inside Climate News,* April 29, 2022. https://insideclimatenews.org/news/29042022/pjm-interconnection-solar-projects/

[82] FERC, "Explainer on the Interconnection Final Rule: Improvements to Generator Interconnection Procedures and Agreements, Docket No. RM22-14-000, Order No. 2023. https://www.ferc.gov/explainer-interconnection-final-rule

[83] Hannah Edelheit, "Reducing the Review Time and Costs for New Energy Projects," National Conference of State Legislatures, *State Legislative News*, December 5, 2024. https://www.ncsl.org/state-legislatures-news/details/reducing-the-review-time-and-costs-for-new-energy-projects

[84] U.S. Department of Energy, "Biden Harris Administration Announces Initial List of High Priority Areas for Accelerated Transmission Expansion," May 8, 2024. https://www.energy.gov/articles/biden-harris-administration-announces-initial-list-high-priority-areas-accelerated

[85] Jeff St. John, "Biden administration announces more than $2 billion in grants to boost US power grid," *Route Fifty,* August 13, 2024. https://www.route-fifty.com/infrastructure/2024/08/biden-administration-announces-more-2-billion-grants-boost-us-power-grid/398797/?oref=rf-homepage-river

[86] U.S. Department of Energy, "FACT SHEET: Obama Administration Announces Clean Energy Savings for All Americans Initiative" July 19, 2016. https://obamawhitehouse.archives.gov/the-press-office/2016/07/19/fact-sheet-obama-administration-announces-clean-energy-savings-all

[87] U.S. Department of Energy, "FACT SHEET: Obama Administration Announces New Financing for Renewable Energy Projects And Actions To Spur Innovation and Promote Energy Access Globally," November 14, 2016.

percent carbon pollution-free electricity by 2030.[88] The Bipartisan Infrastructure Law budgeted $62 billion to the Department of Energy to help achieve these goals.[89]

The enactment of the Inflation Reduction Act of 2022[90] directed at least $369 billion "toward incentives for nearly every sector of the economy to adopt renewable energy and other low-carbon technologies"[91] and has spurred more aggressive moves to renewable energy activities at the state level.[92]

Federal Loan Guarantee and Grant Programs, and Tax Credits

The Bipartisan Infrastructure Law and the Inflation Reduction Act provided multiple funding opportunities to encourage development of renewable energy. Both the U.S. Department of Energy and the U.S. Department of Agriculture offer several programs of specific interest to agrivoltaics.

In May 2022, the DOE's Solar Energy Technologies Office announced $8 million in funding available to study collocation of agriculture and solar energy through the Foundational Agrivoltaic Research for megawatt Scale (FARMS). Six projects (none in Pennsylvania) received grants ranging from $500,000 to $1.8 million.[93]

The USDA administers the Rural Energy for America Program (REAP), which provides guaranteed loan financing and grant funding to agricultural producers and rural small businesses for renewable energy systems or to make energy efficiency improvements. Agricultural producers may also apply for new energy efficient equipment and new system loans for agricultural production and processing. Loan guarantees are available on loans up to 75 percent of total eligible project costs. Grants can be for up to 50 percent of total eligible project costs. Combined grant and loan guarantee funding are available for up to 75 percent of total eligible project costs. Grants are divided into two classes, renewable energy system grants and energy efficiency grants. Renewable

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[88] The White House, Briefing Room, "FACT SHEET: President Biden Signs Executive Order Catalyzing American's Clean Energy Economy Through Federal Sustainability," December 8, 2021. https://www.whitehouse.gov/briefing-room/statements-releases/2021/12/08/fact-sheet-president-biden-signs-executive-order-catalyzing-americas-clean-energy-economy-through-federal-sustainability/ See also Presidential Executive Order 14057, December 8, 2021, https://www.fedcenter.gov/programs/eo14057/

[89] U.S. Department of Energy, "The U.S. Department of Energy Office of Policy is Putting Clean Energy Front and Center: A 2021 Year in Review," December 29, 2021. https://www.energy.gov/policy/articles/us-department-energy-office-policy-putting-clean-energy-front-and-center-2021-year

[90] Pub. L. 117-169, 136 Stat. 1618, August 16, 2022.

[91] Rachel Waldholz, "A year in, landmark U.S. climate policy drives energy transition but hurdles remain," *NPR,* August 16, 2023. https://www.npr.org/2023/08/16/1193726242/a-year-in-landmark-u-s-climate-policy-drives-energy-transition-but-hurdles-remai

[92] Lori Bird and Joseph Wombole, "State of the US Clean Energy Transition: Recent Progress, and What Comes Next," *World Resources Institute,* February 7, 2024. https://www.wri.org/insights/clean-energy-progress-united-states

[93] U.S. DOE, Solar Energy Technologies Office, "Funding Notice: Foundational Agrivoltaic Research for Megawatt Scale FARMS), May 5, 2022 and "DOE announces $8 Million to Integrate Solar Energy Production with Farming," December 8, 2022. https://www.energy.gov/eere/solar/foundational-agrivoltaic-research-megawatt-scale-farms-funding-program

energy system grants range from $2,500 minimum to $1 million.[94] Development assistance grants are also available annually, for up to $100,000.[95] Thirty projects were funded in Pennsylvania in 2023, with half of them for the purchase and installation of photovoltaic systems on farms.[96]

The DOE's Renewable Energy Siting through Technical Engagement and Planning (R-STEP) is intended to support state-level programs that serve as a resource to local areas to assist them in better planning and engagement in developing large-scale renewable energy and energy storage projects. The program funds 16 state-based collaboratives for a total of $29 million. Pennsylvania's Department of Environmental Protection was awarded $1.96 million to "expand and enhance the decision-making capacity and expertise of local governments and community members for planning, siting, and permitting solar, wind and battery energy storage projects by disseminating information through direct training, engagement, and outreach." Collaborative partners include Penn Extension Energy Team, Penn State Center for Energy Law and Policy, and the Pennsylvania State Association of Township Supervisors.[97]

In September 2024, the DOE announced it was opening a competition for a total of $8.2 Million in prize funding to advance agrivoltaics; specifically, the collocation of solar energy production and cattle grazing.[98] The American-Made Large Animal and Solar System Operations Prize (LASSO) supports pilot and demonstration projects for cattle agrivoltaics. Prizes will be awarded to teams, which must include a U.S.-based solar developer and a U.S.-based rancher or farmer. Systems must have a PV capacity of at least 250 kilowatts direct current. Submissions were due March 6, 2025, with the initial phase of prizes expected to be awarded in May 2025.[99]

The US DOE supports an initiative that pairs communities with researchers from national laboratories to provide short-term technical assistance to address clean energy goals. The Clean

[94] USDA, Rural Development, "Rural Energy for America Program Renewable Energy Systems & Energy Efficiency Improvement Guaranteed Loans & Grants," accessed December 23, 2024. https://www.rd.usda.gov/programs-services/energy-programs/rural-energy-america-program-renewable-energy-systems-energy-efficiency-improvement-guaranteed-loans

[95] USDA, Rural Development, "Rural Energy for America Program Energy Audit & Renewable Energy Development Assistance Grants in Pennsylvania," accessed December 23, 2024. https://www.rd.usda.gov/programs-services/rural-energy-america-program-energy-audit-renewable-energy-development-assistance/pa

[96] USDA, Rural Development, Rural Energy for American Program, November 1, 2023. https://www.rd.usda.gov/media/file/download/usda-rd-reap-chart-11-01-2023.pdf

[97] US DOE, Office of Energy Efficiency and Renewable Energy, "Renewable Energy Siting Through Technical Engagement and Planning (R-STEP™) accessed December 23, 2024. https://www.energy.gov/eere/renewable-energy-siting-through-technical-engagement-and-planning-r-steptm

[98] UD. DOE, Office of Energy Efficiency and Renewable Energy, "Biden-Harris Administration Invests Nearly $20 Million to Improve Siting of Renewable Energy and Co-Locate Solar with Cattle Grazing," September 10, 2024. https://www.energy.gov/eere/articles/biden-harris-administration-invests-nearly-20-million-improve-siting-renewable-energy

[99] US DOE, Solar Energy Technologies Office, "American-Made Large Animal and Solar System Operations (LASSO) Prize, accessed December 23, 2024. https://www.energy.gov/eere/solar/american-made-large-animal-and-solar-system-operations-lasso-prize

Energy to Communities (C2C0) program has worked with approximately two dozen communities exploring agrivoltaics.[100]

It should be noted that with the election of the Trump Administration and the activities of the "Department of Government Efficiency" in the early months of 2025, there is much uncertainty as to the stability and resiliency of any federal programs.

Pennsylvania Energy Law and Policy

Implementation of Pennsylvania energy law and policy is spread across several agencies, including the Public Utilities Commission, the Department of Environmental Protection, the Department of Conservation and National Resources, the Department of Community and Economic Development and the Department of Agriculture. No single entity is responsible for all energy policies in the Commonwealth. Commercial endeavors can, for the most part, be found under the Public Utility Code, a "public utility" is defined as "any person or corporations now or hereafter owning or operating in this Commonwealth equipment or facilities for producing, generating, transmitting, distributing or furnishing natural or artificial gas, electricity, or steam for the production of light, heat, or power to or for the public for compensation." Public utilities do not include people who furnish service only to the individual or entity itself, any building or facility owner/operators who hold ownership over and manage the internal distribution system serving such building or facility and who supply electric power and other related electric power services to occupants of the building or facility, non-profit cooperatives or electric generation supplier companies. Electric generation supplier companies sell electricity to end users (retail market) through the transmission or distribution networks owned and operated by electric distribution companies.[101]

Alternative Energy Portfolio Standards Act

In 2004, Pennsylvania enacted its alternative energy law.[102] The standards required that electric generation by electric utilities in the Commonwealth include established amounts of energy sold from alternative energy sources in their portfolios. Alternative energy sources are defined as:

- Solar photovoltaics or other solar electric energy
- Solar thermal energy
- Wind power

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[100] Sarah Meehan, "Clean Energy to Communities Agrivoltaics 101 Resources Provide a Guide Toward Implementation," US DOE, Office of Energy Efficiency and Renewable Energy, National Renewable Energy Laboratory, November 26, 2024. https://www.nrel.gov/news/program/2024/clean-energy-to-communities-agrivoltaics-101-resources-provide-a-guide-toward-implementation.html

[101] 66 Pa.C.S. § 102.

[102] Act of November 30, 2004 (P.L. 1672, No. 213), known as the Alternative Energy Portfolio Standards Act (AEPS Act).

- Large-scale hydropower
- Low-impact hydropower
- Geothermal energy
- Biomass energy
- Biologically derived methane gas
- Fuel cells
- Waste coal
- Coal mine methane
- Demand-side management, to include energy efficiency technologies, load management or demand respond technologies, and industrial by-product technologies
- Other small-scale power generation of electricity and useful thermal energy (distributed generation systems)[103]

The law requires that eight percent of electricity be produced by renewable energy by 2021, and that 0.5 percent of electricity be generated by solar photovoltaic technologies. It is important to note that the statute applies to electric distribution companies and electric generation suppliers as defined in the Public Utility Code.[104] It does not apply to rural electric cooperatives, but they may voluntarily offer energy efficiency and demand-side management programs.[105] A 2017 amendment to the Administrative Code of 1929 added additional requirements for solar photovoltaic systems to meet in order to qualify for solar renewable alternative energy portfolio standards. These additional criteria limit the provision of solar photovoltaic electricity outside of Pennsylvania. To wit, a system must either:

- Directly deliver the electricity it generates to a retail customer of an electric distribution company, or the electric distribution system operated by an electric distribution company that is operating within the Commonwealth and covered by the compliance requirements of the AEPS Act.
- Be directly connected to the electric system of an electric cooperative or municipal electric system operating within the Commonwealth.
- Connect directly to the electric transmission system at a location within the service territory of an electric distribution company operating within the Commonwealth.[106]

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[103] §§ 2 and 3 the AEPS Act.
[104] See definitions at page 20, infra.
[105] § 8 of the AEPS Act.
[106] § 2804 of the act of April 9, 1929 (P.L.177, No.175), known as the Administrative Code of 1929, as added by § 11.1 of the act of October 30, 2017 (P.L. 379, No.4).

Solar Industry in Pennsylvania

Perceptions of the effectiveness of solar energy by the public are influenced by how informed people are about technology; misunderstandings may arise about its suitability to a particular environment. Pennsylvania has a moderate humid climate and is considered a cloudy state. Therefore, those unfamiliar with solar technology may assume the state is not well suited to solar energy production. However, solar panels can generate electricity from diffuse sunlight, which occurs when sunlight is scattered by clouds or atmospheric particles. Although solar panels are potentially 10-25 percent below their maximum capacity on strongly overcast skies, modern solar panels are sensitive enough to capture and convert diffused light into electricity.[107]

Another limitation of solar energy is that it is not dispatchable, or able to generate on command when it is needed. "Make hay while the sun is shining" is a time-tested adage, however it also applies to PV solar generation. Much of the electricity is created during the four hours of the day when Pennsylvania receives the most sunlight.[108] While this limitation means that sunlight may not exclusively power homes and businesses without battery systems, it can reduce the amount of electricity that needs to be generated and transmitted from off-site locations. However, electric generation systems do not need to be entirely self-sufficient to be cost effective or to pay for themselves over time.

Pennsylvania may not receive as much sun as leading solar producing states in the southwest of the country such as New Mexico and this will affect the total amount of energy that PV panels in the Commonwealth will produce. See Map 1 below, which shows the average amount of kilowatt-hours of electricity per cubic meter that could be produced throughout one day. The majority of Pennsylvania could produce under 4 kWh per cubic meter in a day while some locations in the southwest could generate 44 percent higher in the same space.

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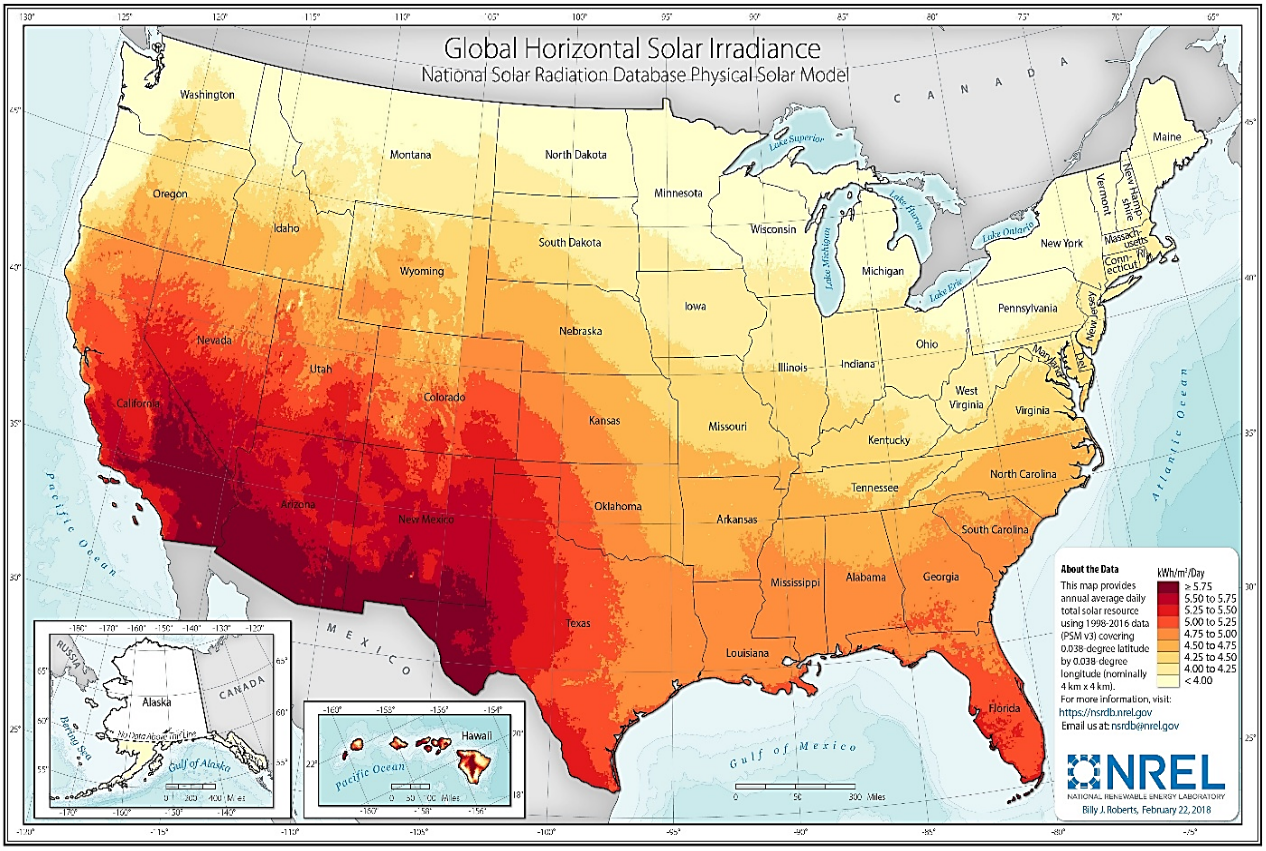
[107] PA Public Utility Commission, "Solar Energy: Frequently Asked Questions," Puc.Pa.Gov, May 2018. http://www.puc.pa.gov/Electric/pdf/Renewable/FS-Solar_FAQ.pdf

[108] Pennsylvania Sunlight Hours & Renewable Energy Information, TurbineGenerator.org, visited March 10, 2025. https://www.turbinegenerator.org/solar/pennsylvania/

Map 1

United States Annual Solar Global Horizontal Irradiance
2018



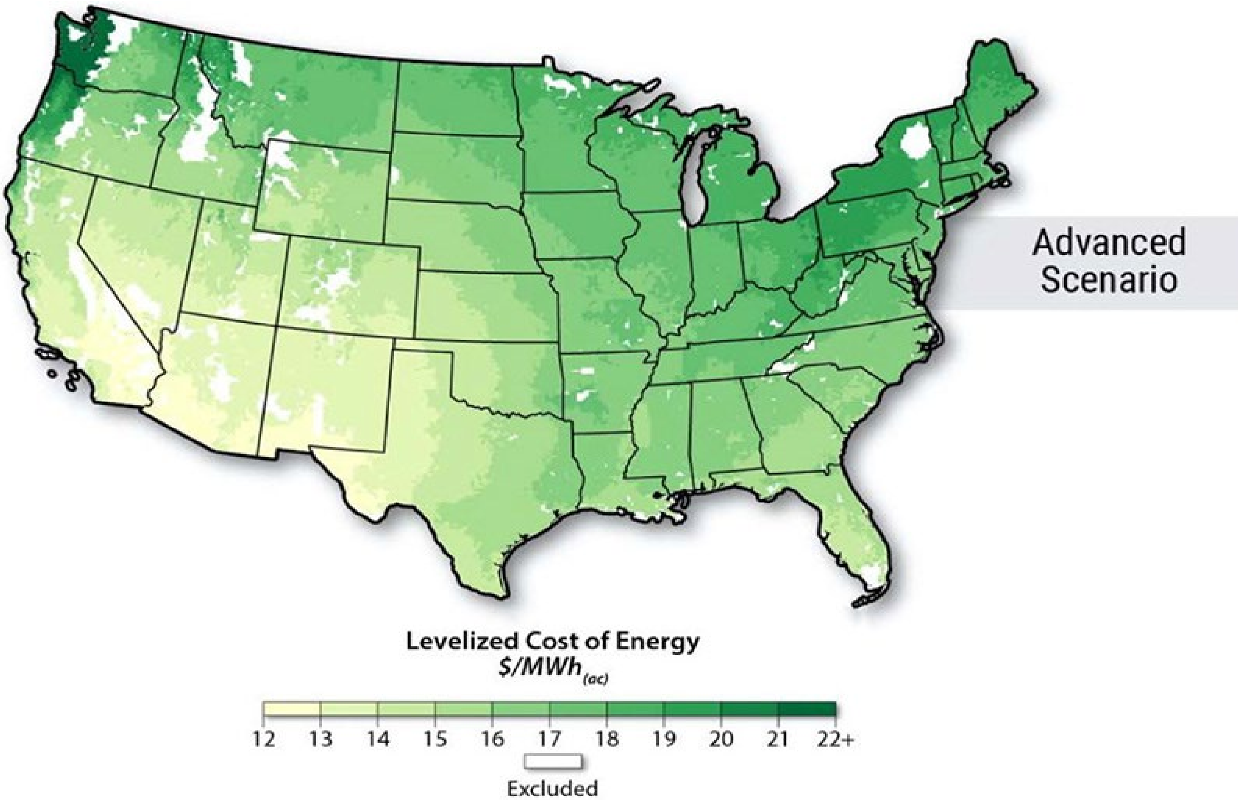
Source: NREL, Publication Date: Feb. 22, 2018. https://www.nrel.gov/gis/solar-resource-maps

The amount of available sunlight in a location has a direct impact on the cost of generating that electricity. See Map 2 which models the cost of using advanced PV technologies over its lifetime compared to the energy produced. This estimate is the levelized cost of energy or LCOE. A particular location in Pennsylvania may have a have a LCOE between $17-20 per MWh depending on its location, while an area in New Mexico might have a LCOE as low as $12 per MWh.[109] While Pennsylvania may never be the most competitive state for solar nationally, it is comparable in climate to Germany whose energy policy has made it a global leader in renewable energy production. Similarly, Pennsylvania receives as much or more sun than parts of France and the United Kingdom which have also invested in solar energy.

[109] NREL, "Solar Levelized Cost of Energy Analysis" accessed April 28, 2025. https://www2.nrel.gov/solar/market-research-analysis/solar-levelized-cost.

Map 2

Solar Levelized Cost of Energy Analysis
2021



Source: NREL, https://www2.nrel.gov/solar/market-research-analysis/solar-levelized-cost.

In addition to the price of solar panels decreasing over time, state and federal tax credits reduce the amount of time necessary to pay off these investments for residences and businesses. Advances in technology, such as batteries which store electricity and bifacial panels that can generate reflected light from the underside of the panels, have the potential to maximize the amount of energy produced in the future but are still more expensive options currently. Whether solar is appropriate for a given state or country is largely determined by the policy choices and desirability of the technology.

While the Alternative Energy Portfolio led Pennsylvania to become an early adopter of solar energy, over time this lead has diminished as demand for solar energy has rapidly expanded throughout the country while Pennsylvania lacked the regulatory incentive that was driving the growth of solar in other places.[110] Despite the comparative sluggishness in scaling up Pennsylvania's solar infrastructure, it has still increased by 500 percent in the last decade, much

[110] Johanna Neumann and Tony Dutzik, "Renewables on the Rise Dashboard," Penn Environment Research & Policy Center, October 22, 2024. https://environmentamerica.org/pennsylvania/center/resources/renewables-on-the-rise-dashboard/

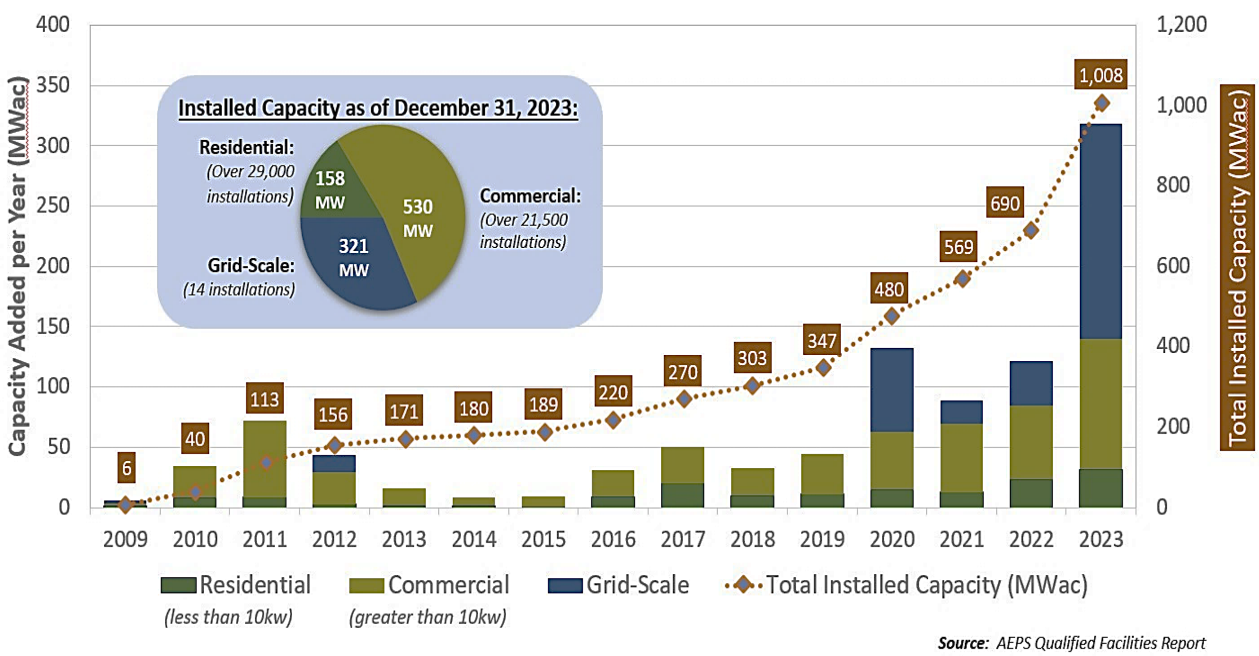
of it only in the last few years.[111] Part of the reason for this shift is that PV module prices which have fallen 42 percent over the last decade. This shift has been caused by federal tax credits and advancements in the production of panels made it more affordable for both middle-class households as well as making large scale projects more feasible.[112]

As of 2024, Pennsylvania had over 2,492 MW of PV solar capacity over 83,743 installations.[113] Over the next 5 years it is projected it will grow by 3,919 MW. Currently, Pennsylvania ranked 22nd in cumulative capacity among the 50 states. Pennsylvania is also home to 4,287 solar jobs, 100 manufacturers, 212 developers, and 128 other solar-related companies. However, solar still accounts for less than 1 percent of the state's total electricity generation.

Between 2009 and 2023 Pennsylvania's installed capacity, that is, the amount of solar power that can be theoretically generated, grew from 6 MWac to over 1,000 MWac, and the increase accelerated over the past several years. There were 321 MW of grid-scale installations, 158 MW of residential installations, and 530 MW of commercial installations over the 14-year period. Grid-scale installations have seen enormous growth between 2020 and 2023. See Chart 1 below.

Chart 1

Pennsylvania Annual Solar Installations and Cumulative Capacity (MWac) 2009-2023



[111] PA Public Utility Commission, "Alternative Energy Portfolio Standards Act of 2004: Compliance for Reporting Year 2022-23," accessed June 24, 2024. https://www.puc.pa.gov/media/2997/aeps-2023-report-final.pdf
[112] SEIA, "Solar Industry Research Data," March 12, 2025, accessed April 28, 2025, https://seia.org/research-resources/solar-industry-research-data/.
[113] Solar Energy Industry Assoc., "State Overview: Pennsylvania." https://seia.org/state-solar-policy/pennsylvania-solar/ accessed 4, 28, 2025

Support for Specific Locations for Solar Installations

In 2024, Pennsylvania enacted the Solar for Schools Act. The Solar for Schools Grant Program created under the act would provide photovoltaic or solar thermal devices. Grants can be awarded for up to 50 percent of an approved solar energy project. The program is administered by the Department of Community and Economic Development and eligible grantees include school districts, intermediate units, charter schools including cyber, regional, and a school for education of the deaf or the blind, area career and technical schools, specific trade and technical schools, and community colleges.[114]

House Bill 272, Printer's No. 216 was introduced and referred to the House Energy Committee on January 22, 2025. The bill would create the Municipal and Emergency Responder Solar Act. The bill would also establish a grant program within the Department of Environmental Protection to support solar energy projects by a political subdivision or local authority on facilities owned by the political subdivision, a fire department, and police department of ambulance service company. The bill was previously introduced as HB 2577 in September 2024 but died in committee at the end of the 2023-2024 legislative session.

Grid-Scale Solar Projects in Pennsylvania

One analysis noted that as of fall 2024 there were currently 46 operating solar utilities in Pennsylvania with a total capacity of 562 MW.[115] An additional nine projects are currently under construction, which would accordingly increase installed capacity by 263 MW. An additional 20 solar projects are still in the planning stages. As of April 25, 2025, PJM identifies 31 grid-scale (5MW installed capacity or more) solar projects with a total capacity of 948 MW, with another nine projects under 5 MW[116]. While much media attention has been given to the 480 projects sitting in PJM interconnection queue, which would represent over 10.4 GW of solar capacity, there is reason to suspect that much of this activity is speculative due to the low barrier for entering PJM connection queues.[117] One research team provided a conservative estimate of 180 solar projects in this queue with selected sites.[118] Pennsylvania has a lot of potential for solar development because it has cheap land close to transmission lines and population centers.

There is support for grid-scale solar projects that specifically use non-agricultural lands, such as brownfields and former mined lands. A study commissioned by the Department of Environmental Protection found that there are 169,000 surface acres of abandoned mine lands that

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[114] Act of July 17, 2024 (P.L.813, No.68).
[115] Yoann Hispa, "Pennsylvania Solar Development Analysis," Landgate (blog), December 19, 2024. https://www.landgate.com/news/pennsylvania-solar-development-analysis
[116] PJM Serial Service Request Status dashboard. https://www.pjm.com/planning/service-requests/serial-service-request-status
[117] Ryan Kennedy, "Pennsylvania Queued Solar Projects Would Increase Total Capacity 18x," Pv Magazine USA, November 7, 2024. https://pv-magazine-usa.com/2024/11/07/pennsylvania-queued-solar-projects-would-increase-total-capacity-18x/
[118] Center For Rural Pennsylvania, Utility-Scale Solar Energy in Pennsylvania: Key Findings from Recent Research, webinar October 7, 2024. https://www.rural.pa.gov/research-grants/webinars/Solar-Energy-in-Pennsylvania

could potentially host solar facilities. The analysis, however, points out that the area could be further reduced by factors such as slope/terrain, aspect/orientation, and access to electric distribution infrastructure.

Four Twelve Renewables opened a solar facility in Greene Township, Beaver County, that is situated on a brownfield. It's 98,000 bifacial solar panels are projected to generate approximately 66 GWh of electricity. The company entered a 15-year power purchase agreement with Pennsylvania American Water. The proceeds generated from the project will be used to provide yearly utility assistance grants to provide basic natural gas, water, wastewater, and electric utility service to low- and moderate-income Southwestern Pennsylvania households undergoing hardship.

Solar developments have not gone uncontested by local governments. While some municipalities welcome solar farms, others oppose or wish to restrict them, sometimes in the same county. For example, Straban Township in Adams County approved a grid-scale facility that will be supplying electricity to the City of Philadelphia through a power purchase agreement. (See next section). However, Mount Joy Township was engaged in litigation to prevent solar development in that municipality. The township, dominated by farms, denied one of the permits needed for a project that would be spread across 18 farms and over 1,000 acres. The developer sued and the Commonwealth Court ultimately found in favor of the township. In March 2024, the developer announced that the project was terminated.[119]

Pennsylvania is home to a multitude of government, business, and academic institutions with a greater demand for renewable energy than electric wholesalers can meet. Accordingly, solar developers have built large grid-scale installations with power purchase agreements to sell solar electricity directly to these entities already in place.[120] Some of these projects include:

- The three Whitetail Solar sites in Franklin County that reduce the amount of energy Pennsylvania State University uses drawn from the grid by about a quarter.

- Prologis, a real estate investment company, purchases power from a 4MW solar project in Easton.

- Elk Hill Solar 1 and Elk Hill 2 have a 25 MW and 17.5 MW solar installation, respectively, in Peters Township, Franklin County, whose electricity is purchased by SEPTA.

[119] See Ad Crable, "Large Pennsylvania solar project gets second blow from court," *Bay Journal,* December 19, 2023. https://www.bayjournal.com/news/energy/large-pennsylvania-solar-project-gets-second-blow-from-court/article_5d2bf3a2-9e89-11ee-8b9d-f782ed3df99a.html Richard Franki, "Brookview solar project terminated by developer," *Gettysburg Times*, March 16, 2024. https://www.gettysburgtimes.com/news/local/article_5a0d5e11-5063-5c4b-9f8f-004b4275c943.html. *Brookview Solar I, LLC v Mount Joy Township Board of Supervisors,* 305 A.3d 1222 (Pa. Cmmw. Ct. 2023).
[120] Solar Energy Industry Assoc. "State Overview: Pennsylvania." SEIA.org, season-03 2024. https://seia.org/state-solar-policy/pennsylvania-solar/

In 2024 Great Cove Solar will produce 220 MW of electricity in Pennsylvania across two sites and electricity will be sold to the University of Pennsylvania.[121] This is a vast increase from Gaucho Solar Project in southwestern Pennsylvania which previously held the largest capacity at 20MW.[122]

In early 2024, Energix Renewable announced a power purchase agreement with the City of Philadelphia to supply 70 MW of PV electricity. The solar project is in Straban Township, Adams County, and includes 230,000 solar panels spread across approximately 700 acres, making it one of the country's largest municipal power purchase agreements.[123]

Proposed Legislation

Independent Energy Office

Senate Bill 187 (Printer's No.126) was introduced and referred to the Senate Environmental Resources and Energy Committee on January 24, 2025. The bill would create a nonpartisan independent agency to be known as the Independent Energy Office. The office would be charged with planning recommendations that cover virtually all current energy technologies and analyzing policies, regulations and laws that relate to energy generation, production or distribution, as well as formulating and reviewing energy initiatives. SB 187 passed the Senate (27-21) on February 3, 2025 and was referred to the House Energy Committee on February 4, 2025/

House Bill 114, Printer's No. 2025 was introduced and referred to the House Energy Committee on January 14, 2025. The Office created in that bill would be headed by the Energy Advocate within the Independent Regulatory Review Commission. The office would be responsible for protecting reliability and affordability of the electricity grid and promoting the use of energy produced in the Commonwealth. Additionally, the office would review regulations, policies, documents, and actions of any governmental agency that could harm energy reliability and affordability, and reverse or block agency actions that do so. HB 114 was previously introduced as HB 2573 but died in committee at the end of the 2023-2024 legislative session.

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[121] Erica Moser, "Penn Celebrates Operation and Benefits of Largest Solar Power Project in Pennsylvania | Penn Today," Penn Today, March 18, 2024. https://penntoday.upenn.edu/news/penn-celebrates-operation-and-benefits-largest-solar-power-project-pennsylvania

[122] Aurora Sharrard, "Pitt & Vesper Energy Cut Ribbon on New Gaucho Solar Project Near Pittsburgh International Airport," Pitt Sustainability, March 11, 2024. https://www.sustainable.pitt.edu/pitt-vesper-gaucho-operational/

[123] Susan Phillips, "Philadelphia will power up to 25% of its buildings with solar energy from Adams County array," *The Allegheny Front (public radio program),* January 17, 2024. https://www.alleghenyfront.org/philadelphia-solar-power-buildings-climate-goal/; and City of Philadelphia, Municipal Energy Office, Office of Sustainability, "Adams Solar Project Is Complete, Supplies 25% of Municipal Electricity Demand," May 1, 2024, https://www.phila.gov/2024-05-01-adams-solar-project-is-complete-supplies-25-of-municipal-electricity-demand/

Renewable Energy Standards

Senate Bill 372, Printer's No. 320, was introduced and referred to the Consumer Protection and Professional Licensure Committee on March 6, 2025. The bill would amend the AEPS, renaming it the Energy Future Act, and making provision for advanced nuclear energy production and carbon recapture programs. The bill would also amend the Commonwealth's renewable energy production goals.

Solar Facility Siting

Senate Bill 336, Printer's No. 272 was introduced and referred to the Senate Agriculture and Rural Affairs Committee on February 26, 2025. The bill would create the Solar Energy Facility Location Act. The act would prohibit location of a solar energy facility on agricultural land with soil that is deemed Class 1 or Class 2 within the Land Capability Classification System of the Natural Resource Conservation Service. Landlords would be required to request an evaluation of the soil on their land by the Department of Agriculture before any solar facility installation could begin. The act would also provide a tax credit for owners of solar energy facilities that are located on non-agricultural lands, unless the Class 1 or Class 2 soils make up a *de minimus* portion of the land used for the project.

Lake Erie Energy Development Act

House Bill 522, Printer's No. 515, was introduced and referred to the House Environmental and Natural Resource Protection Committee on February 5, 2025. Referencing the Pennsylvania environmental amendment found in § 27 of the Pennsylvania Constitution, the General Assembly declared that the Commonwealth holds in trust the portion of Lake Erie located in Pennsylvania, including the lakebed and associate wind, air, water, and solar resources. The bill would authorize DEP, in consultation with the Department of General Services, to enter leases of at least 25 but no more than 10,000 contiguous acres of the lakebed located in Erie County for the use of wind, water, and solar resources of Lake Erie. Initial feasibility leases may last up to seven years, but once approved, long-term leases of an initial term up to 35 years would be authorized. This proposal was introduced as HB 254 in March 2023, and passed House on April 16, 2024 (102-99). It was introduced and referred to the Senate Environmental Resources and Energy Committee in April 2024 but failed to pass by the end of the 2023-2024 legislative session. A companion resolution, House Resolution 53, Printer's No. 473, directing the Joint State Government Commission to conduct a study on the proposal was introduced and referred to the House Environmental and Natural Resources Committee on February 4, 2025. The resolution was voted out of committee on March 18, 2025, and awaits adoption by the House.

Solar Arrays on Commonwealth Property

Senate Bill 292, Printer's No. 269, was introduced and referred to the Senate Appropriations Committee on February 26, 2025. A budget bill, this proposal includes an allocation of $10 million to the Department of General Services to design and construct solar panel and electric vehicle charging stations at Commonwealth facilities, including land acquisition and site and utility work. The specific appropriation is found at Section 3(7)(iii)(B) of the bill.

Decommissioning of Solar Energy Facilities

Senate Bill 349, Printer's No. 286, was introduced and referred to the Senate Environmental Resources and Energy Committee on February 26, 2025. It received second consideration in the Senate on March 31, 2025. The bill requires the entity leasing land under a solar energy facility agreement to be responsible for decommissioning the project at the end of the lease and requires financial assurance in the form of an escrow account, letter of credit or bond equal to the estimated cost of decommissioning. No later than 30 days prior to commencing construction, the leasing entity must file a decommissioning plan and financial assurance with the county recorder of deeds. Updates would be required every five years. This bill was introduced as SB 211 in January 2023 and passed the Senate (36-13). It was referred to the House and received second consideration in October 2024 but failed to pass by the end of the 2023-2024 legislative session.

House Bill 1080, Printer's No. 1198, was introduced and referred to the House Energy Committee on April 1, 2025. The bill requires the owner of a solar facility on leased land to decommission the facility within 18 months of ceasing production of electricity. Decommissioning plans and proof of financial assurance must be provided to the county recorder of deeds. The amount of financial assurance is to be equal to the estimated cost to decommission the facility, updated every five years by a DEP approved third-party professional engineer. Financial assistance is required to be in the form of an escrow account, certificate of deposit or another financial instrument, or a bond. The amount of assistance rises at five-year intervals from 10 percent initially, to 100 percent by year 25.

Senate Bill 590, Printer's No. 597, was introduced and referred to the Senate Environmental Resources and Energy Committee on April 9, 2025. The bill would add photovoltaic modules to the list of covered devices under the Covered Device Recycling Act, [124] which requires manufacturers to develop plans and take responsibility for recycling used covered devices such as televisions and computers.

Governor's Lightning Plan

In support of Governor Shapiro's 2025 proposal, the following bills have been introduced:

- House Bill 502, Printer's No. 1479, introduced and referred to House Energy Committee on April 23, 2025. Establishes the Reliable Energy Siting and Electric Transmission (RESET) Board.
- House Bill 503, Printer's No. 1460, introduced and referred to House Energy Committee on April 23, 2025. Enacts the Pennsylvania Climate Emissions Reduction Act (PACER).

[124] Act of November 23, 2010 (P.L. 1083, No.108), known as the Covered Device Recycling Act.

- House Bill 504, Printer's No. 1481, introduced and referred to the House Consumer Protection, Technology and Utilities Committee on April 23, 2025. The bill received first consideration and was laid on the table May 2, 2025. Enacts the Community Energy Act.
- House Bill 505, Printer's No. 1482, introduced and referred to the House consumer Protection, Technology and Utilities Committee on April 23, 2025. Modernizes the law governing energy utility energy efficiency plans.
- House Bill 1260, Printer's No. 1414, introduced and referred to the House Energy Committee on April 21, 2025. Enacts the Solar-Ready Warehouse and Distribution Center Act, which provides for solar-ready construction or retrofit of warehouses and e-commerce distribution centers.

Additionally, a co-sponsorship memorandum began circulating on February 13, 2025, that would establish a clean energy manufacturing tax credit. As of late April 2025, legislation enacting this proposal had not been introduced.

Pennsylvania Municipal Solar Ordinances

Municipal ordinances regulate land use, health and safety, occupancy, and fire protection, among others. While there are some county-wide ordinances affecting some aspects of homeownership, many of these rules are enacted at the local municipal level (city, borough, town, or township) and vary within counties and from county to county. This section will look at municipal ordinances as they relate to solar installations as they relate to agrivoltaics and farmland protection.

For municipalities to accomplish their community development objectives and comprehensive plans, municipalities are empowered to enact zoning ordinances governing the use of land, watercourses and bodies of water within their jurisdiction.[125] If there are individual municipalities within a county that do not adopt a zoning ordinance, then the county may adopt a zoning ordinance that would be applicable to those municipalities. If a municipality later adopts a zoning ordinance after the county has done so, the municipal zoning ordinance becomes primary and the county ordinance is treated as repealed as to that municipality.[126]

Ordinances governing solar installations vary from municipality to municipality. Some municipalities do not regulate any solar installations; others limit regulation to accessory, permitted, or specials uses of solar systems. Some municipalities regulate net-metering systems and grid-scale solar developments, while some only provide regulations for grid-scale solar. There is not a lot of standardization regarding technical specifications, but there are many common issues that are addressed in some form in these ordinances.

[125] § 601, Act of July 31, 1968 (P.L. 805, No. 247), reenacted and amended December 21, 1988 (P.L.1329, No.170); known as the Pennsylvania Municipalities Planning Code, 53 P.S. § 10601.
[126] Ibid., § 602, 53 P.S. § 10602.

Penn State University's Center for Energy Law and Policy has developed a database of local regulations governing solar energy systems. While the Center's disclaimer notes that the list is not comprehensive and is evolving with new updates regularly, it is one of the few sources of municipal ordinances that are gathered in one accessible place. The Center summarized its general findings on its website:

> Local regulation of medium- and large-scale solar differs substantially among municipalities, as the spreadsheet shows. For example, many local governments require that solar companies construct access roads to solar sites, with ordinances setting mandatory minimum widths for such roads at 12, 14, 16, 20, and 25 feet in different municipalities and counties. Many local governments also require solar energy developers to post bonds or other financial securities to cover the cost of decommissioning the project at the end of its useful life. Local governments require solar energy developers to post financial security at 25, 100, 110, or 150 percent of decommissioning costs (minus salvage and resale value, in some cases), depending on the jurisdiction. Others require a specific amount of financial security, such as $50,000. The spreadsheet shows this and other variation, including, for example, variation among required setbacks of solar farms from the edges of lots or other land uses; the minimum required height of fences or landscaping to screen solar farms from view; the amount of prime agricultural soils that the solar farm may cover; what counts as "impervious cover" at a solar farm (the area of a lot that water cannot infiltrate); and other differences.[127]

Examining the database, there are 13 of Pennsylvania's 67 counties where no solar energy regulations exist. Of the remaining 54 counties, 23 of the counties each have one municipality within the county that has solar regulation. The remaining 31 counties have regulations in two or more municipalities. Those counties with the most widespread distribution of solar ordinances include Adams, Allegheny, Beaver, Berks, Bucks, Cumberland, Chester, Erie, Lackawanna, Lancaster, Luzerne, Monroe, Montgomery, and York.

Penn State Extension, with support from DEP's Energy Programs Office has published a guide to grid-scale solar development in Pennsylvania for use by municipal officials to assist in crafting appropriate zoning ordinances and other land use regulations for solar development proposals. The guide is available on Penn State's Marcellus Center for Outreach and Research website at https://marcellus.psu.edu/solar-energy/.

Zoning ordinances directly impacting agrivoltaics are examined in depth later in this report.

[127] Pennsylvania State University, Center for Energy Law and Policy, "Pennsylvania Solar Ordinances," accessed April 9, 2025. https://celp.psu.edu/pa-solar-ordinances/

FARMLAND AND AGRICULTURAL PRESERVATION IN PENNSYLVANIA

Pennsylvania ranks high among the states in agricultural preservation laws and policies according to the American Farmland Trust (AFT). The AFT is a non-profit organization formed in 1980 to protect agricultural land, promote environmentally sound farming practices, and keep farmers on the land.[128] AFT maintains the federally funded Farmland Information Center (FIC) as a clearinghouse of farmland protection information. In May 2020 the FIC released a policy scorecard reflecting how states have responded to the leading threats to agriculture: development pressure, weaking agricultural viability, and the transfer of land to a new generation. Pennsylvania ranked fourth highest of the 50 states, with only New Jersey, Delaware, and Maryland ranking slightly higher.[129]

Pennsylvania has several statutes and programs to protect agricultural lands, but it is important to note that all these efforts are based on the voluntary participation of the landowner. There is no legal way to compel a farmer to participate in a program. Various financial incentives, however, are available to encourage participation.

"The challenge of preserving enough farmland for food production will be a defining challenge for the 21st century."

– John Ikerd

[128] American Farmland Trust, "About," https://farmland.org/about/, accessed November 4, 2024.
[129] American Farmland Trust, Farmland Information Center, "Farms Under Threat: The State of the States," May 2020, p. 37. https://farmlandinfo.org/wp-content/uploads/sites/2/2020/09/AFT_FUT_StateoftheStates_rev.pdf

Definition of a "Farm"

There is no standard definition of what constitutes a "farm" or "farmland" in Pennsylvania. Different statutes have different definitions, and various federal and state programs provide different definitions based on the purpose and goals of the particular program.

Statute/Program	**Minimum Acreage**	**Minimum Income**
Right-to-Farm Law	10 acres	If less than 10 acres, projected gross annual income of $10,000 or more.
Agricultural Security Area Law	10 acres	If less than 10 acres, projected gross annual income of $2,000 or more.
Clean and Green Act	10 acres	If less than 10 acres, projected gross annual income of $2,000 or more.
United States Department of Agriculture, Economic Research Service, USDA – ERS	n/a	Any place from which $1,000 or more agricultural products were produced and sold, or normally would have been sold, during the year.

The Internal Revenue Service (IRS) takes a more direct profit-based definition of a farm for purposes of income tax determinations and deductibility of farm-related expenses. The IRS draws a distinction between a for-profit farming enterprise and a "hobby" farm. The intent to make a profit (not the actual making of a profit) is the pivotal point. This becomes a facts-and-circumstances determination based on a variety of factors that contribute to defining a farm's activities as a business.[130]

If the primary goal is to preserve farmland, but avoid intruding into everyone's garden, the Agricultural Security Area and Clean and Green definitions would seem best suited to accomplish those goals. Generally, a farm would be defined as 10 acres or more, but if less than 10 acres, having a projected gross annual income of at least $2,000.

[130] Internal Revenue Service, IRS TAX TIP 2022-57, April 13, 2022. https://www.irs.gov/newsroom/heres-how-to-tell-the-difference-between-a-hobby-and-a-business-for-tax-purposes

Nature of Pennsylvania's Farmland

There are farms in all 67 counties of the Commonwealth. Pennsylvania's farms are relatively small, in terms of both acreage and value of sales despite agriculture being a major driver in the state's economy. Table 1 shows the counties ranked by farm acreage. Table 2 shows the ten counties with the largest and smallest average farm size, respectively.

Table 1
Counties Ranked by Total Farm Acreage
Pennsylvania
2022

County	Total Acreage	Number of Farms	Average Size of Farm in Acres
Lancaster	378,574	4,680	81
Bradford	281,106	1,315	214
Franklin	263,611	1,439	183
York	243,980	1,929	126
Bedford	214,933	1,106	194
Berks	208,478	1,767	118
Tioga	204,782	998	121
Crawford	204,717	1,022	200
Somerset	197,565	998	198
Adams	183,184	1,243	147

Source: United States Department of Agriculture,
National Agricultural Statistics Service, 2022 Census of Agriculture – County Data,
Table 1, County Summary Highlights: 2022, https://www.nass.usda.gov/Publications/AgCensus/2022/Full_Report/Volume_1,_Chapter_2_County_Level/Pennsylvania/st42_2_001_001.pdf

Table 2
Counties with the Largest and Smallest Farms
by Average Farm Acreage
Pennsylvania
2022

Largest Farms		**Smallest Farms**	
County	**Avg. Farm Size**	**County**	**Avg. Farm Size**
Potter	248	Philadelphia	9
Bradford	214	Delaware	16
Susquehanna	213	Montgomery	55
Blair	210	Allegheny	74
Crawford	200	Bucks	79

Source: United States Department of Agriculture, National Agricultural Statistics Service, 2022 Census of Agriculture – County Data, Table 1, County Summary Highlights: 2022, https://www.nass.usda.gov/Publications/AgCensus/2022/Full_Report/Volume_1,_Chapter_2_County_Level/Pennsylvania/st42_2_001_001.pdf

Overall, Pennsylvania ranks 32nd among the states on total acreage in farmland[131] and is 33rd in terms of overall land area.[132] Only five states have smaller average size farms than Pennsylvania, and they are all also much smaller in landmass. They are Connecticut, Massachusetts, New Hampshire, New Jersey, and Rhode Island.[133]

Looking at data from the five states closest to Pennsylvania in terms of total acres in farmland, Pennsylvania has the smallest average sized farms in acreage, and three of the other five states have an average higher market value of agricultural products sold per farm. See Table 3.

[131] Identified by staff from United States Department of Agriculture, National Agricultural Statistics Service, 2022 Census of Agriculture – State Data, Table 1, State Summary Highlights: 2022. (NASS 2022 Census) https://www.nass.usda.gov/Publications/AgCensus/2022/Full_Report/Volume_1,_Chapter_2_US_State_Level/st99_2_001_001.pdf
[132] World Stats and Facts, accessed October 16, 2024. https://worldstatsandfacts.com/geography/us-states-by-area/
[133] Identified by staff from the NASS 2022 Census, State Summary Highlights.

Table 3
Farmland Acreage of Selected U.S. States
2022

State	Total acres in farmland	Avg. size farm in acreage	Avg. market value of agricultural product sold per farm
North Carolina	8,128,136	190	$436,569
Louisiana	7,986,381	319	192,239
Virginia	7,309,687	187	140,838
Pennsylvania	**7,058,325**	**144**	**209,618**
New York	6,502,286	212	262,228
Nevada	5,896,654	1,889	307,393

Source: United States Department of Agriculture, National Agricultural Statistics Service, 2022 Census of Agriculture – State Data, Table 1, State Summary Highlights: 2022. (NASS 2022 Census) https://www.nass.usda.gov/Publications/AgCensus/2022/Full_Report/Volume_1,_Chapter_2_US_State_Level/st99_2_001_001.pdf

A review of 2017 U.S. Census of Agriculture conducted by Penn State College of Agricultural Sciences confirmed the small size of many of Pennsylvania's farms in a manner consistent with the 2022 data, which was released in early 2024. Key points noted in that analysis show that about half of Pennsylvania farms sold less than $10,000 in agricultural products and 24 percent of farms sold less than $1,000 that year. In 2022, 48.6 percent of Pennsylvania's farms sold less than $10,000. The lowest category in the breakdown of income in the 2022 data was under $2,500, which represents 30 percent of Pennsylvania's farms.[134]

The report further noted that small farms are most common in the Appalachian Highlands of western Pennsylvania and the Northern Tier. Larger farms tend to be found in the ridge and valley region of southeast Pennsylvania.[135]

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[134] Percentages calculated by staff based on Table X (value of annual sales)
[135] "Understanding the Quiet Majority: Small Farms in Pennsylvania, 2017," PennState College of Agricultural Sciences, Center for Economic and Community Development, 2021.
https://aese.psu.edu/research/centers/cecd/publications/pa-agriculture-analysis/small-farms-in-pa-in-2017_psu-cecd_may2021.pdf

Table 4
Size of Farms by Acreage
Pennsylvania
2022

Size of Farm in Acres	Number of Farms
1 – 9 acres	5,836
10-49 acres	14,918
50-179 acres	17,817
180-499 acres	7,855
500- 999 acres	1,803
1,000 or more acres	824
Total Farms	49,053

Source: United States Department of Agriculture,
National Agricultural Statistics Service,
2022 Census of Agriculture – County Data, Table 1,
County Summary Highlights: 2022, https://www.nass.usda.gov/Publications/AgCensus/2022/Full_Report/Volume 1,_Chapter_2_CountyLevel/Pennsylvania/st42_2_001_001.pdf

Table 5
Size of Farms by Value of Annual Sales
Pennsylvania
2022

Size of Farm in Value of Sales	Number of Farms
Less than $2,500	14,692
$2,500-$4,999	4,179
$5,000-$9,999	4,987
$10,000-$24,999	6,668
$25,000-$49,999	3,964
$450,000-$99,999	3,338
$100,000 or more	11,225
Total Farms	49,053

Source: United States Department of Agriculture,
National Agricultural Statistics Service.

The size of Pennsylvania's farms has an impact on the ability to engage in agrivoltaic farming. The use of solar panels for the sole consumption of the farmer can be conducted virtually anywhere. While they may not all be able to provide all the energy needs of the farm, they can help offset the need to purchase power from traditional energy providers.

Nature of Pennsylvania's Agricultural Products

Pennsylvania's top agricultural products include milk and other dairy products, chicken eggs, chicken broilers, corn, cattle and calves, and mushrooms, although the top agricultural product statewide is hardwoods. Pennsylvania is the number one producer of mushrooms in the country, with that industry centered in Kennett Square and surrounding counties in southeast Pennsylvania. Other products include 51,500 colonies of honeybees (double the number in 2017).[136] Other products identified by the USDA/NASS were goats, sheep, hogs, turkeys, hay and haylage, corn, soybeans, apples, peaches, tobacco, pumpkins, wheat, oats, barley, rye, and maple syrup.[137] According to the Penn State study, small farms tend to focus on agricultural products different from their larger brethren, with their focus on hay, beef cattle, sheep or goats.[138]

Farmland Preservation in Pennsylvania

Pennsylvania Constitution

The Pennsylvania Constitution includes an environmental rights amendment that is foundational for all uses of the Commonwealth's public natural resources.

> § 27. Natural resources and the public estate.
> The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment. Pennsylvania's public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people.[139]

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[136] "Top Pennsylvania Agriculture Facts From the 2024 Census of Agriculture," *Farm Flavor,* May 28, 2024. https://farmflavor.com/pennsylvania/pennsylvania-crops-livestock/top-pennsylvania-agriculture-facts-from-the-2024-census-of-agriculture/

[137] USDA/NASS, 2023 State Agriculture Overview Pennsylvania, 2023, accessed October 16, 2024. https://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=pennsylvania

[138] Supra, n. 13 (Quiet Majority).

[139] Article I, Section 27, Pennsylvania Constitution. https://ldpc6.legis.state.pa.us/cfdocs/legis/LI/consCheck.cfm?txtType=HTM&ttl=0. Pennsylvania is only one of six states with an environmental rights amendment. See Dana Drugmand, "Advocates Nationwide Push for State-Level Green Constitutional Amendments," *Sierra,* March 28, 2024. https://www.sierraclub.org/sierra/advocates-nationwide-push-state-level-green-constitutional-amendments

Any energy development, including solar energy, that makes use of public lands is subject to this protective trust. Additionally, Pennsylvania has several statutes designed to protect and preserve Pennsylvania's privately-owned farmlands.

Right-to-Farm Law

Pennsylvania's right to farm law protects agricultural operations from municipal ordinances and lawsuits alleging that an agricultural operation is creating a public nuisance. While not a blanket immunity statute, agricultural operations may not be defined as a public nuisance in local ordinances, and operations in place for at least a year prior to the cause of action that have not substantially changed since the operation was established may not be the subject of a lawsuit. Exceptions exist for operations that have a direct adverse effect on public health and safety. Agricultural operations must be at least 10 acres in area or if less, have an anticipated annual yearly gross income of at least $10,000. Agricultural commodities include:

- Agricultural, aquacultural, horticultural, floricultural, viticultural or dairy products.
- Livestock and livestock products.
- Ranch-raised fur-bearing animals and their products.
- The products of poultry or beekeeping.
- Forestry and forestry products.
- Any products raised or produced on farms intended for human consumption, and the processed or manufactured products of such products intended for human consumption.[140]

Agricultural Security Areas

In 1981, the General Assembly enacted the Agricultural Area Security Law.[141] Under this law, farmers with a combined minimum of 250 acres may petition their local government unit to form an agricultural security area (ASA). The land must be actively used for agricultural production or be agriculturally viable and used, at least in part, for commercial equine activities. Inclusion in an ASA helps protect farmers from local ordinances and nuisance lawsuits affecting normal farm activities. The act further establishes the Agricultural Lands Condemnation Approval Board organized by the Pennsylvania Department of Agriculture to review any farmland condemnation (eminent domain) proceedings initiated by state and local agencies. In its 2016 security area handbook, the department identified nearly four million acres of land owned by 40,296 landowners in 996 townships as part of an ASA.[142]

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[140] Act of June 10, 1982 (P.L.454, No.133), referred to as the Right-to-Farm Law, §§ 2-4.
[141] Act of June 30, 1981 (P.L. 128, No. 43), known as the Agricultural Area Security Law.
[142] Pennsylvania Department of Agriculture, Bureau of Farmland Preservation, "Agricultural Security Area Handbook," April 11, 2016, p. 25, accessed November 6, 2024. https://www.pa.gov/content/dam/copapwp-pagov/en/pda/documents/plants_land_water/farmland/asa/documents/ASA%20Handbook%2004.06.16%20single%20sider%20full.pdf. See also, Pennsylvania Department of Agriculture website at: https://www.pa.gov/en/agencies/pda/plants-land-water/farmland-preservation/agricultural-security-areas.html

Agricultural Conservation Easements

In 1967, Pennsylvania passed an act preserving land for open air spaces that included the ability of state and local government to acquire an interest in real property, including easements, remainders, future interests, leases, or contractual interest or right concerning the use of or power to transfer property. Among the justifiable reasons is the protection and conservation of farmland.[143]

The specific ability to purchase agricultural conservation easements was added to the Agricultural Area Security Law in 1988. Under the authority of the Department of Agriculture and the State Agricultural Land Preservation Board (created under this amendment), state and local governments were authorized to purchased conservation easements within ASAs of other lands meeting eligibility criteria.[144] According to the Department of Agriculture's website, more than 630,000 acres of easement purchases have been made with over 6,200 farms.[145] In June 2024, the Shapiro Administration announced that it was purchasing conservation easements in 28 farms in 19 counties, comprising 2,629 acres and costing $9.8 million.[146] In October 2024, additional easement purchases were announced on another 28 farms in 16 counties, comprising 1,953 acres and costing $6.7 million.[147]

In 2001, Pennsylvania enhanced its commitment to supporting the use of conservation easements. The statute provides statutory instructions as to how conservation easements are to be interpreted by Pennsylvania courts, if the easement meets the standards of the statute. These instructions include a presumption that an easement is valid, and that language in a grant of a conservation easement should be interpreted in favor of conservation.[148]

Pennsylvania has several tax incentive programs that can encourage farmers to keep their land in agricultural production.

[143] Act of January 19 (1968) 1967 (P.L. 992, No.442).
[144] Sections 14.1 – 14.3 of the Agricultural Area Security Law, as added by the act of December 14, 1988 (P.L. 1202, No. 149).
[145] Pennsylvania Department of Agriculture website accessed Novembre 5, 2024.
https://www.pa.gov/en/agencies/pda/plants-land-water/farmland-preservation.html
[146] PCED, Newsroom, "Shapiro Administration Invests $9.8 Million to Protect 2,629 Acres on 28 Farms in 19 Counties from Future Development," June 13, 2024. https://www.pa.gov/en/agencies/pda/newsroom/shapiro-administration-protects-28-farms-in-19-pennsylvania-coun.html Counties included Adams, Beaver, Berks, Bucks, Butler, Carbon, Centre, Chester, Columbia, Cumberland, Franklin, Indiana, Lancaster, Lehigh, Mercer, Northampton, Tioga, Union, and Washington.
[147] Pennsylvania Department of Agriculture, "Pennsylvania Invests Over $6.7 Million to Ensure 28 Farms in 16 Counties Stay Farms Forever," Press Release October 10, 2024. https://www.pa.gov/en/agencies/pda/newsroom/pa-invests-over--6-7-m-to-ensure-28-farms-in-16-counties-stay-fa.html Counties included Adams, Beaver Berks, Blair, Bucks, Cumberland, Franklin, Lancaster, Lawrence, Lebanon, Luzerne, Lycoming, Monroe, Montgomery, Tioga, and Westmoreland.
[148] Act of June 22, 2001 (P.L. 390, No. 29), known as the Conservation and Preservation Easements Act. See also, Andrew M. Loza and Justin Hollinger, Esq., "Guide to the Conservation and Preservation Easements Act: Pennsylvania Act 29 of 2001," WeConservePA, February 2, 2024. https://conservationtools-production.s3.amazonaws.com/library_item_files/957/2745/G_CPEA_240203e.pdf

Clean and Green

Preferential tax assessments for farms may be available through "Clean and Green," which provides property value assessments based on the use value rather than the fair market value of land. Parcels must consist of at least 10 acres in agricultural use, agricultural reserve or forest reserve. Smaller properties may be eligible if they produce at least $2,000 per year of farm income.[149] The definitions of agricultural reserve and agricultural use both include "any land devoted to the development and operation of an alternative energy system, if a majority of the energy annually generated is utilized on the tract." Alternative energy sources include solar photovoltaic or other solar electric energy and solar thermal energy.[150] These limitations, however, favor net-metering, and would not be suitable for grid-scale solar energy in most cases. More than 9.3 million acres are enrolled in the program statewide.[151]

Beginning Farmer Realty Transfer Tax Exemption and Tax Credit Programs

A transfer of real estate that is part of an agricultural conservation easement under an ASA is exempt from state realty transfer tax. An individual must apply to the Department of Agriculture for certification as a beginner farmer to benefit from the exemption.[152] Additionally, a tax credit was created for the benefit of owners of agricultural assets (land, livestock, facilities, buildings, and machinery used for farming) who sell or rent agricultural assets to a beginning farmer. The tax credit is a 10-year, $59 million program that began in 2020 and expires at the end of 2029.[153]

First Industries Fund (FIF)

This program is administered by the Department of Community and Economic Development (DCED) under the direction of the Commonwealth Financing Authority. Funds can be used for land and building acquisition and construction, machinery and equipment purchases and upgrades and working capital in agriculture and tourism industries. Loan guarantees can be made for up to 90 percent of the outstanding principal balance up to $2.5 million for agricultural projects. Approval projects can include "Energy-related activities impacting production agriculture or agribusiness."[154] In 2023, $2.5 million was granted to seven projects across Lancaster, Northumberland, and Perry County. Five of the projects involved infrastructure for the poultry industry.[155] Five projects were approved in spring 2024 in Berks, Columbia, Lancaster

[149] The act of December 19, 1974 (P.L. 973, No. 319) known as the "Pennsylvania Farmland and Forest Land Assessment Act of 1974" (Clean and Green).
[150] Clean and Green, § 2. See also the AEPS Act.
[151] Pennsylvania Department of Agriculture accessed November 5, 2024. https://www.pa.gov/en/agencies/pda/plants-land-water/farmland-preservation/clean-and-green.html
[152] Section 1101-C of the act of Act of March 4, 1971 (P.L. 6, No. 2), known as the Tax Reform Code of 1971, as amended by the act of June 28, 2019 (P.L.50, No. 13).
[153] Article XVIII-H, §§ 1801-H et seq., of the Tax Reform of Code of 1971, as added by the act of July 2, 2019 (P.L.399, No. 65). See also DCED, "Beginning Farmer Tax Credit: Program Guidelines," November 2021. https://dced.pa.gov/download/beginning-farmer-tax-credit-guidelines/?wpdmdl=95140
[154] DECD, "First Industries Loan Guarantee Program: Program Guidelines," May 2023. https://dced.pa.gov/download/first-industries-loan-guarantee-guidelines/?wpdmdl=69425
[155] DCED, Newsroom, "Shapiro Administration Announces More Than $3 Million in New Investments to Enhance Communities and Strengthen Economy Across Pennsylvania," July 24, 2023. https://dced.pa.gov/newsroom/shapiro-

and Lebanon County.[156] None of these projects specifically address solar integration into agriculture.

Alternative and Clean Energy Program (ACE)

The ACE program provides grants and loans to promote the development of alternative and clean energy projects, infrastructure associated with compressed natural gas and liquefied natural gas fueling stations, and energy efficiency and conservation projects. Projects also include facilities that generate, use, or distribute alternative and clean energy sources. Businesses, economic development organizations, and municipalities, counties, and school districts can be eligible applicants. The development of community solar linked to agrivoltaics would logically fall within the parameters of this loan and grant program.[157]

Next Generation Farmer Loan Program

This program provides loan guarantees for purchases of agricultural land, improvements, and depreciable property. Depreciable agricultural property is defined as personal property suitable for use in farming for which an income tax deduction for depreciation is allowable under the Internal Revenue Code. The program allows for purchases from related persons of the buyer, defined as individual: grandfather, grandmother, father, mother, brother, sister, child, grandchild, or spouse, thus the title "next generation." Transfers must be at fair market value.[158] This program could also potentially be used to purchase farmland to establish an agrivoltaic operation.

Federal Farmland Preservation Programs

The United States Department of Agriculture (USDA) is the principal driver for farmland preservation at the federal level. Generally, for USDA purposes, a farm is defined as "any place from which $1,000 or more of agricultural products were produced and sold, or normally would have been sold, during the year." The USDA categories farms into three broad types (with subcategories within).

- Residence farms: Farms with less than $350,000 in gross cash farm income and where the principal operator is either retired from farming or has a primary occupation other than farming.

administration-announces-more-than-3-million-in-new-investments-to-enhance-communities-and-strengthen-economy-across-pennsylvania/

[156] "DECD, Newsroom, "Shapiro Administration Announces More Than $1.8M in New Investments to Strengthen Agriculture Industry Across Pennsylvania," May 21, 2024. https://dced.pa.gov/newsroom/shapiro-administration-announces-more-than-1-8-million-in-new-investments-to-strengthen-agriculture-industry-across-pennsylvania/

[157] DCED, "Alternative and Clean Energy Program (ACE)," accessed November 18, 2024. https://dced.pa.gov/programs/alternative-clean-energy-program-ace/

[158] DECD, "Next Generation Farmer Loan Program: Program Guidelines," March 2024. https://dced.pa.gov/download/next-generation-farmer-guidelines/?wpdmdl=84578

- Intermediate farms: Farms with less than $350,000 in gross cash farm income and a principal operator whose primary occupation is farming.
- Commercial farms: Farms with $350,000 or more gross cash farm income and nonfamily farms.[159]

The Natural Resource Conservation Service (NRCS) of the USDA oversees several programs and initiatives impacting farmland protection and preservation. Two of the programs with the greatest potential impact on agrivoltaic farming are the ACEP and CRP programs.

Agricultural Conservation Easement Program (ACEP)

ACEP provides for two types of easements: agricultural land easements (ALE) to protect croplands and grasslands on working farms and ranches by limiting non-agricultural uses of the land through conservation easements; and wetland reserve easements (WRE) to restore and enhance wetlands which have been previously degraded due to agricultural uses. Private and tribal landowners, land trusts, and state and local governments are eligible for ALEs, while only private and tribal landowners may apply for WREs. The Inflation Reduction Act (IRA) provided $1.4 Billion in additional funding for ACEP over five years.[160] In March 2024, NRCS announced it would be dedicating $138 million funding for 138 climate-smart conservation easements to assist farmers and ranchers in conserving wetlands, grasslands and prime farmlands. Pennsylvania is not listed as an eligible state for the climate-smart conservation easements,[161] but is covered under the broader ACEP program.

Conservation Reserve Program (CRP)

The CRP provides a yearly rental payment to farmers to not use environmentally sensitive land for agriculture production, as well as plan species that will improve environmental health and quality. Rental contracts vary from 10 to 15 years in length. "The long-term goal of the program is to re-establish valuable land cover to help improve water quality, prevent soil erosion, and reduce loss of wildlife habitat."[162] The Conservation Reserve Program (CRP) is administered by the USDA's Farm Service Agency (FSA) and is a voluntary program that encourages farmers and landowners to convert highly erodible and other environmentally sensitive acreage to vegetative cover, such as native grasses, trees, and riparian buffers. Eligible applicants include farmers and landowners with environmentally sensitive land. The program currently has 26 million acres enrolled.[163]

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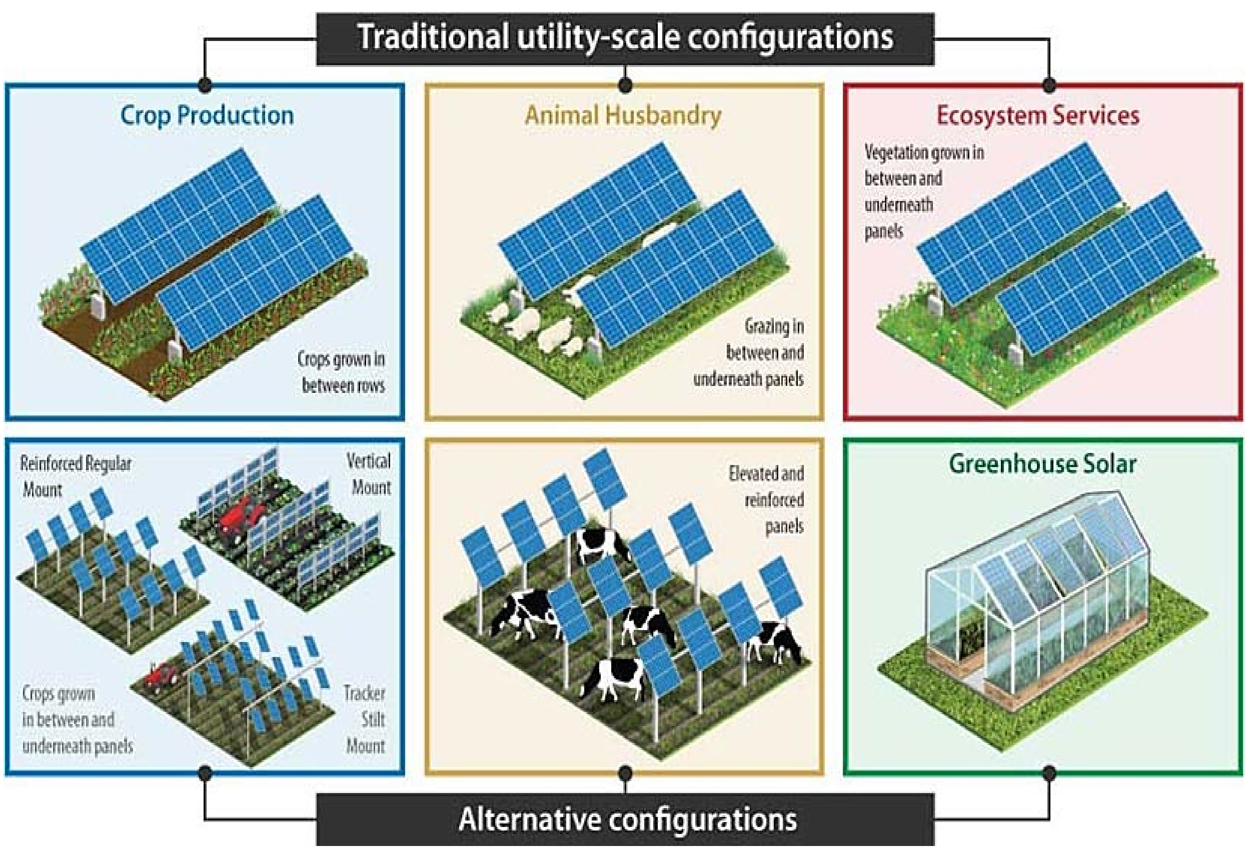
[159] USDA, Economic Research Service, "Farm household well-being: Glossary," December 3, 2024. https://www.ers.usda.gov/topics/farm-economy/farm-household-well-being/glossary/
[160] USDA, NRCS, "Agricultural Conservation Easement Program," accessed December 20, 2024. https://www.nrcs.usda.gov/programs-initiatives/acep-agricultural-conservation-easement-program
[161] USDA, NRCS, "Agricultural Producers to Conserve Land through Climate-Smart Easements as part of President Biden's Investing in America Agenda," March 13, 2024. https://www.nrcs.usda.gov/news/agricultural-producers-to-conserve-land-through-climate-smart-easements-as-part-of-president
[162] USDA, NRCS, "Conservation Reserve Program," accessed December 20, 2024. https://www.nrcs.usda.gov/programs-initiatives/crp-conservation-reserve-program
[163] USDA, FSA, "Conservation Reserve Program (CRP), accessed December 20, 2024. https://www.fsa.usda.gov/resources/programs/conservation-reserve-program

THE INTERSECTION OF SOLAR ENERGY AND FARMING

The competition between farmland for agricultural uses and solar energy production can potentially be resolved through incorporating agrivoltaics into a farm. For some it may be baffling why agriculture lands are chosen for solar when compared to other options such as residences, rooftops, parking garages appear to be readily available. As solar energy expands in the state, more land is needed to host solar projects and farmland located near transmission infrastructure is among the top choices for solar developers. Even though large solar farms are more efficient compared to other forms of solar, the total amount of rural farmland is enough to shock rural communities accustomed to that land being used for agricultural purposes. While local communities may prefer developing other types of land for solar energy, agricultural lands are the easiest to develop, and commercial scale rooftop solar is more costly to design and cannot produce electricity as inexpensively as grid-scale solar on the ground.

Solar energy production can be configured in multiple ways to accommodate agricultural activities. The diagram below provides examples supplied by NREL.



Agrivoltaics includes many different uses. Agrivoltaics systems can be installed in the same basic row layout as a traditional large-scale solar plant—or they can be modified to provide extra space for workers, animals, or farm equipment to move under and between them.[164]

The NREL maintains a database of agrivoltaic PV installations in the United States. As of May 2025, the site lists 599 agrivoltaic sites spanning 38 states. Combined, these sites encompass over 64,600 acres and a total installed electrical capacity of more than 10,310 MW. Based on the amount of installed MW, Agrivoltaic systems represents over four percent of all PV solar installed in the United States as of December 2024.[165] Tables 9 and 10 describe the type of AV activities and the size of the AV systems within the country.

Table 9
U.S. Agrivoltaic PV Systems by Activity
2025

Type of AV Activity	Number of Sites	Total Megawatts	Acres
Crop Production	43	267	1,713
Habitat	419	4,119	22,740
Solar Grazing	232	8,069	53,176

Source: https://openei.org/wiki/InSPIRE/Agrivoltaics_Map

Table 10
Size of U.S. Agrivoltaic PV Systems
2025

AV System Size	Number of Sites	Total Megawatts in Size Class	Acres
Under 1 MW	68	23	160
1-5 MW	334	707	3,824
5-10 MW	111	730	3,484
10-100 MW	51	1,641	9,859
Over 100 MW	33	7,209	47,361

Source: https://openei.org/wiki/InSPIRE/Agrivoltaics_Map

Of the technologies reviewed, 1-axis tracking which enables panels to follow the sun was the most employed at agrivoltaics sites. (306 sites, 7,457 MW). Other innovations that could allow greater compatibility with solar projects appear to be still limited. No sites reported using double-axis tracking arrays, 33 sites employed bifacial panels, while only four sites reported using translucent panels.

[164] Harrison Dreves, "Growing Plants, Power, and Partnerships Through Agrivoltaics," NREL, August 18, 2022, https://www.nrel.gov/news/program/2022/growing-plants-power-and-partnerships.html.
[165] SEIA. "Solar Market Insight Report" March 2025. https://seia.org/research-resources/us-solar-market-insight/

Solar grazing and pollinator habitat support are the two most widely recognized types of agrivoltaics in the country. Crop production lags due to its increased cost, scaling issues, and technical complexity. The data source may not accurately account for all agrivoltaics activity being conducted by the country. Contracted solar grazing operates as a natural form of vegetation management service, and as sheep would be moved from site to site and may not necessarily be tied to a specific AV site.

Whether a small solar installation is grid-tied or not makes little difference regarding agrivoltaics. While rooftop installations outside of greenhouses have little implications on agrivoltaics, starting small by growing gardens under backyard solar panels could be a way to build public confidence in agrivoltaics with root vegetables and shade tolerant leaves. It would, however, likely take much more to prove the viability of agrivoltaics at farms. Some research into how panels interact with growing plants to learn more about configurations of plants with shade but has been done with fake panels that are not generating electricity which may skew the results.

Currently, the scale of solar is important for agrivoltaics development in the United States. Small-scale PV generation hypothetically makes it easier for an entity to own both land and solar panels, allowing for whatever agriculture activities the land is zoned for. However, developing agrivoltaics solar systems are expensive which limits small landowners from expanding their systems or uncovering synergies with their crops if only a small amount of land used for agrivoltaics.

At the other end of the spectrum there are larger, grid-scale solar installations which are typically installed on land leased from landowners. While solar developers may have access to more capital and larger tracts of land, their business model is devoted to energy production first and foremost and are risk adverse of incorporating agricultural practices without demonstrated benefits to their businesses.

Like grid scale solar the viability of agrivoltaics projects for farmers who lease their land to a merchant generator is likely dependent on the specific lease agreement to determine whether agricultural activities could commence near the panels. Such a company may have limited incentives to do so and would likely forbid some activities to reduce perceived risks to investments.

While encouraging both food and energy production is a priority for many communities, agrivoltaics in its current form is not a blanket panacea for crop and solar energy production. Without careful planning an agrivoltaics array may not generate enough electricity for a project to be affordable or be able to create conditions necessary for the selected crops to flourish. Alternatively, an agrivoltaic system can be designed to mitigate specific agricultural problems, such as protection from wind or hot temperatures while generating renewable energy.

A scenario in which landowning farmers with enough funding to build their own systems or form partnerships with solar companies interested in pursuing agrivoltaics is the most promising. Currently agrivoltaics progress is limited by lack of capital and scientific expertise on the part of farmers and financial incentives on the part of solar developers.

Agrivoltaic systems combine two sciences of solar energy production and agricultural cultivation which were infrequently utilized in the past. The benefits and costs of agrivoltaics are largely dependent on the design of the solar system and the specific agricultural practice in question. Different agrivoltaic practices vary in maturity and may range from strategies that are widely adopted, undergoing assessment by researchers, or still being developed. Part of the challenge of designing agrivoltaic systems is that products may be competing for the same resources: frequently ground space and access to sunlight. If the crops or grasses beneath a panel do not receive enough light, they will be unable to grow, and the project fails. If the agriculture component receives the most sunlight at the expense of the solar panels, the time and resources spent developing an array may cause it to be impractical. While the United States has not yet implemented some of the more advanced agrivoltaic system designs seen elsewhere in the world, there are also cheaper and less complex implementations of these concepts in use in the United States that benefit both solar developers and agricultural producers.

The United States Department of Agriculture (USDA) and the United States Department of Energy (DOE) are both actors in the agrivoltaics movement in the United States. In 2023, USDA initiated three agrivoltaics projects, including a project exploring sustainable agricultural systems in the northern Great Plains, and assessing the viability of locating solar panels on livestock grazing pasture. The other two projects were focused on best practices for managing crop and livestock agrivoltaics in the Southwest.[166]

According to USDA, in 2024, the majority of agrivoltaics systems have grasses and/or pollinator habitat under their solar panels. Over 25 percent involve sheep grazing, while less than five percent include crops like fruits or vegetables.[167]

Agricultural Land Impact

The Economic Research Service of the U.S. Department of Agriculture conducted a study released in 2024, covering the impact of solar and wind development in rural areas for the period 2009-2020. The study examined how these alternative energy sources changed the nature of the land on which they were developed. In the aggregate, solar farms contain a miniscule portion of total farmland nationwide, with approximately 897 million acres of land in farms and an estimated 336,000 acres in solar development. Nationwide, 43 percent of solar farms were installed on land that was in cropland, and another 21 percent in pasture-rangeland. Regionally, in the Midwest, 66 percent of installations were on land characterized as cropland prior to installation. In the Plains and the West, pasture-rangeland was the most common type. From three to five years after installation, 82 percent of cropland remained in the same land cover category. The Atlantic Region, where Pennsylvania is located, has a smaller impact. Land cover prior to installation was found to be 37 percent in continuous cropland, while 23 percent was in forests. Further, the study showed that while cropland is 15 percent of all lands in the Atlantic Region, 43 percent of all solar

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[166] Karen McGuire, "Common Ground for Agriculture and Solar Energy: Federal Funding Supports Research and Development in Agrivoltaics," *Amber Waves,* USDA Economic Research Service, April 22, 2024.
https://www.ers.usda.gov/amber-waves/2024/april/common-ground-for-agriculture-and-solar-energy-federal-funding-supports-research-and-development-in-agrivoltaics
[167] Maguire, "Common on Ground."

installations are located on that 15 percent of cropland. As the study noted, "land suited for crop production is also well-suited for solar development."[168] The goal of agrivoltaics is to allow those two activities to co-exist.

Solar Land Lease Agreements

Most farmland that is developed for grid-scale solar energy is leased, not purchased. Leases can average 25 years and are paid on an annual basis. There may be restrictions on the use by the farmer of the land, both in local zoning regulations and within the lease agreement. Generally, a short-term (a few years) option will be purchased from the landowner. Generally, they are binding on the landowner but allow the developer to withdraw from the proposal if permits and feasibility analyses may lead the developer to withdraw from the project. The option may require participation by the landowner to assist in the permitting process. Factors that should be addressed in the lease include maintenance, decommissioning, site selection, and other concerns. Landowners considering entering an option and subsequent solar land lease should consult experienced legal counsel. Pennsylvania's Department of Environmental Protection provides information on their website on landowner resources for grid-scale solar.[169] The Public Utility Commission also provides guidance to landowners considering leasing or installing solar on their properties.[170] Additionally, Penn State Extension produced a guide to leasing, and the USDA also has a guide.[171]

Support for Agrivoltaics in Pennsylvania

While PV arrays can be placed on rooftops or on other structures, the preferred site for solar developers is agricultural land.[172] According to Penn State Extension this includes:

- Flat or terrain with a less than 7 percent slope going east, south, or west.
- Proximity to transmission infrastructure is also vital; ideally projects are within one to three miles of a substation.
- Locations with established solar policies which set guidelines over property setbacks, fences, and panel coverage.

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[168] Karen Maguire et al., "Utility-Scale Solar and Wind Development in Rural Areas: Land Cover Change (2009-2020)," May 2024. https://ers.usda.gov/sites/default/files/_laserfiche/publications/109209/ERR-330.pdf?v=66145
[169] Pennsylvania Department of Environmental Protection, "Solar Energy: Landowner Resources for Grid-Scale Solar," accessed December 17, 2024.
https://www.pa.gov/agencies/dep/residents/solar-energy-resource-hub/landowner-resources.html
[170] Pennsylvania Public Utility Commission, Renewable Energy, Land Lease Agreements for Solar, accessed April 29, 2025. https://www.puc.pa.gov/electricity/renewable-energy/
[171] Penn State Extension, "Pennsylvania Landowners Guide to Utility-Scale Solar Leasing," Updated January 24, 2025. https://extension.psu.edu/pennsylvania-landowners-guide-to-utility-scale-solar-leasing; and Peggy Kirk Hall et et al. "Farmland Owner's Guide to Solar Leasing," *USDA National Agricultural Law Center,* August 2019. https://nationalaglawcenter.org/wp-content/uploads/assets/articles/hall_solar_Leasing.pdf
[172] Thomas Beresnyak, "Grid-Scale Solar 'Basics,'" PennState Extension, October 28, 2024.
https://extension.psu.edu/grid-scale-solar-basics

These competing interests can be at least partially reconciled through the implementation of agrivoltaics – the collocation of solar panels on farmlands with agricultural activities occurring under and around the panels. As farmers are learning more about solar energy development on their farmland, the ability to still pursue agricultural activities on the same land is spurring more interest in the practice.

A study conducted during 2023-2024 by The Pennsylvania State University surveyed farmers and received 90 responses. Overall, it appeared that respondents were intrigued by agrivoltaics and felt strong support for the potential environmental, social, and economic benefits of maintaining the productive use of land under solar panels while generating solar energy. Many were interested in decreased energy costs and diversified income.

Concerns about the costs of installation and maintenance were raised. Some obstacles cited were the difficulty in using machinery for soil preparation, planting, or harvesting. Other concerns were more site-specific, such as excess shade and insufficient direct moisture. Of those engaged in agrivoltaics (which was found to be ambiguously defined by individuals), the top practices were grazing, specialty crop production, and garden production for home consumption. Many of the recommendations from the study are mirrored in the recommendations of the HR224 advisory committee.[173]

Various plans and programs have been developed within multiple organizations, all with the goal of increasing Pennsylvania's use of renewable energy, and especially solar energy, to shift away from less environmentally friendly sources. Expanding solar energy requires the use of land to site the solar panels and arrays. Unfortunately, some of the best suited and cheapest to develop is agricultural land, thus spurring the conflict between solar energy and farming. Agrivoltaics become very important in reconciling those competing interests. While Pennsylvania does not have a specific solar facility siting law, guidance is available regarding grid-scale solar panel siting on agricultural lands, offered by the Pennsylvania Department of Agriculture and the Pennsylvania Land Trust Association.[174] The Department of Environmental Protection addresses siting issues in its solar stormwater FAQ.[175] Additionally, Penn State Extension has studied land conversion issues related to solar energy development.[176]

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[173] Stephanie Buechler et al., "Emerging Perspectives of PA Farmers on Agrivoltaics," October 2024. Article not available online; copy on file at the JSGC offices.

[174] Pennsylvania Department of Agriculture, "Farmland Considerations for Siting Grid-Scale Solar Panels," updated December 22, 2022. https://www.puc.pa.gov/media/2728/farmland_considerations_for_siting_grid-scale_solar_panels.pdf and "Solar Energy Development and Land Conservation," Pennsylvania Land Trust Association, November 20, 2019. https://www.puc.pa.gov/Electric/pdf/Renewable/Solar_Energy_Development-Land_Conservation_guide.pdf

[175] Pennsylvania Department of Environmental Protection, Bureau of Clean Water, Chapter 102 Permitting for Solar Panel Farms Frequently Asked Questions (FAQ) Version 1.1, revised April 30, 2021. (DEP Solar Panel Farms) https://files.dep.state.pa.us/Water/BPNPSM/StormwaterManagement/ConstructionStormwater/Solar_Panel_Farms_FAQ.pdf

[176] Penn State Extension, "Land Conservation Issues with Grid-Scale Solar Development," updated January 6, 2025.

The Pennsylvania Energy Development Authority (PEDA) assists in funding energy development projects in Pennsylvania.

> The authority's mission is to finance clean, advanced energy projects in Pennsylvania. Pennsylvania projects that could potentially qualify for funding from the Authority include solar energy, wind, low-impact hydropower, geothermal, biomass, landfill gas, fuel cells, integrated gasification combined cycle, waste coal, coal-mine methane, and demand management measures. The authority presently can award grants, loans, and loan guarantees. Tax-exempt and taxable bond financing for clean, advanced energy projects also are available through the Pennsylvania Economic Development Financing Authority (PEDFA).[177]

Agrivoltaics could be included in solar energy projects under this funding but are neither specifically authorized nor encouraged.

In 2023, the Fiscal Code was amended to add additional Keystone Opportunity Expansion Zones that would provide tax advantages to newly designated zones. One zone encompasses Clearfield County and would provide tax relief for the development of deteriorated, underutilized, or unoccupied parcels, while the other covers Allegheny and Washington Counties and is designed to deal with land currently or formerly impacted by mining operations (brownfields).[178] Developers in the Clearfield zone must employ a micro-grid power source using renewable and nonrenewable energy sources, including solar, wind, natural gas, or biomass. Developers in the Allegheny/Washington zone are required to use the property for activities related to the production, generation or storage of renewable energy.[179] Both of these enterprise zones could include agrivoltaics but again, they are not specifically authorized or encouraged.

A Fiscal Code amendment in 2024 created the Agriculture Innovative Grant Program. Approved uses include innovations that produce energy from agricultural sources, including manure, food waste, or biomass, and innovative equipment that provides low-carbon or no-carbon energy sources from agricultural commodities.[180] Some aspects of agrivoltaics may be considered "innovative" under this grant program, as it specifically addresses agricultural production.

Pennsylvania's Solar Future Plan was developed by the Department of Environmental Protection's Energy Programs Office (EPO) and released in November 2018. The plan established

[177] Pennsylvania Energy Development Authority, accessed December 23, 2024. https://extension.psu.edu/land-conversion-issues-with-grid-scale-solar-development
https://www.pa.gov/agencies/dep/programs-and-services/energy-programs-office/financial-options/peda.html
Statutory authority is Article XXVIII-C of the act of April 9, 1929 (P.L. 177, No. 175), known as the Administrative Code of 1929, as amended by the act of December 14, 1982 (P.L. 1213, No. 280),

[178] The U.S. Environmental Protection Agency defines a brownfield as "a property where expansion, redevelopment or reuse may be complicated by the presence or potential presence of a hazardous substance, pollutant or contaminant," accessed March 12, 2025. https://www.epa.gov/brownfields/about

[179] § 1611-X et seq. (Clearfield) and § 1621 et seq. (Allegheny/Washington) of the act of April 9, 1929 (P.L.343, No. 176), known as the Fiscal Code, as added by the act of December 13, 2023 (P.L.251, No. 34).

[180] § 1601-Z et seq. of the Fiscal Code, as added by the act of July 11, 2024 (P.L, 550, No. 54).

the goal of generating 10 percent of Pennsylvania's electricity from solar by the year 2030 but does not mention agrivoltaics.[181]

The Commonwealth's Solar Energy Program is administered jointly by the Department of Community and Economic Development and the Department of Environmental Protection under the direction of the Commonwealth Financing Authority. This funding is directed toward the development of solar projects and technologies, and construction or development of facilities used for research and development of technology related to solar energy. Eligible applicants are for- and not-for-profit businesses, economic development organizations, and political subdivisions. Grants and loan guarantees are available, but there are financial matching requirements. The eligibility requirements do not seem applicable to a farmer looking to engage in agrivoltaics on their own but could support an entity engaging with a farmer to create an agrivoltaic operation.[182]

The EPO created the Clean Energy Program Plan and released it in 2020. Among its renewable energy action items was "Support Deployment of Agricultural Renewable Energy," which speaks directly to the need to address combining the interests of solar development with agricultural activities.[183] An augmented report was released in 2022 and updated progress achieved, refinements to ongoing priorities, and presenting new priorities for the period 2023-2025. Updates were focused on energy efficiency efforts in the agricultural sector and agrivoltaics were not mentioned.[184]

In 2021, Governor Tom Wolf announced a new solar energy initiative, the "Project to Utilize Light and Solar Energy" (PULSE).[185] The project was originally scheduled to go online in 2023. Governor Josh Shapiro continued to prioritize the initiative in April 2024. The project is expected to meet the electricity needs of 16 Commonwealth agencies. A public-private partnership, Lightsource bp will own and operate the solar farms, and will serve as the electric generator as Constellation serves as the distribution company purchasing the electricity and selling it to the Commonwealth. Ten solar arrays are planned in six counties – Columbia, Juniata, Crawford, Northumberland, Snyder, and York. The solar panels are mounted on racks that sit on top of scaffolding, leaving 90 percent of the ground underneath available for sheep grazing, beekeeping, pollinator habitat and habitat for wildlife.[186]

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[181] Pennsylvania Department of Environmental Protection, Pennsylvania's Solar Future Plan, November 2018. https://greenport.pa.gov/elibrary/GetDocument?docId=1413595&DocName=PENNSYLVANIA%26%2339%3BS%20SOLAR%20FUTURE%20PLAN.PDF

[182] Pennsylvania Department of Community and Economic Development, Solar Energy Program Guidelines, November 2017. https://dced.pa.gov/download/solar-energy-program-guidelines/?wpdmdl=67690

[183]EPO, Clean Energy Program Plan, p. 43, November 2020. https://greenport.pa.gov/elibrary//GetDocument?docId=3412364&DocName=CLEAN%20ENERGY%20PROGRAM%20PLAN.PDF

[184] EPO, Clean Energy Program Plan: Priorities in Renewable Energy and Energy Efficiency, Security, and Workforce Development, December 2022. https://greenport.pa.gov/elibrary//GetDocument?docId=4852828&DocName=CLEAN%20ENERGY%20PROGRAM%20PLAN%202023-2025.PDF

[185] Institute for Energy Research, "Pennsylvania Governor Makes Large Commitment to Solar Energy," April 12, 2021. https://www.instituteforenergyresearch.org/renewable/solar/pennsylvania-governor-makes-large-commitment-to-solar-energy/

[186] Commonwealth of Pennsylvania, Governor's Office, "Governor Shapiro Unveils New Statewide Energy Initiative, Making Pennsylvania the First State Government to Commit to Getting 50 Percent of Its Electricity from Solar Power," Press Release, April 22, 2024. https://www.pa.gov/governor/newsroom/2024-press-releases/governor-

In support of Governor Shapiro's initiative in 2024, two pieces of legislation would help implement the plan. Senate Bill 1191, Printer's No. 1632, was introduced and referred to the Senate Environmental Resources and Energy Committee on May 28, 2024. The bill would establish the Pennsylvania Climate Emissions Reduction Act (PACER). Of interest to this study the PACER plan includes proposals for grants to support projects involving agricultural conservation and solar technologies. House Bill 2277, Printer's No. 3082, was introduced and referred to the House Environmental Resources and Energy Committee on May 8, 2024. This proposal would update and amend the AEPS Act, renaming it Pennsylvania Reliable Energy Sustainability Standards Act (PRESS). The proposal does not speak specifically to agrivoltaics. Both SB 1191 (2024) and HB 2277 (2024) died in committee at the end of the 2023-2024 legislative session.

In March 2025, Governor Shapiro expanded the PULSE plan with an announcement of a push for a Lightning Plan to speed up energy projects in Pennsylvania.[187] In April 2025, legislation implementing the plan was introduced in five bills:

- House Bill 502, Printer's No. 1479
  Reliable Energy Siting and Electric Transmission (RESET) Board
- House Bill 503, Printer's No. 1460
  Pennsylvania Climate Emissions Reduction Act (PACER)
- House Bill 504, Printer's No. 1481
  Community Energy Act
- House Bill 505, Printer's No. 1482
  Modernizes the law governing energy utility energy efficiency plans.
- House Bill 1260, Printer's No. 1414
  Solar-Ready Warehouse and Distribution Center Act

Additionally, a co-sponsorship memorandum is in circulation to enact the Governor's proposed clean energy manufacturing tax credit.

Agrivoltaic Related Municipal Ordinances

From the Penn State database of municipal solar ordinances, Commission staff have reviewed regulations that bear directly on agrivoltaics and farmland preservation. These include pollinator plantings and vegetation preservation, as well as protection of agricultural activities

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shapiro-unveils-new-statewide-energy-initiative--making.html. See also Jan Murphy, "Shapiro hopes to use solar power for 50% of state agencies by 2027," *PennLive,* April 22, 2024.
https://www.pennlive.com/politics/2024/04/shapiro-touts-plan-to-tap-sun-for-50-percent-of-power-to-state-agencies-by-2027.html

[187] Commonwealth of Pennsylvania, Governor's Office, "At York Hydropower Plant, Governor Shapiro Launches Legislative Push for "Lightning Plan" to Build More Energy Projects, Speed Up Permitting, Lower Costs, and Create Jobs for Pennsylvanians," Press Release, March 11, 2025. https://www.pa.gov/governor/newsroom/2025-press-releases/governor-shapiro-launches-legislative-push-for--lightning-plan--.html

beneath and around the installation, decommissioning and restoration of sites, land development plans, lease agreement disclosures and regulation of soil types and lot size permissible for site location. The most complete sets of ordinances directing impacting agrivoltaics can be found in Adams, Erie, Montour, Lancaster, and York Counties. Again, it should be noted that maintainers of the database disclaim that it is complete or comprehensive, but the result of a combined research effort.

The source of the information in the tables included in this section is: Pennsylvania State University, Center for Energy Law and Policy, "Pennsylvania Solar Ordinances," accessed April 9, 2025. https://celp.psu.edu/pa-solar-ordinances/

Adams County Solar Ordinances Affecting Agrivoltaics Through October 2024	
Municipality	**Ordinance**
Arendtsville Borough/Butler Township, joint ordinance	To prevent Erosion, manage run-off, and provide ecological benefit, the facility shall be planted with "low-profile" native pollinator groundcover w/high infiltration rates, using a mix appropriate for the region and soil conditions. Prior to construction, the operator shall prepare a landscape monitoring and maintenance plan to ensure the establishment and continued maintenance of the native pollinator species, all installed landscape Screening, and all existing vegetation that provides required landscape Screening. Alternatively, the operator may permit livestock grazing on the Solar Farm grounds. For a Solar Farm proposed to be located on a property in the Agricultural Preservation (AP) District, Class I, II, and III agricultural soils as identified in official Federal soils mapping, or a more accurate professional study shall be identified. No more than one-half (1/2) of the identified Class I, II, and III agricultural soils on the property may be devoted to solar arrays. Any soil exposed during the removal shall be stabilized in accordance with applicable erosion and sediment control standards.... Any necessary permits, such as Erosion and Sedimentation and NPDES permits, shall be obtained prior to decommissioning activities.
Bonneauville Borough	If a ground-mounted PSES is removed, any earth disturbance resulting from the removal must be graded and reseeded.
Franklin Township	Rules for the use of agrivoltaics: [A] Only shade-tolerant crops may be used; [B] Crops must be no-tilled in; [C] A written erosion and sediment control plan must be developed for agricultural plowing or tilling activities, or a portion of the overall farm conservation plan must identify BMPs used; [D] Any cutting or mowing of the agricultural crop is limited to a height of no less than four inches;

Adams County Solar Ordinances Affecting Agrivoltaics Through October 2024	
Municipality	**Ordinance**
	[E] Application of chemical fertilization or herbicides/pesticides is limited to the agronomic needs to the crop(s). Any soil exposed during the removal shall be stabilized in accordance with applicable erosion and sediment control standards. Any necessary permits, such as erosion and sedimentation and NPDES permits, shall be obtained prior to decommissioning activities.
Freedom Township	To prevent erosion, manage run-off, and provide ecological benefit, the facility shall be planted with low-profile native pollinator ground cover with high infiltration rates, using a mix appropriate for the region and soil conditions. Prior to construction, the operator shall prepare a landscape monitoring and maintenance plan to ensure the establishment and continued maintenance of the native pollinator species, all installed landscape screening, and all existing vegetation that provides required landscape screening. Alternatively, the operator may permit livestock grazing on the solar farm grounds. Any soil exposed during the removal shall be stabilized in accordance with applicable erosion and sediment control standards. Any necessary permits, such as erosion and sedimentation and NPDES permits, shall be obtained prior to decommissioning activities.
Countywide	Any soil exposed during the removal shall be stabilized in accordance with applicable erosion and sediment control standards. Any necessary permits, such as Erosion and Sedimentation and NPDES permits, shall be obtained prior to decommissioning activities.

Erie County Solar Ordinances Affecting Agrivoltaics Through October 2024	
Municipality	**Ordinance**
Franklin Township	Solar grazing with sheep is highly encouraged and a preferred method of controlling ground cover growth. Solar grazing with sheep is highly encouraged and a preferred method of controlling ground cover growth. The Township believes co-pasturing is very beneficial to maintain our rural character. 1) Benefits of solar grazing: (a) Farm income is more diversified and increases family farm viability. (b) Farmland conservation and keeping farmland in farm production. (c) Added visual benefit and

Erie County Solar Ordinances Affecting Agrivoltaics Through October 2024	
Municipality	**Ordinance**
	aesthetics for the community. (d) Solar grazing contributes dairy, meat, and wool to the locally sourced, renewable farm market. (e) With time, planning, and good management, sheep can do 90% to 100% of the vegetative maintenance work inside the fence, eliminating the need for mowing and reducing emissions and costs. If a ground mounted PSES is removed, any earth disturbance as a result of the removal of the ground mounted solar energy system must be returned to an environmentally stable condition.
Greene Township	If a ground mounted PSES is removed, any earth disturbance resulting from the removal must be graded and reseeded.
McKean Township	Solar grazing with sheep is highly encouraged and preferred method of controlling ground cover growth. Township believes co-pasturing is very beneficial to maintain our rural character. Benefits of solar grazing: Farm income is more diversified and increases family farm viability; Farmland conservation and keeps farmland in farm production; Added visual benefit and esthetics for the community; Contributes dairy, meat, and wool to the locally sourced, renewable farm market; With time, planning, and good management, sheep can do 90 to 100% of the vegetative maintenance work inside the fence, eliminating the need for mowing, reducing emissions and costs. If a ground mounted PSES is removed, any earth disturbance as a result of the removal of the ground mounted solar energy system must be returned to an environmentally stable condition.
Millcreek Township	If a ground-mounted Solar Energy System is removed, any earth disturbance as a result of the removal of the ground-mounted Solar Energy System shall be graded and reseeded.

Lancaster County Solar Ordinances Affecting Agrivoltaics Through October 2024	
Municipality	**Ordinance**
East Cocalico Township	Disturbed earth shall be graded and reseeded, unless the landowner requests in writing that the access roads or other land surface areas not be restored.

Lancaster County Solar Ordinances Affecting Agrivoltaics Through October 2024	
Municipality	**Ordinance**
	Within the (A) Zone, the location of any ground- mounted solar energy system and/or ground-mounted wind energy system is not situated upon Class 1 or 2 prime agricultural soils according to the latest USDA soil survey for Lancaster County, PA.
East Donegal Township	Whenever practical, all principal solar energy systems in the A Zone shall be attached to a building; or if ground mounted and/or freestanding, the applicant shall demonstrate by credible evidence that: The area proposed for the principal solar energy systems does not predominantly consist of Class I, II and/or III soils, as identified in the soil survey, and is generally unsuitable for agricultural purposes;
Manor Township	The PSES shall not be located on soils designated as prime agricultural soils as determined by the current soil survey of the United States Department of Agriculture (USDA)… System components of the PSES shall be located on land, in descending order of desirability based upon the soil type classifications D, C, B, and A. Decommissioning shall include removal of all panels, buildings, cabling, electrical components, foundations, and any other associated features, facilities, or related components in their entirety, whether above, equal to or below ground. Stormwater facilities and healthy landscaping shall remain undisturbed. Disturbed earth shall be graded and re-seeded unless the landowner requests in writing that the access roads or other land surface areas not be restored.
Providence Township	Whenever practical, all principal solar energy systems in the A zone shall be attached to a building; or if ground mounted and/or freestanding, the applicant shall demonstrate by credible evidence that: [1] The area proposed for the principal solar energy systems does not predominantly consist of Class I, II and/or III soils, as identified in the soil survey, and is generally unsuitable for agricultural purposes; and [2] such facilities cannot feasibly be attached to a building due to structural limitations of the building.

Montour County Solar Ordinances Affecting Agrivoltaics Through October 2024	
Municipality	**Ordinance**
Mahoning Township	Solar arrays may be located only on 75% of the total Class I and II agricultural soils within the SEF development area, unless the area will be devoted to agrivoltaic

Montour County Solar Ordinances Affecting Agrivoltaics Through October 2024	
Municipality	**Ordinance**
	activities, in which case 100% of the Class I and II soils may be included in the SEF development area." "Agrivoltaics may be used, provided that: [A] Only shade-tolerant crops may be used; [B] Crops must be no-tilled in; [C] A written erosion and sediment control plan must be developed for agricultural plowing or tilling activities or a portion of the overall farm conservation plan must identify BMPs used; [D] Any grazing, cutting or mowing of the agricultural crop is limited to a height of no less than four inches; [E] Application of chemical fertilization or herbicides/ pesticides is limited to the agronomic needs to the crop(s); [F] If the property will be used for the grazing of livestock, a manure management plan must be developed. Any soil exposed during the removal shall be stabilized in accordance with applicable erosion and sediment control standards;... Any necessary permits, such as erosion and sedimentation and NPDES permits, shall be obtained prior to decommissioning activities. Solar arrays may be located only on 75% of the total Class I and II agricultural soils within the SEF development area, unless the area will be devoted to agrivoltaic activities, in which case 100% of the Class I and II soils may be included in the SEF development area.
Countywide	Any soil exposed during the removal shall be stabilized in accordance with applicable erosion and sediment control standards. Any necessary permits, such as Erosion and Sedimentation and NPDES permits, shall be obtained prior to decommissioning activities.

York County Solar Ordinances Affecting Agrivoltaics Through October 2024	
Municipality	**Ordinance**
Dover Township	The PSES owner shall be required to conduct base-line soil testing and additional testing at certain intervals (every 5 to 10 years until removal of the panels) to assure no soil contamination. The PSES shall timely forward a copy of these soil testing reports containing the results to the Township engineer. Solar Related Equipment may: (1) Not be located on prime (Class I, II and III) agricultural soils; **or**

York County Solar Ordinances Affecting Agrivoltaics Through October 2024	
Municipality	**Ordinance**
	(2) Only be located on 10% of the PSES development area containing prime soils; **or** (3) Be limited to 10% of the development area containing prime soils, unless the area will be devoted to Agrivoltaic activities, in which case 5% of the prime soils may be included in the development area. Agrivoltaic is the co-development of the same area of land for both solar photovoltaic power and Normal Farming Operations, as defined by P.L. 454, No. 133 (1982).
East Manchester Township	No more than 10% of the entire area for development shall consist of Class I and Class II prime agricultural soils as defined by the current version of the NRCS Custom Soils Resource Report. When the equipment comprising the PSES is removed, any disturbed earth as a result of the removal of the equipment shall be restored, graded and reseeded or immediately returned to another allowed use.
Hellem Township	If a ground-mounted solar energy system is removed, any earth disturbance as a result of the removal of the ground-mounted solar energy system shall be graded and reseeded.
Hopewell Township	No more than 20% of the entire area for development shall consist of Class II or Class III prime agricultural soils as defined by the current version of the Hopewell Township Soils Map, unless agrivoltaic production will be used in which case the area for agrivoltaic production will not count as part of the 20% allowed development. When the equipment comprising the PSES is removed, any disturbed earth as a result of the removal of the equipment shall be restored, graded and reseeded, or immediately returned to another allowed use.
North Codorus Township	A PSES shall be designed to use primarily low-growing vegetative surfaces incorporating pollinator-friendly and native species, when possible, under the solar arrays as a best management practice for stormwater management and shall be configured to minimize disturbance of prime agricultural soils. When the equipment comprising the PSES is removed, any disturbed earth as a result of the removal of the equipment shall be restored, graded and re-seeded or immediately returned to another allowed use. A PSES shall be designed to use primarily low-growing vegetative surfaces incorporating pollinator- friendly and native species, when possible, under the solar arrays as a best management practice for stormwater management and shall be configured to minimize disturbance of prime agricultural soils.

Two additional municipalities specifically authorize the use of grazing to control ground cover growth incidental to a solar installation. They are Amity Township in Berks County and Marlborough County in Montgomery County.

Specific Costs and Benefits Associated with Agrivoltaic Projects

The goals of farmland conservation and solar energy development do not have to be mutually exclusive. Agrivoltaics can be a compromise that benefits both goals. Diversification of the Commonwealth's and the country's renewable energy sources can help lower energy costs and dependence on foreign sources. Equally, maintaining land in agricultural use helps meet the nation's food security needs.

From the perspective of the solar developer, cleared land near grid transmission lines are ripe for the placement of solar panels. The initial construction phase can bring new jobs to the community and generally increase economic activity in terms of living expenses for construction workers. Purchases of building supplies can also increase economic activity temporarily while the installation is in progress. Some solar panel configurations, coupled with specific crops, can also contribute to water conservation or provide additional shade for livestock.

Since most developers rent the land for the installations, not purchase it, there is a guaranteed income flow to the farm owner for the duration of the lease (the next 25 or 30 years). The income from the lease agreement can help farmers diversify their income and provide some insurance against crop failures.

Complementary new farming technologies can be integrated into agrivoltaics, such as precision agriculture and more sustainable soil conservation practices such as no-till farming and planting cover crops. Precision agriculture includes technology-based activities such as:

- Tractor guidance (also called autosteer) uses GPS and can result in accuracy within one centimeter when planting, spraying herbicide, or applying fertilizer. This can result in fewer overlaps (areas in the field with double application) and gaps (or skipped areas in the field) and overall improved efficiencies (both economic and environmental).
- Variable rate technology allows crop producers to apply variable rates of fertilizer across a field.
- Yield monitoring systems record yield data (grain and grain moisture) on a combine during harvesting.

These technologies provide farmers with additional farm-level information for managing risk and more precisely managing fertilizer, seed, and herbicide. Specialized tractors and other equipment may be necessary to permit the equipment to fit in and around panel arrays.

Agrivoltaics and precision farming technologies can both have an impact on farm workers. While crops may require a similar amount of manpower to harvest, converting croplands to pollinator habitat or grazing can decrease workforce needs for farmers. While these can reduce costs for farmers, they can contribute to the unemployment of farm workers. Additionally, there is likely to be a learning curve for farmers practicing agrivoltaics and training and educational opportunities may be necessary.

The increasing demand for power for artificial intelligence data centers can be expected to impact all forms of energy production, including alternative and renewable sources. This need may drive increased demand for farmland to be converted to solar energy. While it may lead to higher lease payments to farmers, it may make agrivoltaics less attractive, due to the added costs of installation of suitable panels.

In 2024, the Center for Rural Pennsylvania conducted a study on the impact of solar development on Pennsylvania farmland, which includes an exhaustive analysis of the benefits and risks of solar installations. Staff refers readers to the Center for Rural Pennsylvania's report for a more detailed analysis of the risks to farmland beyond those addressed in this report.[188]

Installation Costs

The NREL estimated that in 2023 the installed cost per MW of residential solar systems was $2.70 per watt. Grid-scale ground mounted solar with a single axis tracker was significantly less expensive at $1.20 per watt. Commercial scale rooftop solar was somewhere in between with $1.80 per watt.[189] Overall, these figures demonstrate that solar-PV generates energy more cheaply at larger scales. These costs, however, are for solar system installation in general, and do not take into account adding costs to incorporate agricultural activities as well.

In a separate analysis conducted in 2020, the NREL noted that there were not sufficient data to fully understand the economic viability of dual use agrivoltaics projects. The small number of operations that existed as well as an incomplete understanding of certain lifetime costs limited the analysis to changes to the cost of installation compared with typical fixed and tracking PV systems. The analysis hypothesized how much agrivoltaics would add to the installation costs of a 50kw system with different types of solar panel installations. In this analysis, sheep grazing added $0.07/watt for fixed panel systems and $0.10 per watt for pivoting PV systems.[190] Pollinator habitat, which required extra seeding, costs $0.10 - $0.12 more per watt.

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[188] Zachary Goldberg et al., "Understanding and Addressing the Impact of Solar Development on Pennsylvania Farmland," August 29, 2024.
https://www.rural.pa.gov/download.cfm?file=Resources/reports/assets/262/Impact%20of%20Solar%20Development%20on%20Pennsylvania%20Farmland%20Report%20Web.pdf

[189] National Renewable Energy Laboratory, "Solar Installed System Cost Analysis," nrel.gov, accessed January 6, 2025. https://www.nrel.gov/solar/market-research-analysis/solar-installed-system-cost.html

[190] Kelsey Horowitz et al., "Capital Costs for Dual-Use Photovoltaic Installations: 2020 Benchmark for Ground-Mounted PV Systems With Pollinator-Friendly Vegetation, Grazing, and Crops," December 1, 2020. https://doi.org/10.2172/1756713

By far the most expensive type of agrivoltaics is a combination of PV panels and crop production. The NREL examined three scenarios: vertical mounts, tracking PV on stilts, and taller reinforced fixed PV mounts. Vertical mounts cost $0.30 more per watt than standard. Typically installed in between rows of crops, these produce less energy than tilted panels. Meanwhile tracking PV on higher stilt mounts cost $0.43 per watt more than a ground mounted system with 1 axis tracking. Raised and reinforced mounts had by far the highest cost, at $0.80 more per watt than standard fixed array. Part of this is due to the material cost of raising panels higher in the air to allow for harvesting equipment to pass underneath significantly increases the amount of materials needed.

European studies have focused on other factors of agrivoltaics crop production that could increase costs compared to standard utility scale solar.[191] More expensive tracking systems that allow plants to get the optimal amount of sun per day, as well as soil treatment were considered more important along with more environmental studies and evaluations to ensure that appropriate sites were selected. Because agrivoltaics is generally more complex than solar-only installations, they are harder to design and compliance is more costly. Laying cables deeper than one meter underground was also noted to be important for use with conventional farming equipment.

To better accommodate plant life, more expensive PV modules are used that may be double facing or transparent. It was noted that some materials did not change in cost between the agrivoltaics and traditional PV projects: cables, inverters, and transformers. Similarly, assembling, connecting to the grid, and monitoring systems were not significantly more expensive. Installing vertical panels increased costs between $0.26 and $0.30 per watt for the modules and between $0.09 and $0.24 per kW for the racks.

A review of costs of PV systems used in agrivoltaics studies in Germany noted

- 850 kW standard installation cost of $677/kW for a total project cost of $575,000
- 345.8 kW vertical racks cost $814/kW for a total project cost of $281,481
- 650 kW raised solar installation was $1460/kW for a total project cost of $949,000[192]

It is likely that vertical and raised solar panel cost could be reduced with mass production techniques.

Under a power purchase agreement with a solar developer that involves the lease of a property owner's land, the installation costs will be borne by the solar developer. Homeowners installing a net-metered system on their property may incur substantial costs to install necessary upgrades to be able to connect the system to the grid, include new utility poles, and transformers.[193]

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[191]Emiliano Bellini, "Cost Comparison Between Agrivoltaics and Ground-mounted PV," *pv magazine international*, March 26, 2021. https://www.pv-magazine.com/2021/03/26/cost-comparison-between-agrivoltaics-and-ground-mounted-pv/

[192] JSGC staff conversion. Assuming 1 euro was worth 1.183 USD in 2021.

[193] Elizabeth Deornellas, "New Pennsylvania solar customers face unexpected hurdles, costs," *Lancaster Online,* January 13, 2024. https://lancasteronline.com/news/local/new-pennsylvania-solar-customers-face-unexpected-hurdles-costs/article_8bcd1ecc-b183-11ee-bd29-af0f0beddd41.html

Decommissioning Solar Installations

As grid-scale solar becomes more common throughout the country, more states are adopting practices to ensure that lands that host solar projects can still be useful after the terms of their, typically 30-year leases are completed. Generally, solar panels have a useful lifespan of 30 to 35 years.[194] Some solar operators may choose to extend their leases with panels functioning at lower efficiency, while others may replace worn out modules. When it is eventually time for a solar operation to cease, and the solar array has been dismantled, panels might be sold, refurbished, recycled, or sent to a landfill.[195]

Recycling solar panels is another area of concern since panels can be considered hazardous waste in some situations. While most modern panels pass Toxic Characteristic Leaching Procedure tests and can go to landfills, some older models from the early days of solar panel production may not pass this test.[196] Modules should be tested before entering the waste stream.

A possible area of government action is providing necessary guidance for disposal solar panels or for establishing programs to recycle the panels. At least five states, including New Jersey, have created end-of-life plans for solar panels.[197] In New Jersey, recycling centers are being created to handle these materials. More information on recycling solar panels can be found on the U.S. EPA's website.[198]

Decommissioning a solar site involves more than just panels. A series of racks on which the panels are mounted must be dismantled. Metal posts which hold the racking system are pulled out of the ground or cut off at specified depths. These posts are frequently aluminum or steel and can be sold as scrap metal. Once disconnected, copper and aluminum wiring can be recycled or also sold for scrap. Inverters and transformers are dismantled and may be refurbed, recycled, or sent to landfills.

Solar decommissioning is not just conducted with aboveground infrastructure. Concrete and steel foundations are broken up and removed. The disturbed area is then backfilled with soil. Fencing posts can be removed and reused as appropriate. Decommissioning can include de-compacting the soil and revegetating as well as removing access roads on the facility. Ideally, once the site is fully decommissioned, the property is returned to a condition where its original use could be resumed, such as agricultural operations.

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194 "End-of-Life Solar Panels: Regulations and Management," US EPA, October 4, 2024. https://www.epa.gov/hw/end-life-solar-panels-regulations-and-management#Overview

195 American Clean Power Association. "What Happens When a Solar Facility is Decommissioned?" Fact Sheet. December 2021.

196 American Clean Power Association, "What Happens When a Solar Facility Is Decommissioned?"

197 US EPA. "End-of-Life Solar Panels: Regulations and Management," October 4, 2024. https://www.epa.gov/hw/end-life-solar-panels-regulations-and-management#Overview

198 US EPA. "Solar Panel Recycling," November 13, 2024. https://www.epa.gov/hw/solar-panel-recycling

Overall, the responsibility of decommissioning rests with solar developers. It is recommended that solar operators have decommissioning plans that list the necessary actions and their associated costs as well as the responsibilities of the landowner.[199] Sometimes these plans, and proof of enough funding to execute them, are required by local or state governments. However, additional forethought may be needed to ensure the decommissioning plans are detailed and accurate enough to be adequate for their intended use. Decommissioning plans typically include a timeline for completion, estimated costs including tear down, transportation, and disposal of materials. The dismantling stage alone can cost $0.05 to $0.07 per watt, not including the cost to recycle or sell a module.[200] This means that dismantling one of the larger 27MW agrivoltaics sites in Pennsylvania mentioned in the previous section would cost approximately $60,000.

A common difficulty for decommissioning plans is ensuring a plan may still be appropriate decades after its conception. One way to maintain a plan's effectiveness is to account for inflation. For example, one Maryland agency estimated that the total cost of decommissioning a 2MW ground mounted panel system installed in 2023 could cost $60,000 but could rise to $99,000 by 2043.[201] One of the principal costs of decommissioning is tearing down the site, planning largely dependent on labor rates.

In addition to inflation, changing market conditions can lead to decommissioning being more expensive than anticipated. Solar developers in the past assumed that, upon closing old modules that still function could be sold to generate enough revenue to cover the costs of decommissioning a site. However, the growth of the solar industry has led to a decline in the value of these old modules.[202, 203] Because there are currently many projects in development throughout the country, it is likely they will terminate near each other around 2050. It should not be assumed that these panels will be worth anything at the time a solar site ceases operations so cost estimates for panel disposal should be included within decommissioning plans. Using plans created by independent and qualified assessors may provide a more accurate framework.[204] Updating plans on a semi-annual basis can help solar operators ensure that they have enough money to cover the costs of decommissioning.

One of the best practices for decommissioning is through bonding. This ensures that there are sufficient funds in place to cover the cost of decommissioning for the termination project. This is important, because these bonds will allow these funds to remain secure even if a solar operator were to close or file for bankruptcy. Use of bonding helps to avoid surprises and provides a more accurate statement of a project's costs and ability to return on investment.

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[199] Dan Gearino, "Who Pays for Cleanup When a Solar Project Reaches the End of Its Life?," Inside Climate News, January 25, 2024. https://insideclimatenews.org/news/25012024/inside-clean-energy-decommissioning-solar-plants/
[200] "How to Craft a Better Solar Panel Decommissioning Plan," Utility Dive, January 16, 2024, https://www.utilitydive.com/spons/how-to-craft-a-better-solar-panel-decommissioning-plan/704062/.
[201] "Agriculture Law Education Initiative" Maryland solar presentation
[202] "How to Craft a Better Solar Panel Decommissioning Plan," Utility Dive, January 16, 2024. https://www.utilitydive.com/spons/how-to-craft-a-better-solar-panel-decommissioning-plan/704062/
[203] Paul Goeringer and MD. College of Agriculture and Natural resources, "Leasing for Renewables," Slide show, September 26, 2024. https://mda.maryland.gov/Documents/9.26.24%20AgriSolar%20Summit%20.pdf
[204] Dwight Clark and We Recycle Solar, "Overview of Solar Decommissioning," NCSL.com, Slide show, July 2022.

Pennsylvania is one of 18 states without state-wide decommissioning requirement. The level of detail and financial proof varies significantly from state to state.[205] Neighboring states like New Jersey, New York, Ohio, West Viriginia, and Maryland have passed legislation regarding decommissioning rules and financial assurance guidelines, as set forth in table below. While Pennsylvania has no laws requiring solar decommissioning currently in place, legislation has been introduced in the 2025-2026 legislative sessions.

Table 6

Neighboring States of Pennsylvania with Solar Decommissioning Requirements[206]
January 2024

State	Decommission Rules	Financial Assurance
MD	Plan requirement for major and minor non-residential systems. No additional details about how the plan was written.	MD PUC requires funding for decommissioning
NJ	Solar sites subject to the Right to Farm Act, must submit conservation plans to the local social district. Additional landscaping requirements are included in the Pinelands Management area.	Local governments can choose to impose funding requirements.
NY	Facilities over 25 MW must submit detailed plans submitted to the office of renewable energy siting. Includes cost estimate required actions and site restoration.	Letter of credit provided within one year of system operation. A new letter must be provided every five years.
OH	Submit comprehensive plan 60 days prior to solar facility construction to the power siting board. Decommissioning must be completed within 1 year from the end of commercial operations.	Performance bond posted and updated every five year.
WV	Facilities over 1MW, must remove above ground structures, electrical, below ground and foundation must be removed to specified depths. Requirements to restore topography and vegetation.	Bond must be acquired within a year of commercial operations. Bond size determined by state Dept. of Environmental Protection.

Source: "50 States of Solar Decommissioning: 2023 Snapshot." NC Clean Energy Technology Center, January 2024.

205 Lindemann, Justin, and Vincent Potter. "50 States of Solar Decommissioning: 2023 Snapshot." *NC Clean Energy Technology Center*, January 2024.
206 Lindemann and Potter, "50 States of Solar Decommissioning: 2023 Snapshot."

While Pennsylvania does not have a statewide decommissioning requirement, many municipalities have adopted ordinances governing decommissioning, and to a lesser degree, installation limitations. The table below lists these ordinances, which can be found on the Penn State Extension Solar Ordinance database previously referenced.

Table 7
Selected Municipal Solar Ordinances by Pennsylvania County
October 2024

Type of Ordinance	County	Municipality
Installation Ordinances –analysis of soil conditions; use of prime soils limited	Berks	Greenwich Township
	Butler	Forward Township
	Montgomery	Abington Township
	Union	East Buffalo Township Gregg Township
	Sullivan	Foster Township
	Washington	Nottingham Township
Installation Ordinances –vegetation protection, tree removal	Berks	Bern Township
	Elk	Fox Township
	Schuylkill	East Union Township Foster Township
	Wayne	Lake Township
Decommissioning Ordinances – Soil restoration, grading and reseeding, financial security	Armstrong	Gilpin Township
	Beaver	Brighton Township Greene Township
	Bedford	Bedford Township
	Berks	Alsace Township Amity Township Bethel Township Greenwich Township
	Blair	Greenfield Township
	Bradford	Athens Township
	Butler	Alsace Township Amity Township Bethel Township Greenwich Township

Table 7
Selected Municipal Solar Ordinances by Pennsylvania County
October 2024

Type of Ordinance	County	Municipality
continued Decommissioning Ordinances – Soil restoration, grading and reseeding, financial security	Chester	East Caln Township East Whiteland Township
	Clarion	Countywide
	Clinton	Porter Township
	Columbia	Briar Creek Township Fishing Creek Township Hemlock Township
	Dauphin	Gratz Borough
	Elk	Fox Township
	Forest	Countywide
	Franklin	Greene Township
	Luzerne	Conyngham Borough Foster Township Franklin Township
	Lycoming	Hepburn Township
	Monroe	Middle Smithfield Township Polk Township
	Montgomery	East Greenville Borough Marlborough Township
	Northampton	Lehigh Township
	Northumberland	Countywide
	Pike	Porter Township
	Schuylkill	East Union Township Foster Township
	Susquehanna	New Milford Borough
	Tioga	Countywide Gaines Township
	Wayne	Lake Township Salem Township
	Westmoreland	Hempfield Township

Source: Penn State Extension Solar Ordinance database. https://celp.psu.edu/pa-solar-ordinances/

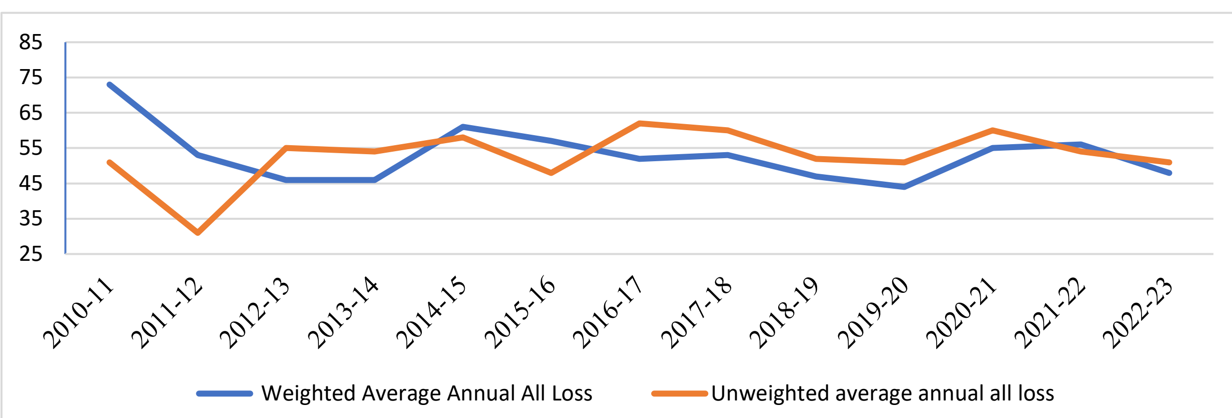
While the foregoing part of this section discusses costs and benefits that can be associated with any agrivoltaics projects, the remainder of this chapter addresses three of the most popular methods of agrivoltaics and the costs and benefits associated with each type.

Agrivoltaics Example: Pollinator Habitats

One of the least complex forms of agrivoltaics involves planting a mix of native grasses, plants, and wildflowers under solar installations to increase the habitat space for pollinating animals. These are especially important considering current environmental practices such as herbicide and habitat conversion which have led to a decline of pollinating insects and birds, both of which are vital to supporting both the ecosystem and farm operations. Pollinators help the reproduction of 80 percent of flowering plants and increase the yields of 75 percent of crop species Each year $18 billion of food crops are pollinated in the U.S. including almonds, non-citrus fruits, berries, melons and squash. Researchers have estimated that without pollination crop production would fall by five percent in high income countries like the U.S. and by eight percent in mid-to-low-income countries.

The non-profit 'Bee informed' conducted a survey of beekeepers across the country. It determined that in Pennsylvania, bee colony collapses measured between 40-60 percent of colonies over a thirteen-year period (See Chart 2). Beekeepers with failed colonies frequently replace the lost one with another the following year. Traditionally, acceptable colony failure rates were 15 percent. This non-profit has since shuttered due to a lack of funding, and thus there is currently no data tracking the health of bee colonies within the country. The question of whether photovoltaic systems (i.e. solar panels) can be installed on Pennsylvania farmland ultimately falls on municipalities to zone for and allow various uses of land within their jurisdiction.

Chart 2
Pennsylvania Annual Loss of Managed Bee Colonies
2010-2023



Source: Created with data from Bee Informed Partnership Surveys: 2010-2023.

Bee colonies represent only a portion of pollination happening since most pollinators are wild, and there are 20,000 species of pollinating bees alone.[207] Penn State researchers tracking wild bee populations at six orchard adjacent sites in south central Pennsylvania noted that one-third of wild bee species observed declined over a six-year period. Over time this study noted that they recorded fewer bees overall as well as less variety among the species. Due to the ongoing loss of bee populations, current conservation efforts to increase pollinator population are likely not adequate, leading to interest in new ways of pollinating crops or helping these animals grow their numbers.

Solar Pollinator Habitat

One of the most direct ways of increasing the number of pollinating animals is by creating new environments for them to live in. By using plants native to the region and not treated by pesticides, bee, wasp, moth, beetle, butterfly, and bird populations can be increased. One study conducted between 2018-2022 in Minnesota found that the number of insects tripled at solar pollinator sites in under five years.[208] Additionally, twenty times the number of bees were present at the research sites. Since solar arrays are frequently sited on or near agricultural lands, the animals attracted can benefit these lands by pollinating crops or may eat pests improving the yield of other crops. The research study noted an increase in pollination of nearby soybean crops.

Currently, most land under solar arrays are required to be covered in gravel or vegetation to prevent erosion or unwanted water runoff, though the specifics vary from state to state.[209] Pennsylvania's Department of Environmental Protection authorizes the use of gravel, but vegetation is preferred.[210] Solar developers frequently use fast-growing non-native grasses, such as Kentucky bluegrass or other types of turf grasses.[211] These grasses are chosen because they are inexpensive, fast growing, and familiar. Turf is one of the commonly used mixes employed throughout the United States for construction projects due to these characteristics. However, despite their ubiquity, the standard grasses can require anywhere between three to six mowings a year to prevent them from growing over panels. Additionally, they may need supplemental water

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207 Food and Agriculture Organization of the United Nations, "Why Bees Matter." Pg 3.

208 Leroy J Walston et al., "If You Build It, Will They Come? Insect Community Responses to Habitat Establishment at Solar Energy Facilities in Minnesota, USA," *Environmental Research Letters* 19, no. 1 (November 23, 2023): 014053. https://doi.org/10.1088/1748-9326/ad0f72

209 Additional information on other state requirements can be found at Rouhangiz Yavari et al., "Minimizing environmental impacts of solar farms: a review of current science on landscape hydrology and guidance on stormwater management," *Environmental Research: Infrastructure and Sustainability,* August 8, 2022.DOI 10.1088/2634-4505/ac76dd

210 Pennsylvania's Department of Environmental Protection regulate erosion and stormwater runoff that results from earth disturbance. The regulations are found at 25 Pa. Code Chapter 102, "Permitting for Solar Panel Farms." A FAQ discussing the requirements in Pennsylvania can be found at DEP, Bureau of Clean Water, Frequently Asked Questions (FAQ) Version 1.1, revised April 30, 2021.
https://files.dep.state.pa.us/Water/BPNPSM/StormwaterManagement/ConstructionStormwater/Solar_Panel_Farms_FAQ.pdf

211 "Forage as Vegetative Cover for Utility-Scale Solar in Ohio," Ohioline, June 24, 2021.
https://ohioline.osu.edu/factsheet/cdfs-4106

as well as herbicides to stop unwanted species from taking root.[212] While the turf grass grows fast enough to hold the earth in place, their shallow roots provide minimal benefits to the topsoil.

The benefits of using pollinator friendly mixes may depend on the exact plant species used although there are some commonalities. Deeper rooted plants that extend four to six feet into the ground can increase the health of topsoil and prevent erosion.[213] One of the downsides of pollinator mixes when compared to typical grasses is that they require higher upfront costs for seeds, labor and planting when compared to standardly used mixes.[214] Pollinator friendly plants also need three to five years to establish and still require both mowing and weed management. Rather than uniformly mowing or applying herbicides to the whole installation they may need more intentional care targeting specific areas of the array.

While pollinator habitat may lead to more up front labor costs, once established they become the most cost-effective option which require mowing only one to two times a year leading to decreased maintenance costs.[215] Other research has found that increases in individual services make operations and maintenance more expensive for low-impact solar array (such as pollinator habitats).[216] Developers frequently select species under 24 inches which will not block panels as they grow, and these plants can be drought resistant and need less herbicide than traditional grass blends once established.

While creating pollinator habitat under solar is broadly beneficial, there are also limitations. Vegetation management must also be planned after flowers have bloomed for pollination to occur. The grasses needed for grazing, as seen in the next section, may or may not be compatible with pollinators and depends on grasses used. This is of note since the size of solar arrays continues to grow in many areas of the country to seek greater efficiency in electric generation. Finally, farmland perseveration advocates believe that even with these agricultural benefits, siting of pollinator habitat is best used on more marginal farmland or brownfields rather than taking current agricultural lands out of production.[217]

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[212] Jesse Klein and Jesse Klein, "Dual-use Solar Farms Welcome Nature Back to the Land," Trellis, June 10, 2020. https://trellis.net/article/dual-use-solar-farms-welcome-nature-back-land/

[213] "The Perks of Pollinators: How Natural Habitat Is Heating up in the Solar Industry," SWCA, May 15, 2023. https://www.swca.com/news/2022/11/the-perks-of-pollinators-how-natural-habitat-is-heating-up-in-the-solar-industry

[214] "Forage as Vegetative Cover for Utility-Scale Solar in Ohio," Ohioline, June 24, 2021. https://ohioline.osu.edu/factsheet/cdfs-4106

[215] 'Minnesota Native Landscapes. "Vegetation Management on Habitat Friendly Solar Projects." Press release. Minnesota Native Landscapes. Accessed January 6, 2025. https://bwsr.state.mn.us/sites/default/files/2024-11/Pollinator%20Solar%20VM%20Sequences%20v2.pdf

[216] James McCall et al., "Vegetation Management Cost and Maintenance Implications of Different Ground Covers at Utility-Scale Solar Sites," Sustainability 15, no. 7 (March 28, 2023): 5895. https://doi.org/10.3390/su15075895.0

[217] American Farmland Trust, "Recommendations for State and Local Governments to Advance Smart Solar Policy," February 2024, accessed April 16, 2025. https://farmland.org/wp-content/uploads/2023/12/AFT-Recommendations_for_State_and_Local_Governments_to_Advance_Smart_Solar_Policy.pdf

Solar Pollinators in Pennsylvania

From 2018 to 2022, at least six pollinator PV projects were installed throughout the Commonwealth across 461 acres and have a combined maximum capacity of over 65 MWdc.[218] The largest of these sites used Bifacial PV panels. While Inspire maintains a list of solar projects within the state, as they grow more common, they may become harder to track. This list is likely not exhaustive, as JSGC staff located a 1.7 MW solar array installed at Bucknell University on seven acres of land in 2022. See table below.

Table 8
Pollinator Habitat Projects in Pennsylvania[219]
2018-2022

Name	System Size (MWdc)	Site Size (Acres)	Year Installed	PV Technology	Type of Array
Penn State Orchard Road	2	15	2018	NA	Fixed
Penn State Whitetail 2	27	167	2020	Bifacial PV	Single-axis Tracking
Penn State Whitetail 3	27	167	2020	Bifacial PV	Single-axis Tracking
Pennsylvania: Habitat	1.83	7	2018	NA	Fixed
University Area Joint Authority	6.2	98.33	2021	Bifacial PV	Fixed
Bucknell Campus Array	1.76	7	2022	NA	Fixed

Source: InSPIRE 2024.

In 2018 GIANT food stores partnered with developer Entersolar to install pollinator habitats under solar panels at its Carlisle facilities in phases and provide pollinator habitat for bee colonies on site. The project rolled out in phases starting with a 625 kw roof system that was later expanded to nearby fields by adding 1.83 kw across seven acres in 2020.[220] This was enough energy to cover 100 percent of the headquarters' energy needs. The project used donations from Ernst Conservation to seed the field with 20 varieties of wildflowers native to the northeast and central Pennsylvania like Butterfly Milkweed, Mountain Mint, Blue Mistflower, and Golden Alexander.[221] At the time they estimated that once mature, the field would contain over a million

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[218] "InSPIRE Agrivoltaics Map," Open Energy Information, accessed March 13, 2025. https://openei.org/wiki/InSPIRE/Agrivoltaics_Map
[219] "InSPIRE Agrivoltaics Map," Open Energy Information, accessed March 13, 2025. https://openei.org/wiki/InSPIRE/Agrivoltaics_Map
[220] GIANT Food Stores, "GIANT COMPLETES PHASE ONE OF SOLAR DEVELOPMENT AT CARLISLE SUPPORT OFFICE," Press release, April 25, 2019. https://giantfoodstores.com/pages/giant-completes-phase-one-of-solar-development-at-carlisle-support-office
[221] GIANT Food Stores, "THE GIANT COMPANY COMPLETES POLLINATOR FIELD AT CARLISLE, PA HEADQUARTERS," Press release, June 22, 2020. https://giantfoodstores.com/pages/62220-pollinator-field-carlisle

pollinating plants that would benefit local farms. Later the project ran into an unforeseen setback as $2,000 in bees were stolen from the site.[222]

More case studies include the University Area Joint Authority in Centre County which offsets energy consumption of a water treatment facility by 60 percent. The project was completed in two phases, the first of which was completed in 2018. While most of the other sites specifically focused on pollinator habitat, one used native grasses which could also be grazed by sheep. This project was completed in 2021 and contains several innovative features such as a 5MW AC microgrid, and a 500kVA battery.[223]

The success of the Orchard Road project was attributed to partnerships with Ernst Conservation donating seeds, and Meadville Land Service donating resources to the project and working to develop the site.[224] While the 10-acre solar project was built in 2018, it was converted into a pollinator habitat in the summer of 2020, demonstrating the possibility of other sites being converted with the right partners. Orchard Road as well as Whitetail 2 & 3 all have power purchase agreements with Penn State.

Agrivoltaics Example: Solar Grazing

Of the agrivoltaic practices employed throughout the country, solar grazing is the most popular. It occurs when farm animals, chiefly sheep, feed on the grass and plants growing under and in between rows of solar panels. Additionally, shade cast by the panels helps to cool animals in hot weather.[225] Solar grazing not only benefits the animals but also the operators of solar arrays, since the animals consume vegetation grown on the site. While many types of solar grazing have been experimented with, in its typical commercial configuration solar developers enter contracts with farmers and pay for their sheep to manage vegetation on the site.

Historically grazing animals were used as a general-purpose management vegetation and manure before the invention of mechanical mowers. Using grazing animals for a specific purpose has also been employed in modernity: targeted grazing have been employed as a method to prevent wildfires, particularly in the western region of the country, for decades.[226] When it comes to solar grazing, the primary benefit on the part of the developer is cost saving measures, which has shown

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[222] Sean Adams, "Tens of Thousands of Bees Stolen From Grocery Store's Central Pa. Headquarters," PennLive, February 9, 2022. https://www.pennlive.com/news/2022/02/tens-of-thousands-of-bees-stolen-from-grocery-stores-central-pa-headquarters.html

[223] University Area Joint Authority, "Solar Array," uaja.com, accessed January 6, 2025. https://uaja.com/treatment/solar-array/

[224] "Penn State Powers up With Solar," psu.edu, October 15, 2020. https://www.psu.edu/news/campus-life/story/penn-state-powers-solar

[225] Robert Handler and Joshua M. Pearce, "Greener Sheep: Life Cycle Analysis of Integrated Sheep Agrivoltaic Systems," Cleaner Energy Systems 3 (October 27, 2022): 100036. https://doi.org/10.1016/j.cles.2022.100036

[226] American Sheep Industry Association, "Targeted Grazing: A Natural Approach to Vegetation Management and Landscape Enhancement," Sheepusa.Org, December 2006, p. iv, https://www.sheepusa.org/wp-content/uploads/2022/01/Targeted-Grazing-Book-compressed.pdf.

between a 19 to 75 percent reduction on maintenance and operations costs compared to mechanical mowing.[227]

Another advantage of solar grazing is that it can be scaled to the necessary level of solar operation occurring and has been utilized by both large grid-scale, smaller distributed and mid-sized community levels. In the latest community survey 40 percent reported grid scale solar.[228] The type of panel used is also flexible, as sheep can be used with both fixed and tracking solar arrays; a small number have experimented with vertical solar fences.

Grazing livestock on lands that would otherwise have little purpose can effectively double space efficiency compared to non-agrivoltaics solar projects. The amount of carbon avoided from combining solar and grazing equates to taking thousands of cars off the road compared to using them individually.[229] Grazing can also improve soil health by restoring nutrient levels of depleted soil.[230]

Animal Selection and Site Preparation

Currently sheep are the preferred solar grazing animal of choice because of their size, temperament, and eating habits which are well suited to the standard layout of a solar farm.[231] Unliked cows, sheep are small and flexible enough to graze under standard sized panels. Sheep are complete grazers and will eat most vegetation they come across, but unlike goats, they will not climb on the equipment or on top of the panels. However, solar sites still need accommodation for sheep and other types of animals. For example, sheep primarily eat low to ground, so cables need to be raised off the ground to prevent possible injury.

In addition to sheep, solar grazing has been experimented with chickens, turkeys, pigs and rabbits.[232] While there have been ongoing efforts to design solar farms that are compatible with cattle, it remains uncertain over how economical this is due to the increased in cost in raising the panels to a height they can eat under and reinforcing the solar array to be sturdier.

Regardless of animal type there are some commonalities, and the sooner solar grazing is factored into the design of a PV project, the better it can be accommodated. Each solar site needs to be tailored to the livestock that will graze there. For example, grazing animals need high enough fences to ensure the animals stay where they are wanted and to deter predators. Water sources

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[227] Brawley, "Landscape to Lambscape: How Sheep Are Reshaping Solar Farm Maintenance," Maintenance World, August 30, 2023. https://maintenanceworld.com/2023/08/30/landscape-to-lambscape-how-sheep-are-reshaping-solar-farm-maintenance/
[228] American Solar Grazing Association, "The Landscape of Solar Grazing Census Report," ASGA Zoom Call 85, Slide show, March 11, 2025.
[229] Robert Handler and Joshua M. Pearce, "Greener Sheep: Life Cycle Analysis of Integrated Sheep Agrivoltaic Systems," Cleaner Energy Systems 3 (October 27, 2022): 100036. https://doi.org/10.1016/j.cles.2022.100036
[230] Kelly Pickerel, "Minnesota Research Finds Sheep Grazing at Solar Sites Actually Improves Soil Quality," Solar Power World, January 25, 2022. https://www.solarpowerworldonline.com/2022/01/minnesota-research-finds-sheep-grazing-at-solar-sites-actually-improves-soil-quality/
[231] David Hartman, "Sheep Grazing to Maintain Solar Energy Sites in Pennsylvania," PennState Extension, June 2023. https://extension.psu.edu/sheep-grazing-to-maintain-solar-energy-sites-in-pennsylvania
[232] "Solar Grazing," United Agrivoltaics, accessed March 10, 2025. https://www.unitedagrivoltaics.com/

provided by the site owners are a benefit, otherwise water must be transported to the site. Other site adjustments include areas to unload animals and gates.

One of the most important ways solar sites are made ready for grazing animals is by ensuring that appropriate grass mix is used when seeding the area. Grass mixes with herbicides or pesticides can be harmful to animals. As solar grazing has grown more in popularity, grass mixes specifically formulated for grazing animals can be purchased.[233] While some grass mixes edible by sheep may also support pollinator habitats, the timing is important, as plants must have first flowered to experience those environmental benefits.

Solar Grazing Business

Typically, solar grazing with sheep is conducted on land owned or leased by solar developers. Since it is a comparatively new industry, the average solar grazer has less than three years of experience.[234] In addition to diversifying income, many solar grazers are drawn to the environmental benefits inherent to the industry. It also offers opportunities for first-generation farmers to be able to raise a herd without inheriting or purchasing land to graze. Most solar developers believe they are ready to incorporate solar grazing into one of their sites. However, one of the difficulties is that each member of the partnership must learn about the needs of the other, since the industries are vastly different. Communication is vital to develop relationships between grazers and solar operators to ensure a fruitful partnership.

One of the largest hurdles to starting a solar grazing business is transporting flocks to a solar site since on average the flocks are located 20 miles away from the solar site.[235] Grazing is often supervised by these flock owners to ensure their livestock are healthy and safe. Monitoring famers can also lead to earlier detection of issues at the site such as broken panels. Many provide additional assistance in weeding areas missed by their sheep. A survey of solar grazers showed that approximately a quarter had one-year contracts while two, three- and five-years contracts were also common.[236] Farmers can make between $300-$350 an acre and save money by not having to rent land to graze their sheep.[237]

In New York State, farmers formed co-op organizations to aid them negotiating with solar development companies, which preferred to deal with one representative for numerous small herds. When this arrangement was discussed with farmers knowledgeable about solar grazing in central Pennsylvania, they voiced skepticism over being able to share transportation equipment and finding qualified personnel that farmers would be comfortable using.[238] While this allows farmers to grow herds with less of their own land and potentially grow more winter feed on their

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[233] Lexie Hain, "Fuzz and Buzz: Solar Seed Mix," American Solar Grazing Association, July 24, 2024. https://solargrazing.org/fuzz-and-buzz-solar-seed-mix/
[234] American Solar Grazing Association, "The Landscape of Solar Grazing Census Report."
[235] Tyler Swanson et al., "The Economics of Solar Grazing," Agrisolar Clearinghouse, July 24, 2023, accessed March 10, 2025. https://www.agrisolarclearinghouse.org/fact-sheet-the-economics-of-solar-grazing/
[236] ASGA survey.
[237] John Flesher and Tammy Webber, "Bees, Sheep, Crops: Solar Developers Tout Multiple Benefits," StateImpact Pennsylvania, November 4, 2021. https://stateimpact.npr.org/pennsylvania/2021/11/04/bees-sheep-crops-solar-developers-tout-multiple-benefits/
[238] Rebecca Schweitzer, "Sheep Farmers Are Skeptical of a Proposed Solar Grazing Co-Op," *Lancaster Farming.*

home fields, there are problems for these enterprising farmers to solve such has having enough room for their expanded herd in the winter and maintaining fields at home.[239]

Solar Grazing Growth

While solar grazing was comparatively rare in the 2010s, it is one of the fastest growing types of agrivoltaics and research is ongoing to discover the full scope of the activity within the country. In 2021, the American Solar Grazing Association (ASGA) estimated that 15,000 acres were being grazed by the sheep of its members.[240]

Ongoing self-reported estimates from NREL placed the number at 51,000 acres.[241] In Pennsylvania, there are several notable examples of grazing operations reported by this system. The University Area Joint Authority, which was covered in a previous section as a pollinator habitat, is also grazed. The largest solar grazing site within the state recorded by NREL was Penn State Whitetail 1 which covers 166 acres. Solar grazing is also conducted at Susquehanna University on their 14-acre site with 20 sheep, which started operations in 2019. Pennsylvania is bordered by the regional leader in solar grazing. In New York State Cornell University was offered a million dollar grant to support a new agrivoltaics research program centered around solar grazing sheep.[242] To the south, Maryland also hosts numerous solar grazing farms.

By 2024, ASGA survey estimates had risen to 80,000 sheep grazing 100,000 acres at solar sites.[243] The latest survey shows that 129,000 acres across 506 sites were being grazed by 113,050 sheep.[244] This is particularly notable when the average solar grazer has less than three years of experience. In the northeast over 4,600 acres were grazed by 13,274 sheep.

In the northeast region, a herd size of approximately three sheep per acre is frequently used for solar grazing. For example, it would not be uncommon for 200 sheep to graze rotating segments of a 30-acre solar project.[245] While smaller herd sizes may pose a temporary limit to the amount of solar grazing business in Pennsylvania, these can be scaled up in time. However, as solar developments grow, and more acres are needed to graze, it may be difficult to ensure there are

[239] David Hartman, "Sheep Grazing to Maintain Solar Energy Sites in Pennsylvania," PennState Extension, June 2023. https://extension.psu.edu/sheep-grazing-to-maintain-solar-energy-sites-in-pennsylvania

[240] American Solar Grazing Association, "The Landscape of Solar Grazing Census Report," ASGA Zoom Call 85, Slide show, March 11, 2025.

[241] "InSPIRE Agrivoltaics Map," Open Energy Information, accessed March 13, 2025. https://openei.org/wiki/InSPIRE/Agrivoltaics_Map

[242] Krisy Gashler, "Farmer-first Approach to Agrivoltaics Will Benefit NY Food, Energy Goals," Cornell College of Life Sciences and Agriculture, August 20, 2024. https://cals.cornell.edu/news/2024/08/farmer-first-approach-agrivoltaics-will-benefit-ny-food-energy-goals

[243] American Solar Grazing Association, "ASGA Call 76 Replay: How Big Is Solar Grazing in the U.S.?" *American Solar Grazing Association* (blog), April 10, 2024. https://solargrazing.org/asga-call-76-replay-how-big-is-solar-grazing-in-the-u-s-asga-census-results/

[244] American Solar Grazing Association, "The Landscape of Solar Grazing Census Report," ASGA Zoom Call 85, Slide show, March 11, 2025.

[245] Rebecca Schweitzer, "Sheep Farmers Are Skeptical of a Proposed Solar Grazing Co-Op," *Lancaster Farming*, October 24, 2023. https://www.lancasterfarming.com/farming-news/conservation/sheep-farmers-are-skeptical-of-a-proposed-solar-grazing-co-op/article_38efb4d4-71c9-11ee-9414-5b13df6f0724.html

enough qualified farmers with the necessary expertise to care for and monitor large herds of livestock as well as the equipment to transport them.

While southern parts of the country, particularly Texas, had a similar number of sites as other regions, they had larger herds and acres grazed when compared to the Midwest and Northeast, which were composed of smaller solar sites.[246] One of the largest examples of solar grazing is in Texas where 6,000 sheep graze on over 10,000 acres.[247]

More than just affecting solar operation, solar grazing will cause growth for agricultural industry. Hair sheep, which are raised for meat, are preferred by many farmers for solar grazing over those which produce wool, largely due to being easy to care for and their docile temperament. In the U.S. approximately 69 percent of solar farmers grazed with hair sheep, and a quarter with wool sheep.[248] One result of the increase in the number of sheep raised, is the issue of butchering animals since high volumes of lamb are typically not processed in the country. Sheep and lamb production has declined in the U.S. over the course of the last century.[249] Currently, the United States imports 75 percent of its lamb, so more of this could be produced domestically. Given the number of acres expected to be converted to solar land in the coming decades, grazing on these lands could expand herds in the northeast by up to 300,000 sheep.[250] Additional meat processing facilities will be needed within the region to accommodate these larger herd sizes.

Map 3 details the location of pollinator habitat and solar grazing installations in Pennsylvania and its neighboring states.

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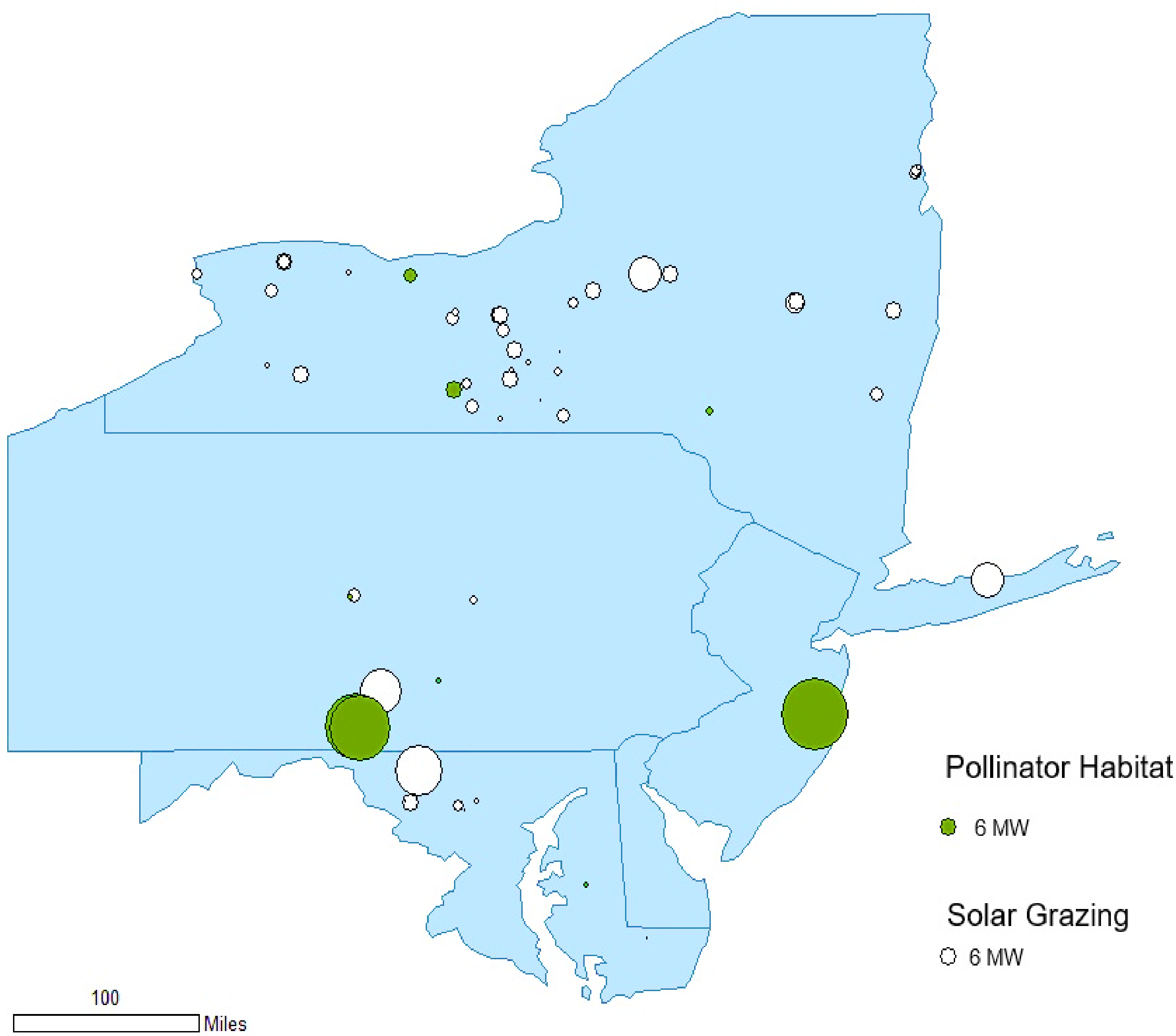
[246] American Solar Grazing Association, "The Landscape of Solar Grazing Census Report," ASGA Zoom Call 85, Slide show, March 11, 2025.
[247] Enel North America, "Enel Grazes Texas Solar Farms With 6,000+ Sheep in Largest Announced U.S. Solar Grazing Contract," Press release, August 15, 2024. https://www.enelnorthamerica.com/about-us/newsroom/search-press/press/2024/08/solar-grazing
[248] American Solar Grazing Association, "The Landscape of Solar Grazing Census Report."
[249] Hartman, "Sheep Grazing to Maintain Solar Energy Sites in Pennsylvania."
[250] Rebecca Schweitzer, "Sheep Farmers Are Skeptical of a Proposed Solar Grazing Co-Op," *Lancaster Farming.*

Map 3

Agrivoltaic Solar Installation by Type and Size of Installed System (MW) in the Mid-Region April 2025



Source: Created by JSGC Staff using data from InSPIRE. 2025. "InSPIRE Agrivoltaics Map." Accessed: 4/29/2025. openei.org/wiki/InSPIRE/Agrivoltaics_Map

Agrivoltaics Example: Crops

Crop production under solar panels represents both great potential and challenges inherent to agrivoltaics. While it defies conventional wisdom that crops could be grown under sunlight-blocking panels, it is possible, though not always economical, to do so. It is the least employed of the agrivoltaics practices in the United States, in part due to its high cost and technological complexity.

The general principle is that plants can only absorb a limited amount of sunlight needed for photosynthesis, and that in extreme conditions, excess can damage plants. When properly designed with the correct climate and with a carefully chosen layout, directional orientation, and tracking systems, certain types of vegetables can be grown under solar panels with minimal loss of yield. Currently, this achievement comes at a loss to the efficiency and cost effectiveness of the solar array as spacing must be changed to allow more light for plants. On a farm they would require other adjustments, as support structures to hold up the panels need to be raised or spaced to allow farm equipment. To date, this has led to an increase in installation costs and less modules absorbing sunlight.

Technological advancements such as semi-translucent photovoltaic panels also have the potential to capture some of the light which passes through it while still giving plants more light to grow than traditional PV panels. Other technologies include spectral-splitting panels that would let red and blue light, the type most needed for plant growth through to the plants and keep the rest for generating electricity.

Temple Case Study

To date this agrivoltaic practice is not employed within Pennsylvania to a significant degree. Students and faculty from the Temple Ambler campus are working to change this by conducting research at sites across the US and world to learn more about agrivoltaics. In discussions with Commission Staff, it was stressed that understanding the conditions under a panel are key to growing crops with agrivoltaics. Because of this, technology cannot be uniformly implemented throughout the country because doing the same thing would have varying results based on the specific climate of a region.

One reason for this is conditions under a panel have less sunlight and more moisture because plants are cool, creating a microclimate. While under panel conditions vary, they are especially useful in arid areas. Not only can panels improve growing plants in some areas but also cool panels help them run more efficiently. In deserts, panels need to be cleaned with water which could double to grow plants.

At Temple's Ambler campus test site, raised flower boxes are placed under a small solar array. Recent research involves sensors collecting data about panel conditions while growing vegetables or flowers, depending on the season. Currently this space offers outreach and educational activities to help community members and children learn more about agrivoltaics. It was also noted that sensor data could also be collected from pollinators and grazing AV sites to help inform planning to grow crops under panels.

One of the studies conducted at the Ambler campus array focused on the use of agrivoltaics in urban settings. The study found that vegetables such as lettuce, basil, cherry tomatoes, beans, and radishes can be grown in garden beds under solar panels in urban environments. Compared to the normal control group, the agrivoltaic-grown vegetables lagged at the start of the season but narrowed the gap as the season progressed. There is potential for shaded vegetables to keep growing longer into the season. It was noted that extending the growing season with AV panels is one potential way of making vegetables grown with the technology more valuable.

Currently, the university tests AV-grown vegetables in a lab to learn how they are different from standard. Some vegetables grown under panels may have desirable characteristics such as greens. When there is less light for these plants their leaves grow larger as they try to capture more sunlight. Researchers hypothesized that using this technology could be a way to attract non-traditional farmers to the profession.

The configuration currently at Temple could be grown on rooftops if they have enough support and are not fragmented. It was noted that with a good understanding of the array's layout, different plants could be grown throughout the array at spots where there is more or less sunlight or water. With this technology vacant space could be transformed into solar-powered community vegetable gardens. Researchers hypothesized that use of this technology could be a way to attract non-traditional farmers to the profession. This potential extends beyond Pennsylvania such as using these systems in conjunction with batteries to power remote areas such as high-altitude farmers in Nepal.

In the future members of the research team will experiment with reducing the amount of water used to grow plants to increase savings. They are also seeking funding to use semi-transparent or spectrum splitting panel technology that could maximize the amount of sunlight plants under solar panels receive.[251]

Agrivoltaics in Other States

AV sites are not evenly distributed throughout the country, and it is likely that state policy choices such as alternative energy portfolio, or large universities play a significant role in determining which states have chosen to host agrivoltaics programs. Kansas, Louisiana, Nevada, North Dakota, Utah, Washington, and Wyoming have no listed AV sites. Other states may have a singular agrivoltaics site. However, Wyoming has three projects in development that would bring sheep grazing to solar facilities. These facilities attempt to address issues faced in the pass with traditional solar panels that were not strong enough to withstand massive hailstorms that occur in

[251] Staff discussion with Sujith Ravi, Director, Environmental Science Program, Department of Earth and Environmental Science, Temple University, February 20, 2025.

the state.[252] California has the largest number of acres and installed capacity across its 31 PV sites, the majority of which devoted their focus wholly or partially to solar grazing. Texas and Minnesota both have similar number acres and installed capacity, with the latter focused on eight large grazing sites while the former has hundreds of smaller sites devoted to habitat support. Colorado, Indiana, Illinois, Minnesota, and Tennessee have predominantly sheep grazing at their agrivoltaics sites.[253]

Arid climates like the American Southwest may be very suitable for solar energy siting, but the standard agrivoltaic products, grazing, habitat, and crop production are limited by the lack of appropriate amounts of water. Additionally, panels need to be rinsed with water to keep dust from decreasing their effectiveness. The run-off from this rinsing could potentially support some forms of crop production. Researchers at Stanford University looked at plants like "agave, which can withstand high temperature, poor soil quality and require a mere amount of water for survival. Agave plants are used to generate biofuel like liquid ethanol that can be mixed with gasoline or used ethanol powered vehicles. Moreover, most of the agave plant can be easily converted to ethanol, unlike corn or other grains."[254]

In Alaska, a site was researching potential for solar and crops in northern climates. Renewable IPP added crops to its Houston, Alaska solar farm in 2023. The project was to cover 45 acres with bi-facial PV panels, expected to generate enough electricity for 1,400. Matanuska Electric Association had committed to purchasing all the energy produced at the facility. The plot was to be prepared in summer 2024, with planting to begin in summer 2025. Commercial vegetables and animal forage crops were to be planted. Native existing blueberry and lingoberry plants would also be studied.[255] However, in early 2025 Renewable IPP announced its withdrawal of its petition for approval of a new site in Nikiski from the Regulatory Commission of Alaska, citing that the project as no longer economic to pursue. Additionally, the company announced that it could no longer afford another planned new solar facility and that it would not continue the expansion of the Houston facility.[256]

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[252] Pat Maio, "Company To Build $155 Million Solar Farm In Wyoming's 'Hail Alley'," *Cowboy State Daily,* March 28, 2024. https://cowboystatedaily.com/2024/03/28/new-solar-farm-planned-in-wyomings-hail-alley-will-resist-falling-ice/

[253] "InSPIRE Agrivoltaics Map," Open Energy Information, accessed March 13, 2025. https://openei.org/wiki/InSPIRE/Agrivoltaics_Map

[254] Neha Shukla, "Photovoltaic Panels and Agave Cultivation: A New Model for Solar Farms," April 15, 2014. https://techietonics.com/futuretech-tonics/photovoltaic-panels-and-agave-cultivation-a-new-model-for-solar-farms.html

[255] "Research Team Adding Crops to New Houston Solar Farm," *Alaska Business Magazine,* December 22, 2022. https://www.akbizmag.com/industry/agriculture/research-team-adding-crops-to-new-houston-solar-farm/ and Savannah Crichton, "Case Study: Alaska Agrivoltaics," March 20, 2024, *Agrisolar Clearinghouse.* https://www.agrisolarclearinghouse.org/case-study-alaska-agrivoltaics/

[256] Alex DeMarban, "Developers put brakes on multiple solar energy projects in Southcentral Alaska, citing costs and federal politics," Anchorage Daily News, February 19, 2025. https://www.adn.com/business-economy/energy/2025/02/18/developers-put-brakes-on-multiple-solar-energy-projects-as-southcentral-alaska-faces-gas-shortage/

In Minnesota the Big River Farms owned by US Solar and part of its Big Lake Solar Project, has adopted multiple agrivoltaics practices over its installed 1 MW on nine acres and produces hand harvested vegetables, supports 20 grazing sheep, and a pollinator habitat.[257]

In 2024, news about the 800 MW solar project in Madison County, Ohio would become the country's largest agrivoltaics system. The total Oak Run Solar project spans 6,050 acres, with the goal of grazing 1,000 sheep and growing crops on a third of the site within the first year. State regulators approved the project in March 2024.[258] A second, smaller project, named Madison Fields Solar Farm is a 180 MW project capable of generating enough power to run 38,000 homes. The farm will also test on whether it is possible to grow crops between and around the rows of 400,000 solar panels on about 1,000 acres of land in Pike Township. Ohio State University is leading the research to test a variety of crops at the site, including wheat, soybeans, alfalfa, corn, hay mixes and pollinating plants.[259]

There is significant variation in the amount of AV utilized when comparing Pennsylvania in the mid-Atlantic region. New York is the regional leader with site size and acres and was predominately focused on solar grazing. Pennsylvania was second had both grazing and habitat support, with the bulk of the projects listed around Centre County in the vicinity of Penn State, which hosted both habitat and grazing related projects at their three Whitetail installations in Franklin County and nearby sewer authority. Temple University's AMBLR Campus also maintains a small agrivoltaic plot to research growing vegetables in urban agriculture experiments. Susquehanna University has been documented as leasing solar grazing services in 2022.

While New Jersey is home to more installed capacity of PV plants, it has fewer agrivoltaics sites. Rutger's University has a separate agrivoltaics program, and has three installations were the program experiments with agrivoltaics: The Rutgers Agricultural Research and Extension Center in Upper Deerfield, where staple and specialty crop production are being tested; Snyder Farm in Pittstown, where hay productions is occurring; and Cook Campus in New Brunswick, where vertical bifacial panels are placed to allow beef cattle to graze and farm equipment to pass through.[260]

Delaware and Washington DC had small amounts of habitat support under panels. None of the sites in the region focused on significant amounts of crop production.

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[257] "Case Study: Agrivoltaics and Local Food Production in Big Lake, Minnesota," *Great Plains Institute.* https://betterenergy.org/big-lake-case-study/

[258] Matthew Eisenson, "Ohio Approves Nation's Largest Agrivoltaics Project, Finding It Will Serve the Public Interest," *Columbia Law School Climate Law Blog,* April 1, 2024. https://blogs.law.columbia.edu/climatechange/2024/04/01/ohio-approves-nations-largest-agrivoltaics-project-finding-it-will-serve-the-public-interest/

[259] Mark Williams, "Can farming and solar panels work together? Madison County project is trying to find out," *Columbus Dispatch,* July 21, 2024. https://www.dispatch.com/story/business/energy-resource/2024/07/21/madison-fields-solar-farm-to-test-agrivoltaic-farming-on-solar-farms/74282422007/

[260] Aleen Mirza, "Curiosity Cultivates Solar Solutions: Innovating Agrivoltaics for a Sustainable Future," *Rutgers University New Jersey Agricultural Experiment Station, School of Environmental and Biological Sciences Office of Public Outreach and Communication,* March 18, 2025. https://sebsnjaesnews.rutgers.edu/2025/03/curiosity-cultivates-solar-solutions-innovating-agrivoltaics-for-a-sustainable-future/

Elsewhere, agrivoltaic crops are already being grown throughout the Northeast, although the practice is still uncommon and frequently serves as demonstrations to the public from environmentally conscious farmers. In Rhode Island, 'Our Kids Farm' demonstrates the potential of growing vegetables small scale with .15 acre feeding into a net metering set up produces 28 kW. An innovative characteristic is this system collects and stores rainwater with special gutters to irrigate the crops. The system grows an assortment of vegetables: broccoli, kale, cabbage, Swiss chard, strawberries, tomatoes, peppers, eggplant, squash, cucumbers, kohlrabi, herbs, salad greens, celery, onions, shallots, leeks, string beans and peas.[261]

Beyond demonstration sites, some believe there may be potential in growing more valuable specialty crops under solar panels whose shade is more benefit than detriment. In Maine, 4 MW of power is generated over 12 acres in a blueberry field. However, it was determined over several years of study that blueberries did not receive adequate light under a fixed panel arrays and produced only nine percent as many berries as reference bushes. Additionally, the arrangement made collecting berries more difficult. In Vermont, saffron is being tested at a solar site with vertical two-sided panels. State incentives in Massachusetts have attracted a few small vegetable producers interested in agrivoltaics. In one such case, a rotation of broccoli and squash on two acres with raised platforms and additional space between rows.

Of particular interest to this study is the experience in Virginia. Currently, there are six agrivoltaics projects in the state, three devoted to grazing and covering 2,400+ acres, and three devoted to habitat development, covering 585 acres.[262] In 2024, the state legislature attempted to enact solar siting reform, highlighting a fight over control of decision-making on grid-scale solar development between solar companies and local government authorities. The bill would have required local authorities to approve solar projects under a model ordinance that would prohibit "unreasonable restriction." The bill would have created a statewide energy facility review board to recommend approval or denial of projects. The bill failed.[263]

The Vermont Law and Graduate School maintains a database state farmland solar policy information. The database reports that six states have statutory laws that address agrivoltaics in particular. Those states are Colorado, Massachusetts, Maryland, New Jersey, New York, and Vermont.[264]

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[261] Gardiner Our Kids Farm, InSPIRE Agrivoltatics Map.
https://openei.org/wiki/InSPIRE/Sites/Gardiner_Our_Kids_FarmOur Kids Farm, Exeter, Rhode Island,
https://ourkidsfarm.com/about-us

[262] InSPIRE Agrivoltaics Map.

[263] Charlie Paullin, "Localities, Rural Lawmakers Win in Halting Solar Siting Reform in Virginia," *Inside Climate News,* March 26, 2025. https://insideclimatenews.org/news/26032025/virginia-utility-scale-solar-reform-bill-denied/

[264] Farmland Solar Policy State Law Database, *Farm and Energy Initiative,* accessed March 31, 2025. https://farmandenergyinitiative.org/projects/farmland-solar-policy/state-law-database/

Agrivoltaics in Other Countries

Like the United States, agrivoltaic grown crops are not commonplace in Canada. However, research from 2023 has suggested that Canda could make significant progress on its adoption of renewable energy goals if it converted just one percent of its agricultural lands to photovoltaics.[265]

Most of the dual use in the United States, involves sheep grazing or pollinator habitat, unlike many other parts of the world where crops are the primary use of the technology. Germany and several other of the world's advanced economies are further along in their pursuit of agrivoltaics technology to raise crops due to broader adoption of solar technology and greater degree of research, investment, and demonstration, and government action that has been put forth to develop the technology.

Several of these countries have been pioneering agrivoltaics technologies for over a decade. In 2010, Germany made solar related adjustments to its renewable energy sources act, which did not provide incentives to solar arrays located on former agricultural lands.[266] The first agrivoltaic systems were installed in France and Germany in 2011. In 2013, Japan became the first government to fund an agrivoltaics program. As the systems matured, they became larger, with the first system over 10 hectares installed in 2015. By 2017 France began investing in agrivoltaics systems. In 2021 it was estimated that over 14 GW of agrivoltaics systems were installed across the world.

This relatively greater amount of support has led to broader social acceptance of solar: in 2023, the EU had almost double the GW of installed capacity as the US and was growing six times faster as well.[267] Unlike the U.S. and Canda which have broad tracks of land which could still be developed either for solar or used farmland, many of these other countries are smaller and land constrained which incentivize them to preserve their remaining farmlands, in the face of regulatory pressure to increase renewable energy . The EU has to install 710GW of solar by 2030. As of 2022 it has only installed 40GW and would have to install 80GW of solar PV a year to reach this goal.[268] Energy bills are higher in Europe, representing half of farmer production costs, and solar power is seen as a method to reduce those costs. Solar installations can help reduce the amount of water needed by a plant by 20 to 30 percent. Currently 14 EU member states have solar PV in the Common Agricultural policy strategic plans.[269]

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[265] Uzair Jamil, Abigail Bonnington, and Joshua M. Pearce, "The Agrivoltaic Potential of Canada," *Sustainability* 15, no. 4 (February 10, 2023): 3228. https://doi.org/10.3390/su15043228

[266] Marcus Herrmann and Harald F. Heller, "The Amendment of the Renewable Energy Act With Respect to the Feed-in-tariffs for Photovoltaic Power Plants," Lexology, July 29, 2010. https://www.lexology.com/library/detail.aspx?g=02a39fac-e951-46e9-8995-3134690a9aaf

[267] Marie Tamba et al., "Transatlantic Clean Investment Monitor: Comparing Deployment and Manufacturing Trends in Europe and the United States," July 15, 2024. https://rhg.com/research/transatlantic-clean-investment-monitor-us-eu/

[268] PVcase. "Agrivoltaics in Europe: A Closer Look at the Facts and Figures," June 29, 2023. https://pvcase.com/blog/agrivoltaics-in-europe-a-closer-look-at-the-facts-and-figures/

[269] Agrisolar by Power Solar Europe, "Agrisolar," Agrisolar Europe, June 22, 2023. https://agrisolareurope.org/whats-agrisolar/

Germany

An agrivoltaics pilot by the Fraunhofer Institute was conducted in Germany from March of 2015 through July of 2021. The demonstration system had an installed capacity of 194kWp.[270] Clover, potatoes, winter wheat and celery were grown under the PV solar panels. The tilted panels were installed above on 16.4 feet high polls. There were over 60 feet between rows of supports, with over 38 feet between corner and central supports. This height and spacing allowed tractors and farm equipment to travel the rows of crops. On top of the structure there were 30 feet between the rows of PV panels.

Part of the pilot was comparing the crops under agrivoltaics panels to a reference yield of crops grown on another part of the farm. In 2017 the pilot had 18 percent less yield than the reference, while in 2018 it had 11 percent more. Research noted that in both years the AV experiment produced a higher portion of vegetables that had a diameter that was marketable (neither too big or too small)[271]. It was found that the panels cooled the ground under them and reduced the amount of water evaporating from plants between 13-17 percent depending on the crop in question.

The Fraunhofer Institute also looked at the difference in cost between agrivoltaics and the average levelized cost of other types of solar configurations: ground mounted photovoltaics, AV on arable land, AV on horticulture, and small rooftop mounted Photovoltaics systems under 10kWp. They found that agrivoltaics is 20 percent cheaper than small rooftop systems. On arable farmlands agrivoltaics cost 20 percent more than on grasslands. Traditional ground mounted PV systems were found to be the most efficient in cost. The main differences in cost between agrivoltaics systems was mounting structure, modules price, and site preparation and installation. Other costs such as planning and electrical components between systems were comparable.

In 2023 Germany adopted a formal definition of agrivoltaics, outlined in a technical document from the Fraunhofer group. It has been one of the most comprehensive to date and put a clear focus on integrating photovoltaic modules in ways that did not disrupt agricultural operations. It was constructed to avoid definitions where traditional ground mounted systems take active farmland out of use while claiming to support the environment. Germany's adopted definition states that "Agrivoltaics is the combined use of the same land area for agricultural production as the primary use and for electricity PV production as the secondary use." Germany's technical document continues to break down agrivoltaics by two categories depending on whether the panels are overhead crops by at least 6.9 feet (category 1) or spaced between crops by 6.9 feet (category 2).

[270] Fraunhofer and Ozal Ozdemir, "Agrivoltaics: International Development, Legal and Economic Aspects," Slide 12, (November 1, 2023).
[271] Fraunhofer and Ozdemir, "Agrivoltaics: International Development, Legal and Economic Aspects." Slide 13

Examples of approved agrivoltaics activities for categories 1 and 2 follow.

- Permanent and multi-year crops (fruits, berries, viticulture, and hops)
- Single-year and long-term crops (Arable crops, vegetables, alternating grassland, fodder)
- Grassland with mowing (intensive and extensive commercial grasslands)
- Grassland with pasture (pastures, pasture rotation between different animal types)

Regardless of category of approved uses, Germany outlined some core criteria that each must meet:

- Agricultural yield must be at least 66% of the reference of the farm.
- Project must be guaranteed to have an agricultural use concept.
- Loss of farming area must be prevented and is limited to a maximum of 10 percent in category 1 and 15 percent in category 2.
- Agrivoltaic systems must meet the agricultural needs of the farm
  - Ensure adequate light, homogeneity, and water.
  - Prevent soil erosion and damage.

Other agrivoltaic issues in Germany being addressed are permanent grasslands and providing different premiums for elevated and ground-mounted systems. Similarly, the country is creating an inheritance law that provides tax benefits for agrivoltaics plants as well as direct payment from the EU.

Italy

Italy has two large programs which differentiate between two types of solar energy development in its agricultural sector. The 'Agricultural Park Call' is aimed at the purchase and installation of PV systems on the roofs of agriculture and related buildings such as those aimed at breeding, meat and food processing, and dairy. The size of the system must be between 6 and 1,000 kWp. Participants of the program must be agricultural entrepreneurs, industrial companies or cooperatives. This program excludes farmlands.[272] Italy has invested over 1.5 billion euros for this program.[273]

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[272] "Difference Between Agrivoltaics and Agrisolar. Let's Make It Clear!," *Greenergy* (blog), September 11, 2024. https://www.greenergy.it/en-us/news/difference-between-agrovoltaic-and-agrisolu-lets-make-clear

[273] PVcase, "Agrivoltaics in Europe: A Closer Look at the Facts and Figures," June 29, 2023. https://pvcase.com/blog/agrivoltaics-in-europe-a-closer-look-at-the-facts-and-figures/

Agrivoltaics is other type of solar development in Italy. Their Ministry of the Environment and Energy Security defines it as "A photovoltaic plant that adopts solutions aimed at preserving the continuity of agricultural and pastoral cultivation activities on the installation site".[274] Italy has four major requirements for its agrivoltaics systems that were adopted in June of 2022:

- The proposed design may not cover more than 40 percent of the farmland with photovoltaics modules.[275]
- There must be synergy between production of energy and agricultural yield. To be eligible for this program the agrivoltaics system must produce more than 60 percent when compared to the governments standards for photovoltaic system arrays, while continuing agricultural activities.
- Systems must be integrated with the crops and be between rows of agricultural products in either a vertical or inclined position.
- Monitoring systems are required to be in place.

Other countries also have standards they are adopted to evaluate the effectiveness of agrivoltaics systems.

France

In France, AV systems must meet three criteria:

- benefit the production of agricultural goods,
- affect the yield of crops within specified parameters, and
- improve the farmer's income.

To date research has been conducted on using solar panels to shade grapes from sunlight and improve the quality of their output.[276]

The Netherlands

Within the Netherlands it is required that PV not interfere with agricultural activity where it is collocated as well as a requirement related to module density.[277]

It can be concluded that many countries who are adopting agrivoltaics believe that installation of a PV systems on a farm should not hinder a farm's agricultural production. If policymakers decide to limit ground mounted PV installations on prime farmlands, these examples suggest that an exception be made for integrated agrivoltaics that do not disrupt farmlands.

[274] "Difference Between Agrivoltaics and Agrisolar. Let's Make It Clear!"
[275] Fraunhofer and Ozdemir, "Agrivoltaics: International Development, Legal and Economic Aspects."
[276] PVcase, "Agrivoltaics in Europe: A Closer Look at the Facts and Figures."
[277] PVcase, "Agrivoltaics in Europe: A Closer Look at the Facts and Figures."

FINDINGS AND RECOMMENDATIONS

"Solar farming" is a misleading misnomer. The only correlation between farming and the facilities to collect and convert sunlight into electric energy is the concept of "harvesting" the power. Solar energy facilities are comprised of solar arrays (a collection of solar panels) and accessory technology. A contributing factor to the misleading nature of the term "solar" farm is that, not infrequently, solar arrays are placed on lands that are farmlands or undeveloped open spaces. These sites are among the least expensive ways to collect solar energy because minimal alterations and earth disturbances are required. Farmlands have already been cleared and semi-level, and rudimentary paths or tracks are already in place. In some instances, installations on open spaces may require clearing, tree-cutting and leveling. Rooftop installations, reclamation of brownfields, abandoned factories and warehouses, or abandoned mine lands require a greater investment in cleanup, preparation and installation. From the perspective of an investor in solar energy development, lower costs and larger profits make using farmland a very attractive option. Agrivoltaics is a form of solar energy production that attempts to reconcile the goal of preserving productive farmland and allowing solar arrays to use farmland by collocating them on the same parcel of land. The recommendations in this report are intended to support the preservation of farmland and assist and encourage farmers to continue engaging in agricultural production.

While the recommendations reproduced in this report are the consensus of the members of the advisory committee, it should not be assumed by the reader that agreement was unanimous. Some provisions were the subject of much debate and concern, and not every recommendation is endorsed by every member.

Agrivoltaic Definitions

Agrivoltaic farming provides for the dual/simultaneous use of farmland for agricultural production and solar energy harvesting. It further seeks to protect farming interests while increasing energy independence. It attempts to create a mutually beneficial co-existence of the two activities and goals, and at a minimum, seeks to find an equitable tradeoff.

- **A statewide definition of agrivoltaics would aid in assisting farmers** in determining the best use of their land.

The following definition is recommended:

> Agrivoltaics is a land use practice where solar energy generation and sunlight dependent agricultural activities are directly integrated and there is a layer of agricultural productivity within the bounds of the solar infrastructure.

Elements of agrivoltaics:

- Panels may be raised or interspaced to create enough space for agricultural operations to occur.

- Panels may also protect crops growing under them from harmful weather conditions like hail.

- Animal grazing (particularly sheep) is the form of agrivoltaics that needs the least accommodation for a multi-acre photovoltaic solar installation. Sheep grazing can also have the effect of cutting grass that saves maintenance costs to the solar company.

- Growing native grasses and other herbaceous plants beneficial to pollinators is also a lower cost means of collocating solar panels and agricultural activities. More pollination can happen on farms because solar installation creates a favorable habitat.

- European models, such as Germany's, have imposed conditions on the use of land to qualify for treatment as agrivoltaics. These include requiring that a certain percentage of agricultural activity occur within the solar installation or requiring agricultural yield to remain within specified parameters. The definition does not include agricultural lands that are leased and taken out of agricultural production, or the installation of photovoltaic panels on the rooftops of agricultural buildings.

Under current Pennsylvania law, agrivoltaics can occur with two types of solar installations. Use of solar arrays to produce electricity for the sole use of the landowner is often referred to as "net-metering." An individual may install solar panels on their rooftop or other property that is also connected to a local electric distribution company. To the extent the homeowner does not produce enough electricity for their own use, the distribution company serves as a backup supplier. If, on the other hand, the individual generates excess electricity, it can be sold to the distribution company. These individual arrangements do not have a significant impact on the U.S. or regional electric grid and may or may not be used for agricultural purposes, and so are a small portion of agrivoltaics. Grid-scale solar energy is the much larger portion of solar energy production. These facilities are by nature physically larger and thereby have a greater impact on the use of farmland. Additionally, the energy they produce is not necessarily dedicated to the landowner or the local community and can be sold to communities that are hours away from the farmland source. Accordingly, most of the findings and recommendations in this report will look to grid-scale solar.

Grid-Scale Solar

(sometimes referred to as Utility-Scale)

The energy produced by grid-scale installations is either sold into the wholesale market operated by PJM or is sometimes purchased for a designated source through a power purchase agreement, typically with a large organization such as a company or college campus. Unlike other forms of energy distribution, the energy produced through grid-scale solar installations might not directly benefit the landowner or the community in which it is generated. However, benefits to the landowner and the community include land lease payments to landowners, taxes and fees to the local government, and potential employment opportunities for construction and maintenance of these solar facilities. These externalities in turn may produce other indirect economic benefits to local businesses.

Incentives for developers wishing to install grid scale solar should be directed towards the development of non-farmland. Prioritized/preferential solar installation on non-farmland locations could include:

- marginal and non-productive land including brownfields and reclaimed mines[278]
- rooftop systems on warehouses, fulfillment centers, and large government buildings
- transportation infrastructure corridors, such as turnpike and divided highway medians, or public utility rights-of-way for solar development
- vertical arrays

Generally, these are more expensive ways of installing solar facilities and may require amending construction codes to require new commercial and industrial facilities to be capable of bearing the weight of a solar array. Infrastructure corridors and public utility rights-of-way may have uses that support the primary use of the land (such as access for maintenance and storm responses) that limit the ability to fit solar installations into the available square footage. The tradeoff for the higher expenses is the preservation of farmland, other open spaces, and the protection of food supply sources.

Financial incentives could include:

- Impose an agricultural impact fee on developers who lease from farm landowners or purchase and convert farmland to non-agricultural use, with the fee used to promote agricultural preservation and education.
- Create property tax exemptions on the added value of solar installations that prove viable agrivoltaics operations.

[278] Land enrolled in a U.S. Department of Agriculture, Natural Resources Conservation Service Conservation Reserve Plan (CRP) while considered marginal for purposes of the program, would not be a preferential location for solar installations, for the same environmental protection reasons why the NRCS established the CRP.

Non-financial incentives for use of non-agricultural lands for solar development could include assistance addressing environmental remediation concerns arising from previous land use, reconciling competing ownership claims of abandoned property, and assistance in feasibility studies to determine suitability of non-farmland.

- Consider a uniform statewide law regarding bonding, decommissioning, cleanup, and restoration of solar installations on any property, not just farmland.

- Encourage solar developers that are utilizing leased farmland to adopt minimally disruptive grading practices that will not damage the land and leave it in as good or better condition, allowing it to be used to resume whatever land use practices, such as full-scale agricultural production, existed on the property immediately prior to the installation of the solar facility.

- Consider options to mitigate the impact on farmers who rent land for agricultural activities when the landowner opts to enter a solar development lease instead.

- Provide guidance to local governments to develop solar zoning policies and ordinances, including siting guidelines.

- Encourage municipalities that restrict solar development to provide exceptions for agrivoltaics projects that continue agricultural operations.

- Collect more data on local tax impacts of grid scale solar installations. This could be assigned to the Department of Community and Economic Development, which already collects data on local taxes.

- Encourage further investment in marketing and workforce development for agricultural production, including educational efforts.

Net-metering Solar

Incentivize farmers to install solar installations that are collocated with agricultural activities to assist in relieving some of the Commonwealth's energy production needs. These could include:

- Provide a sales tax exemption for farmers purchasing solar related equipment to install solar arrays on their property. Policymakers should decide if these tax breaks should be applicable to merchant-generators, who sell all the generated electricity back to the utility.

- Provide longer amortization schedules for state loans for agrivoltaics projects.

- Assist interested farmers in applying for federal funding for small scale agrivoltaics projects.

Community Solar

Community solar projects are a form of energy production not currently authorized in Pennsylvania. The General Assembly should continue to explore this concept. Community solar projects could be established through individual municipalities, regional cooperatives, public-private partnerships, or groups of individuals living in a community.

Some of the potential benefits of community solar include:

- Potential to integrate agricultural operations more readily than grid-scale.
- Community members can purchase the power directly.
- Power generated stays in the geographical area of the community.
- Farmers can be participating owners and profit from solar energy beyond leasing the land to a grid-scale developer.
- Expands access to renewable energy within communities. People who might not be able to install solar panels on their property due to cost or physical property conditions would be to purchase solar energy from a community provider.

Further Research Areas

- Support research to explore the synergy between Pennsylvania-friendly crops and the microclimates created by solar panels.
- Support research on the impact of panel height, spacing, materials, tracking systems, and layout configurations the determine tradeoffs between crop yield and energy production.
- Support research on the compatibility and cost effectiveness of grazing under and around solar installations.

PRINTER'S NO. 2061

THE GENERAL ASSEMBLY OF PENNSYLVANIA

HOUSE RESOLUTION

No. 224 Session of 2023

INTRODUCED BY RABB, MALAGARI, MADDEN, HILL-EVANS, SANCHEZ, KHAN AND OTTEN, SEPTEMBER 29, 2023

REFERRED TO COMMITTEE ON LOCAL GOVERNMENT, SEPTEMBER 29, 2023

A RESOLUTION

Directing the Joint State Government Commission to conduct a study and establish an advisory committee to review and analyze the opportunities for and benefits of agrivoltaic farming systems in this Commonwealth.

WHEREAS, In recent years, Pennsylvania farmers have faced a number of challenges, including the COVID pandemic and rising input costs, such as rising costs for fertilizer; and

WHEREAS, On-farm solar, or agrivoltaic farming, offers farmers and rural communities a consistent, long-term stream of income and can boost agricultural productivity; and

WHEREAS, Agrivoltaic farming is the siting of elevated solar panels above crops which can continue to be cultivated; and

WHEREAS, In some variations, agrivoltaic farming also includes siting of elevated solar panels such that livestock may graze among and around the solar panels; and

WHEREAS, Pennsylvania lost 6,000 farms between 2012 and 2017; and

WHEREAS, Dual use of agricultural land with agrivoltaic farming can be a farmland preservation tool; and

WHEREAS, Consumption of renewable energy in the United States hit a record high in 2020; and

WHEREAS, Renewable energy only accounts for 13% of total United States energy production; and

WHEREAS, Solar energy may need to use 0.5% of United States surface area to meet the 2050 renewable energy goals; and

WHEREAS, According to the United States Department of Agriculture, agrivoltaic farming makes agriculture and solar energy production complement each other rather than contrast; and

WHEREAS, Several profitable crops fare better, or as well, when grown beneath solar panels; and

WHEREAS, Pennsylvania legislators have an obligation to assist struggling farmers in the face of challenges feeding our communities; therefore be it

RESOLVED, That the House of Representatives direct the Joint State Government Commission to conduct a study and establish an advisory committee to review and analyze the opportunities for and benefits of agrivoltaic farming systems in this Commonwealth; and be it further

RESOLVED, That the advisory committee be comprised of the following members:

(1) The Secretary of Agriculture, or a designee.

(2) A member of the Center for Rural Pennsylvania.

(3) A representative of an organization that advocates for use of agrivoltaic technology.

(4) A representative of Penn State College of Agricultural Sciences.

(5) Other individuals or representatives from organizations selected by the Joint State Government

Commission;

and be it further

RESOLVED, That the Joint State Government Commission, in conducting the study, include findings and recommendations regarding:

(1) A comprehensive accounting of which State, county and local agencies utilize or would benefit from agrivoltaic farming systems.

(2) Legislative solutions to boost agricultural productivity.

(3) Suggestions to stabilize rising input costs for farmers.

(4) Methods to facilitate the complementary nature of agrivoltaic farming and solar energy production;

and be it further

RESOLVED, That the Joint State Government Commission issue a report of its findings and recommendations to the House of Representatives no later than one year from the adoption of this resolution.