



Pennsylvania

Solar Development Analysis

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Table of Contents

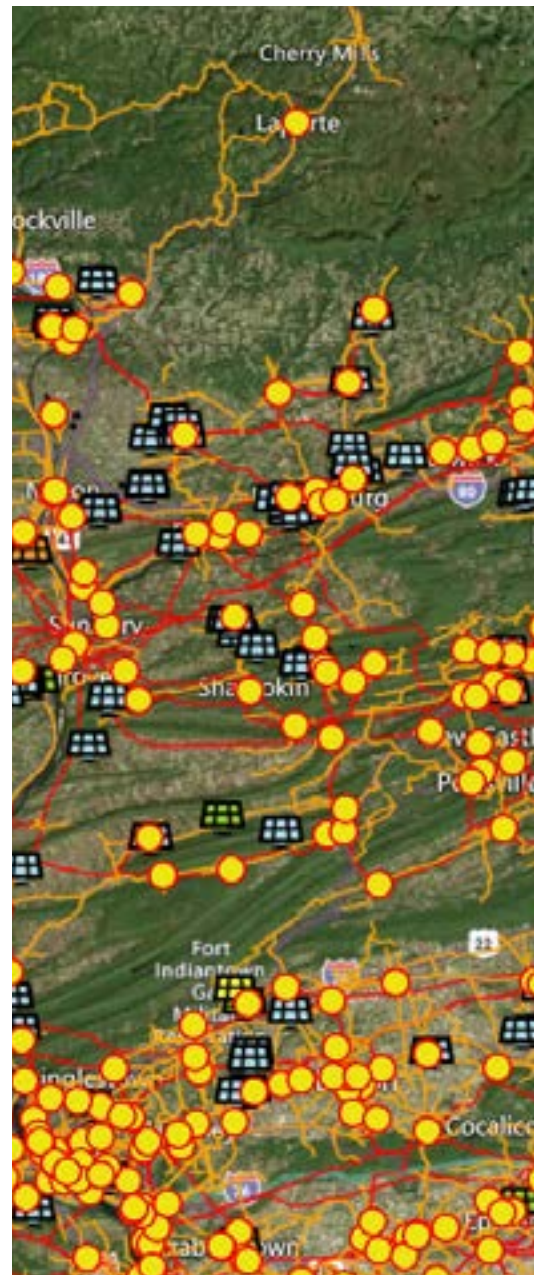
01	Pennsylvania Solar Development Overview	01-05
.....		
02	Utility-Scale vs. Community Scale Solar	06-16
.....		
03	Pennsylvania LMP Overview	17-19
.....		
04	Pennsylvania PPA Overview	20-21
.....		
05	Tax Incentive Programs	21-25
.....		

Pennsylvania Solar Development ANALYSIS

The state of solar development in Pennsylvania can be evaluated by key factors such as federal and local regulations, incentives, grid interconnection and integration. The current state of development activity in Pennsylvania is growing considerably and can be seen in this analysis summarizing all facets of solar energy project development.

We will break down the various federal and state incentives available to solar energy developers in Pennsylvania and how to access them.

LandGate provides key data to the top developers and financiers in the country. To learn more about access to this platform, or to talk about how to apply the information below to your business, book time with a member of our dedicated



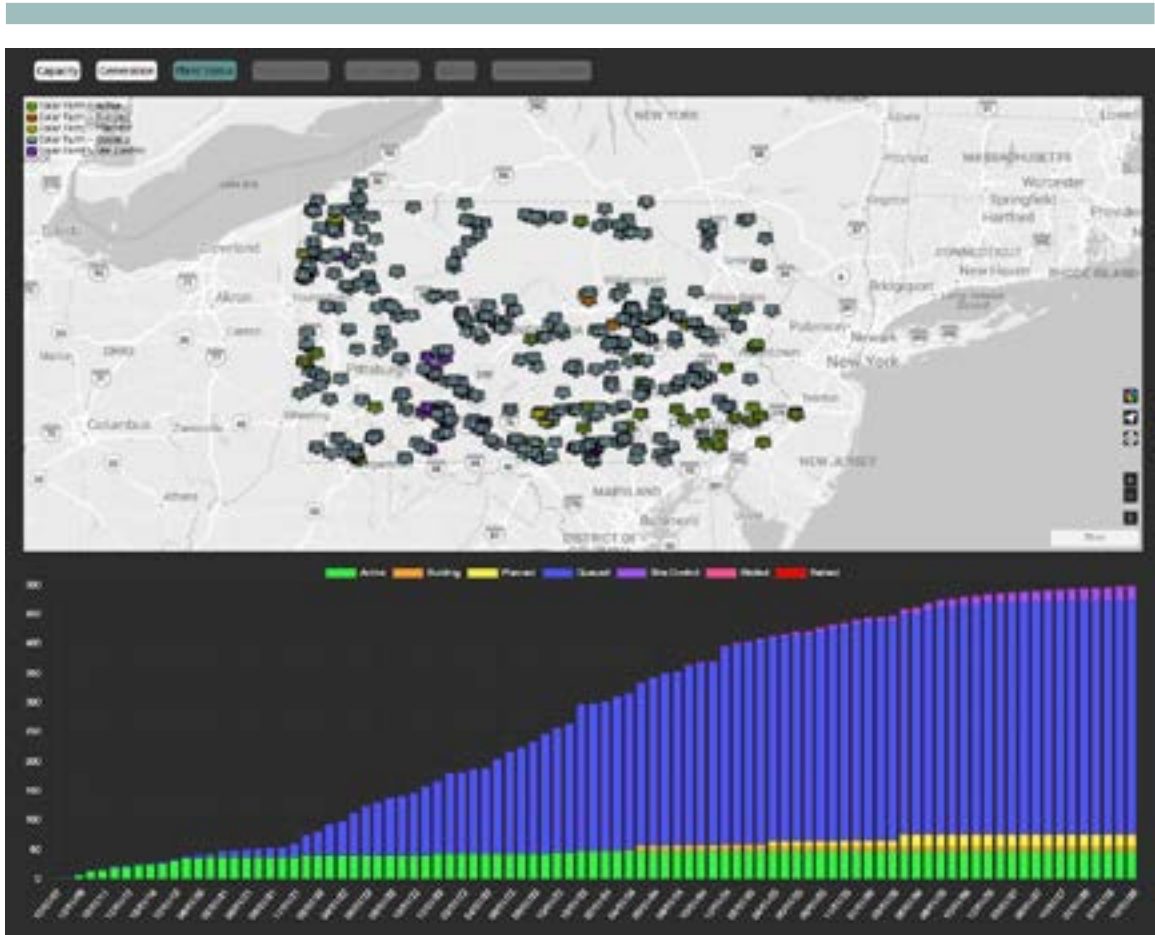
Pennsylvania Solar Energy ACTIVITY

Status	PA Solar Farm Count	PA Solar Farm Capacity (MWac)	PA Solar Farm Generation (MWh)
Operating	46	562	77,493
Under Construction	9	263.4	95,343
Planned	20	251.1	247,870
Queued Projects	480	10,469.31	3,329,293
Site Control (Lease Options)	22	211	70,864

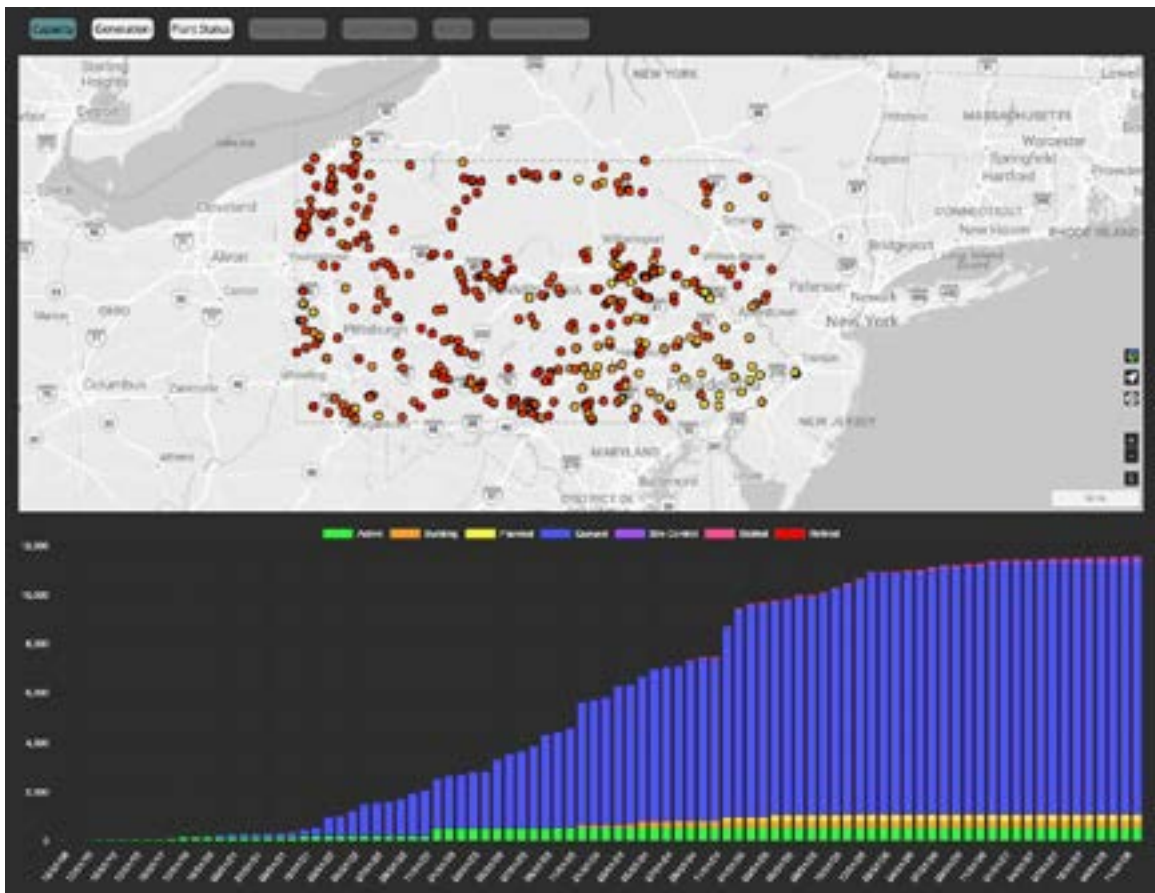
*est is the estimated peak total electricity generation that those solar farms will produce once operational

Pennsylvania currently has **46 active and operating utility-scale solar farms** with a **total capacity of 562 MW**. Pennsylvania also has an extensive pipeline for future development with 9 farms under construction, 20 planned farms, 480 queued projects with a total capacity of over 11,000 MW, and 22 site control farms with a total capacity of 211 MW.

Overall, if all under construction, planned, queued, and site control farms go into operating status, Pennsylvania will expand its capacity by 11 GW! In Pennsylvania, the average solar farm size is 218 acres, producing 12.2 MW of electricity under ideal condition



Solar Farm Count in Pennsylvania



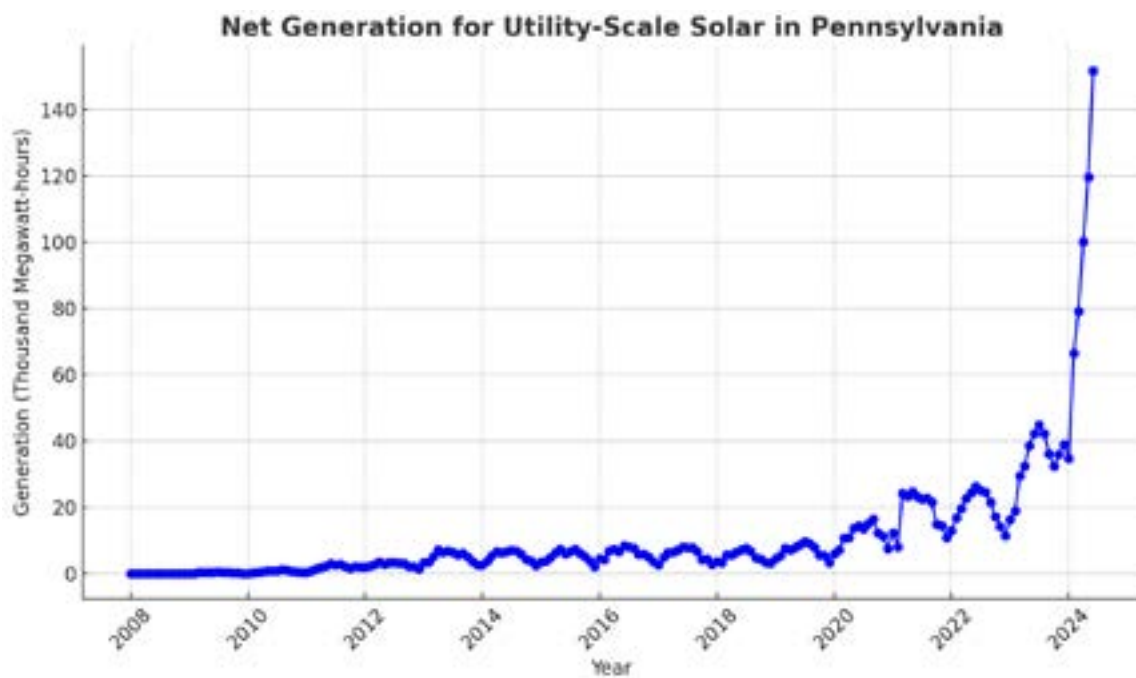
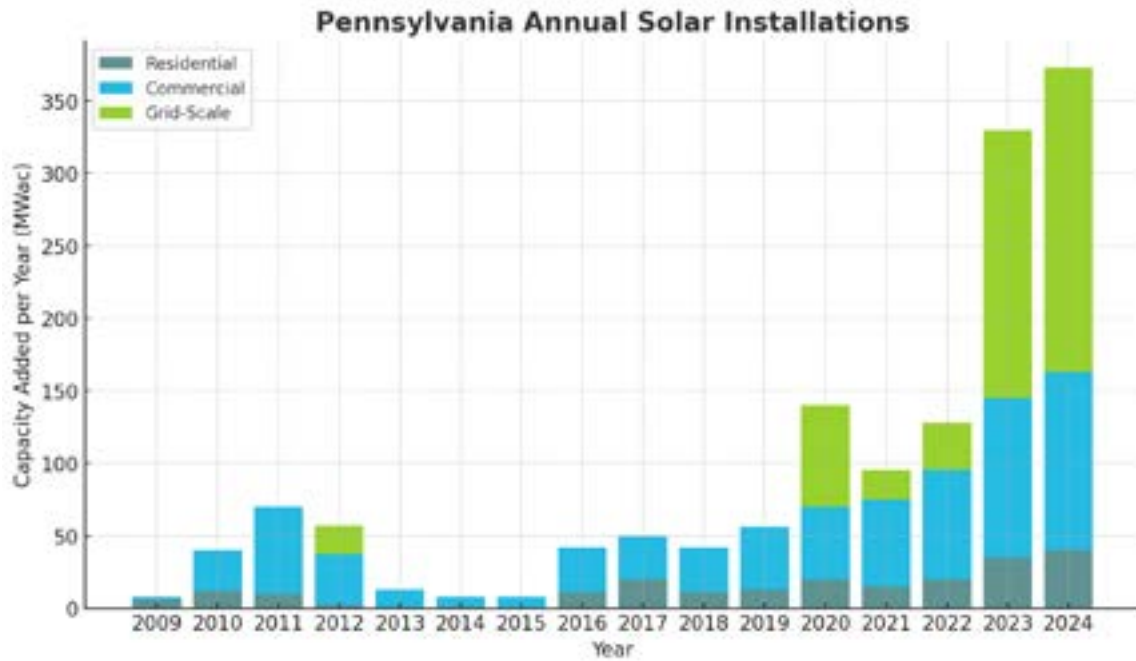
Solar Farm Capacity by Farm Status in Pennsylvania

Overview: Past, Present & Future of Solar in Pennsylvania

Pennsylvania, historically reliant on natural gas, coal, and electricity from fossil fuels, is experiencing a notable shift towards renewable energy sources, particularly solar development. Despite its reputation as a leading supplier of traditional energy, solar energy has been gaining momentum in the state. In 2021, solar energy accounted for 11% of Pennsylvania's total renewable electricity, but the declining costs of installation, available tax credits, and health benefits of solar energy underscore the urgency for Pennsylvania to prioritize its development even further.

The state has realized the need for urgent action from Pennsylvania decision-makers to invest in and expand access to solar energy. Recommendations include increasing solar energy goals through higher Alternative Energy Portfolio Standards (AEPS) targets, with support for Senate Bill 230, aiming to raise the renewable energy goal to 30% by 2030 and permit community solar projects. Additionally, encouraging solar power development on brownfields and through agrivoltaics presents opportunities to utilize Pennsylvania's abundant space for solar energy production.

The state's solar industry is experiencing exponential growth, with over 400 queued projects indicating a promising future for solar development in Pennsylvania. Federal and state incentives, such as the Solar Energy Program (SEP) and High Performance Building Program (HPB), have contributed to this growth. Policy changes, including advancing a cap-and-invest program compatible with the Regional Greenhouse Gas Initiative (RGGI) and enabling community solar, are necessary to ensure the prevalence of solar energy in Pennsylvania's energy mix. By prioritizing pro-solar policies and increasing funding for solar initiatives, Pennsylvania is accelerating its transition to a more sustainable energy future.



While much of the state’s net generation originates from natural gas and nuclear powered energy sources, solar energy is emerging as a contributor to Pennsylvania’ electricity generation landscape in recent years, with 11% of the state’s total net generation stemming from solar power. While this expansion is fairly recent, it’s noteworthy that with an extensive future pipeline for utility scale and small-scale projects, Pennsylvania is poised to become one of the pioneers of solar energy in the United States with the state currently investing over \$USD 3.9 billion.

Utility-Scale SOLAR

Utility-scale solar refers to solar farms often created and managed by utilities, independent power producers, or energy firms. These projects aim to produce electricity on a large scale and deliver it directly into the distribution grid. These solar farms generally have more than 10 MW in capacity. Below is a breakdown of the different types of solar farms and their development statuses.

Utility-Scale

The state of Pennsylvania is regulated by the **Pennsylvania-New Jersey-Maryland Interconnection (PJM)**.

Projects Queued for Development in Pennsylvania

ISO	Number of Solar Farms	Capacity(MWac)
PJM	480	10,469.31

A project in queue means that the project enters the interconnection queue of that region waiting for regulatory approval. During this period, the analysis of possible engineering and land factors is conducted to determine the feasibility of the project to be constructed and connected to the grid. The average amount of time it takes for a farm to go from queue to operational in Pennsylvania is **3 years**. As per the projected in-service dates for the current projects in queue, Pennsylvania will most likely add ~ **10 GW** of Utility Scale farms by the end of 2025. Pennsylvania holds an above average queued project development time as interconnection wait times in the PJM active queue have increased steadily over the years due to the clustered “first ready, first served” approach which have increased project deposits and the readiness criteria for farms.

How do developers screen and run due diligence for those solar farm projects in queues?

Factors to take into consideration:

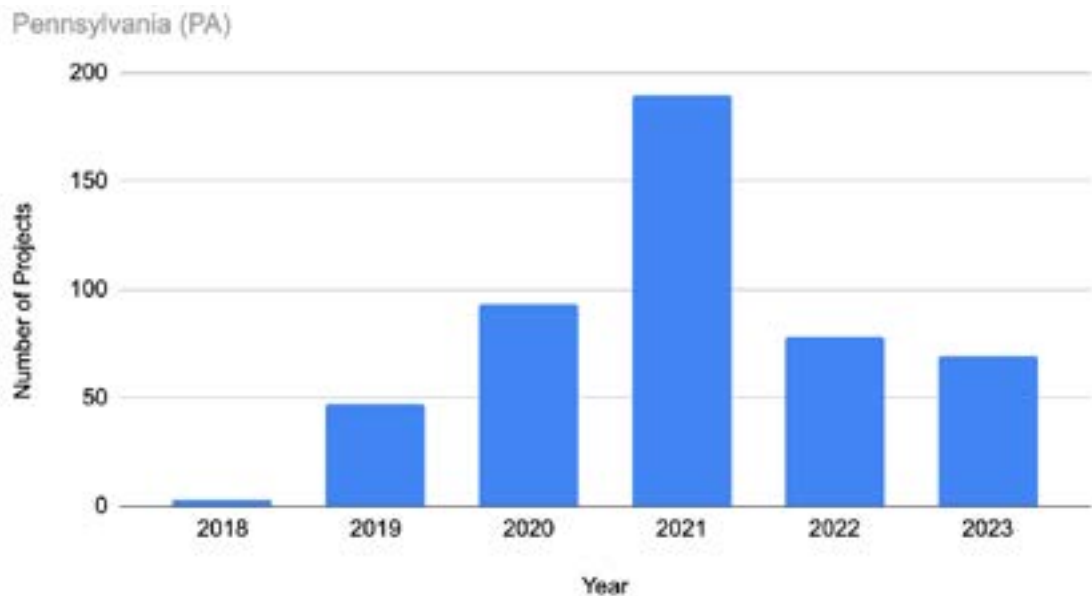
- Electricity generation
- Electricity commodity prices (LMP, incentives, PPA)
- Capital costs
- Operating costs
- Timing
- Risks

Using the factors above and a standard solar panel size, the buildable acreage and a land coverage ratio (encompassing row spacing and maintenance spacing) we calculate the maximum number of panels that could fit on the parcel. This helps us estimate the capacity the project lease will add to the grid and calculates a Market Value of the solar project.

Solar PowerVal enables similar capabilities to evaluate land

parcels for solar development and get an independent economic report for solar projects of all statuses. This tool allows developers and project financiers to fast-track the process of submitting a feasibility study to the queue for approval through independently produced Engineering & Economic analytics and Solar 8760 reports or evaluate projects and parcels for origination and M&A.

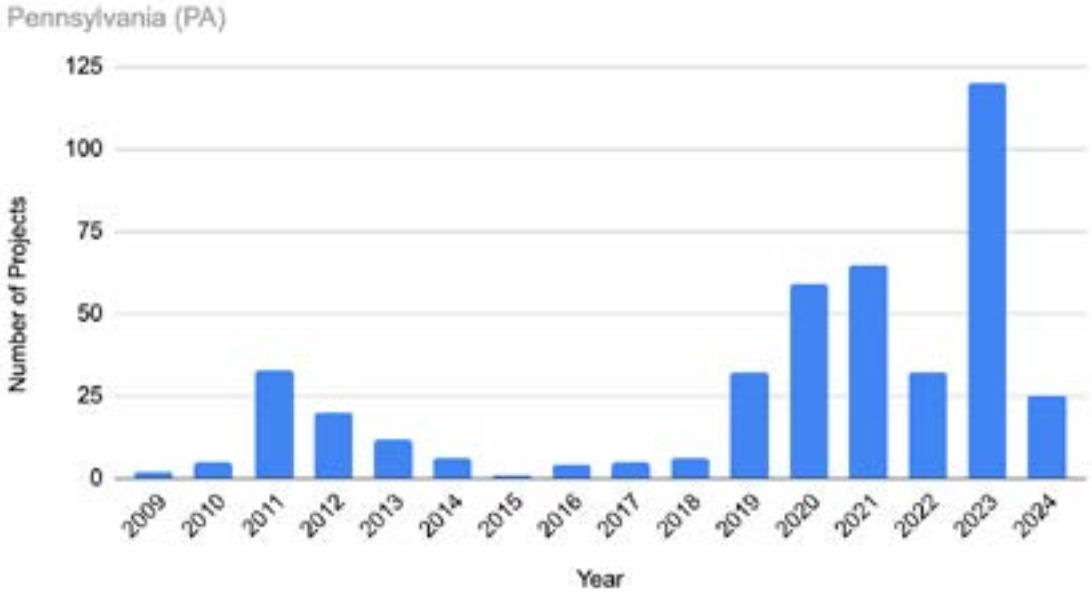
Projects Added to PJM Queue



The number of utility scale solar projects being added in Pennsylvania was on the rise up to 2021. With an extensive future pipeline of queued, planned, building and site control farms on the way, Pennsylvania has become a large proponent of both utility scale and community solar farms in the United States. With a total capacity of nearly 10,000 MW in just queued projects, Pennsylvania is spearheading a state-wide shift in natural gas energy sources to solar projects in the coming years. The average project time in development in Pennsylvania currently stands at roughly 3 years, which is on par with many of the other top states for solar in the United States.

The slight tapering of the number of solar projects added to the PJM Queue, and the reason for no solar projects being added to the queue in 2024 is attributable to the fact that since 2021, there has been a notable decrease in the addition of utility-scale solar projects to Pennsylvania's queue, despite the state's overall slow but steady increase in renewable energy production. Although the state tripled its solar production in the last decade, the growth rate pales in comparison to national trends, with the U.S. experiencing a 12-fold increase in solar power during the same period. This sluggish growth contrasts starkly with leading states like Texas, which have built out significantly more renewable power infrastructure. As a result, many projects were withdrawn in the interconnection queue for PJM in Pennsylvania.

Projects Withdrawn from the PJM Queue



The number of withdrawn projects per year have steadily increased in this same light as well. Pennsylvania had implemented numerous state-wide initiatives that increased the accessibility to both community and utility scale solar projects, but this relationship also arises with the number of withdrawn projects. Many solar projects are withdrawn from the interconnection queue in Pennsylvania due to various factors contributing to project delays and uncertainties. One significant reason is the complexity and length of the interconnection process itself, which often involves navigating regulatory requirements, obtaining permits, and securing agreements with utility companies. Additionally, changes in market conditions, such as fluctuations in financing availability or shifts in policy incentives, can impact the viability of projects and lead developers to reconsider their plans.

How is a Utility-Scale solar project submitted to the queue to connect to the Electric Grid?

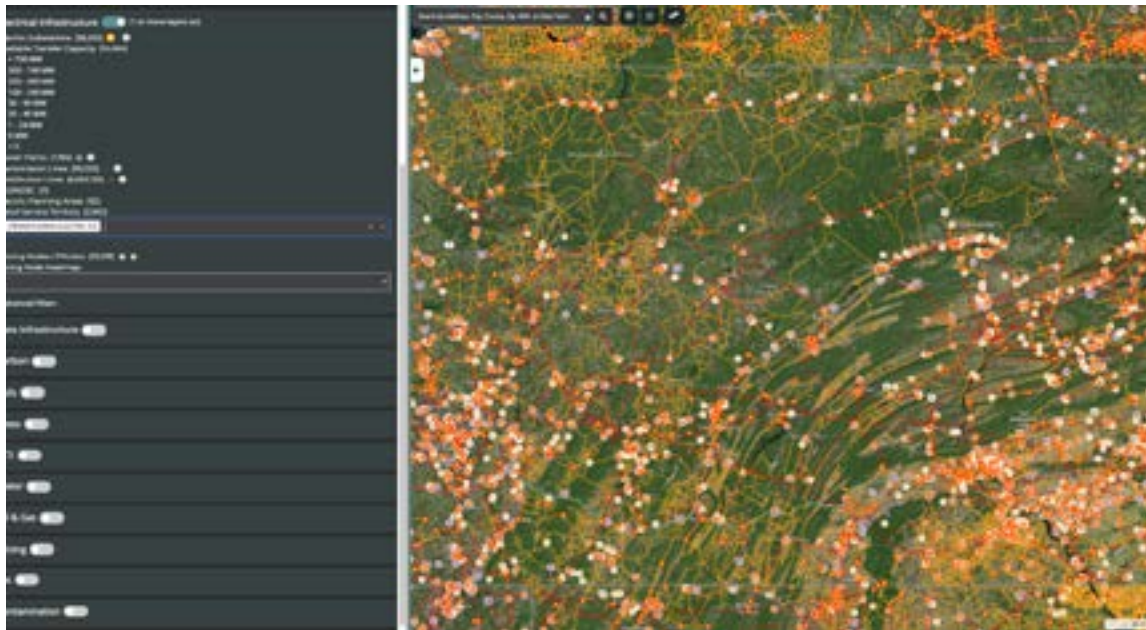
Typically, the queue submission process within an ISO or Utility area follows similar steps.

The solar developer needs to complete and submit an official interconnection request form provided by the ISO or utility, that captures essential project details and starts the interconnection process. Project specifications should include details like name, location (latitude and longitude), point of interconnection, capacity, expected energy production, environmental impact, technology layout-inverters, solar panels, system layout through a Feasibility study with an 8760 report to help initially assess the project's compatibility with the existing grid infrastructure. The Solar developer will also have to pay an initial payment to secure a position in the interconnection queue and contribute towards the cost of initial studies and evaluations conducted by the ISO/Utility. Post the submission of the form, reports and payment,

the project is now effectively in the queue.

After the project has entered the queue, Injection reliability study and system impact study is conducted. These studies determine the exact impact of the project on existing infrastructure and identifies any potential network updates required to reliably interconnect the solar project to the grid. Once the study is completed, the developer gets a complete picture of the financial cost of the solar farm with regards to the complete CAPEX and Budget. This helps the decision making process of whether to move forward with the development of the solar project or withdraw the application from the queue. If the project seems viable to move forward the developer signs an interconnection agreement with the ISO/Utility and essentially looks to produce Economic and Financial reports for Bankers and Investors to help facilitate the construction of the solar project.

How does a Utility-Scale project connect to the Electric Grid?



These projects are interconnected through transmission lines that carry electricity from one point to another in an electric power system grid. These lines are used to transmit electrical power from power generation sources to distribution centers, which are then distributed to end-users. Through LandGate's accessible transmission line data, developers and landowners can evaluate land parcels based on segments & feeders, proximity to existing distribution lines and distribution hosting capacity.

Pennsylvania sees a higher prevalence of currently operating community solar projects compared to utility-scale ones due to a variety of factors. Firstly, the state's policies are tailored to incentivize and facilitate community solar initiatives, offering favorable regulations, financial incentives, and simplified permitting processes to attract developers. Secondly, community solar projects provide accessibility, allowing individuals and businesses to partake in solar energy generation without the need for on-site installations, thus driving greater interest and participation.

Additionally, community solar initiatives benefit from strong community engagement, often involving collaboration among local communities, utilities,

and developers, which fosters support and helps overcome obstacles. Lastly, there's a notable market demand for community solar among residents, businesses, and institutions, driven by factors like environmental consciousness, desire for energy independence, and support for local renewable energy initiatives.

Together, these elements contribute to the proliferation of community solar projects in Pennsylvania over utility-scale installations. (See below: Commercial, Community, & Behind-the-Meter Solar Farms).

Commercial, Community & Behind-the-Meter Solar Farms

Projects Under Development in Pennsylvania

Community Solar Legislation



Community solar is already quite well established in Pennsylvania, with most currently operating solar farms falling under this category. This trend can be attributed to the accessibility and inclusivity of community solar projects, allowing multiple subscribers to benefit from shared solar energy generation. However, there is a notable shift towards utility-scale solar projects in the state's pipeline, as shown before (see Utility Scale Solar). This shift reflects a strategic emphasis on larger-scale solar developments to meet growing energy demands efficiently.

The passage of the Community Solar Act, HB 1842, on March 26, 2024, further solidifies Pennsylvania's commitment to community solar initiatives. The Act establishes third-party-owned community solar programs, setting specific guidelines for facility capacities, subscriber allocations, and billing procedures. With the enactment of this legislation, Pennsylvania is poised to foster a more robust and equitable solar energy landscape, catering to both community-based and utility-scale solar projects while ensuring consumer protections and transparency through oversight by the Public Utility Commission.



PECO Energy Company, a prominent electric and natural gas utility in Pennsylvania, has taken significant steps to promote community solar projects. In June 2023, PECO introduced a novel solar energy incentive tailored for commercial property owners as part of its Act 129 program, which aims to incentivize reductions in electricity usage. This initiative specifically targets “behind-the-meter” solar energy production, offering a financial incentive of \$0.10 per kWh of energy generated based on the property’s first year of annual solar production, minus any excess kWh that surpasses the property’s demand in the same period. This incentive effectively reimburses property owners for a portion of their solar system’s cost, estimated to cover between 4-10% of the total expenses. The combination of this reimbursement with the IRA’s expanded Investment Tax Credit, or Elective Pay for non-tax paying entities, totaling at least 30%, significantly reduces the overall cost of commercial solar projects by 35-40% or more.



Highlights: Notable PECO Solar Projects in PA

Project	Capacity	Description
<p>Lincoln Financial Field</p> 	<p>2.9 MW</p>	<ul style="list-style-type: none"> Owned by NRG Energy Year of commercial operation: 2013 Newly mounted system will generate enough energy to power 10 home games Estimates project that over 20 years the Eagles could save over \$60 million dollars
<p>Ikea Conshohocken Rooftop PV System</p> 	<p>1 MW</p>	<ul style="list-style-type: none"> Owned by IKEA North America Year of commercial operation: 2017 Part of initiative to add solar car parks, additional rooftop solar panels, and battery energy storage systems to 7 IKEA units across the country



PPL, a major energy supplier in Pennsylvania, backs community solar endeavors by facilitating the linking of Small Generation solar projects to the Distribution System. This structure permits the inclusion of modest solar installations into the current distribution network, allowing individuals, businesses, and communities to engage in renewable energy production.




Highlights: Notable PPL Solar Projects in PA

Project	Capacity	Description
<p>Elizabeth Community Solar</p> 	<p>2 MW</p>	<ul style="list-style-type: none"> • Owned by AES Distributed Energy • Year of commercial operation: 2016 • Pennsylvania's largest higher education-sited solar array • Hedges future rising energy costs for Elizabethtown College through a 20-year power purchase agreement
<p>Trexletown North And South Community Solar</p> 	<p>1.9 MW</p>	<ul style="list-style-type: none"> • Generated 512.9 MWh during the 3-month period between September 2023 to December 2023 • Year of commercial operation: 2011 •



FirstEnergy, a significant energy provider in Pennsylvania, supports community solar initiatives by facilitating the interconnection of Small Generation solar projects to the Distribution System. This framework allows for the integration of smaller-scale solar installations into the existing distribution infrastructure, enabling individuals, businesses, and communities to participate in renewable energy generation. By providing the infrastructure necessary for these projects to connect to the grid, FirstEnergy empowers local stakeholders to contribute to the state’s renewable energy goals while fostering a more resilient and sustainable energy landscape in Pennsylvania.

Highlights: Notable FirstEnergy Solar Projects in PA

Project	Capacity	Description
<p>Romark Community Solar</p> 	1.8 MW	<ul style="list-style-type: none"> Owned by Romark Logistics Year of commercial operation: 2011 Utility: PennPower (subsidiary of FirstEnergy)
<p>Knouse Community Solar</p> 	3 MW	<ul style="list-style-type: none"> Owned by Knouse Food Cooperative Year of commercial operation: 2010 Utility: Met-Ed, owned by FirstEnergy
<p>University Park Solar</p> 	1.5 MW	<ul style="list-style-type: none"> Utility: WestPennPower Year of commercial operation: 2018 Provides 1 percent of University Park’s campus electricity needs

Pennsylvania

LMP Data

LMP (Locational Marginal Price) is a pricing mechanism used in wholesale/merchant energy markets to determine the cost of electricity at specific locations (node) within the grid. LMP considers a number of variables, including the cost of generating power, transmission constraints, grid congestion, losses, and load at certain nodes or locations within the electrical grid. The prices at which electricity is bought and sold in the market in real time or on an hourly basis are reflected in its calculation, which is done through market procedures.

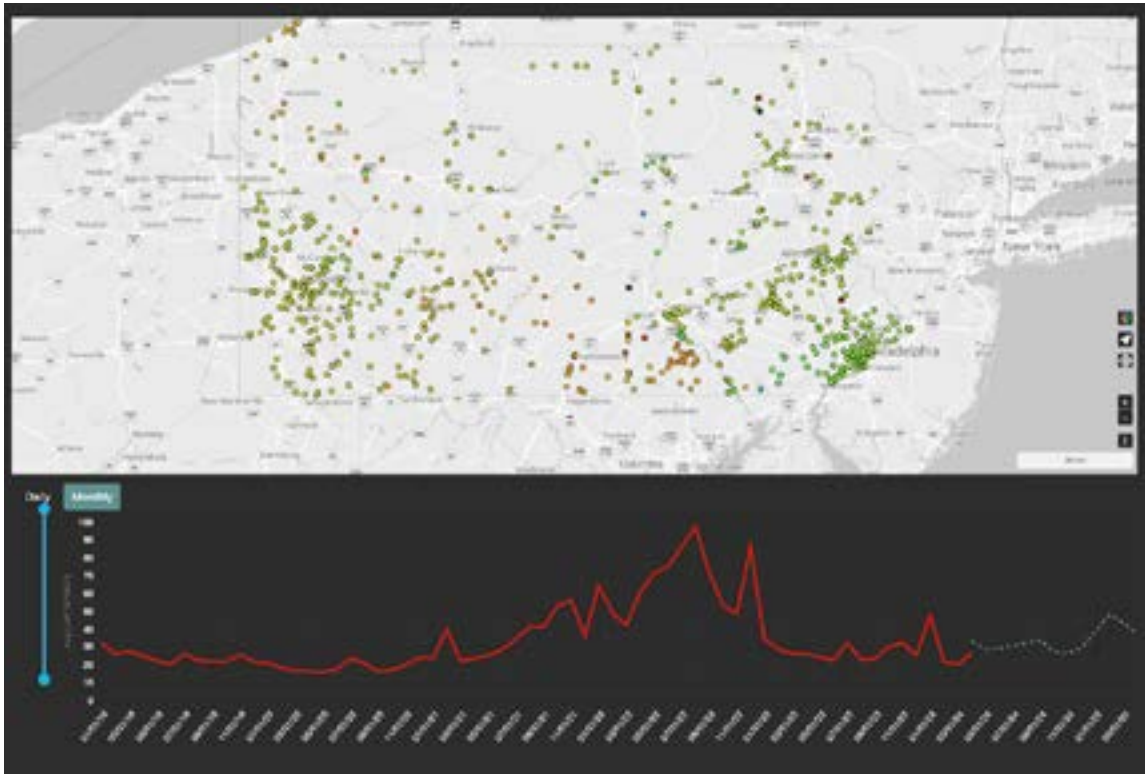
Pennsylvania saw the average LMP price increase by 12.4% in the past 3 years with an average price of \$26.68 \$/MWh in April of 2024. This price is forecasted to increase a further 10.9% in 2024 to \$29.58. Similarly, consumer electricity purchase cost has also increased drastically for the past few years in Pennsylvania. The current commercial electricity rate is 18.12 ¢/kWh which is a 111% increase compared to the commercial electricity

rate of 8.58 ¢/kWh in 2020.

In Pennsylvania, higher Locational Marginal Prices (LMPs) within the energy market could present specific challenges for the state's electricity distribution system. Elevated LMPs may reflect congestion in certain areas of the grid, potentially indicating insufficient transmission infrastructure or imbalances in supply and demand. This congestion could lead to increased costs for consumers, as electricity providers may need to procure power from more expensive sources to meet demand. Additionally, high LMPs may impact the economic viability of renewable energy projects in the state, affecting Pennsylvania's transition towards cleaner energy sources.

Pennsylvania

LMP Scorecard



Merchant Energy Pricing: Market: PJM	
Number of price nodes active:	1,283
Average LMP price as of 04/01/24:	\$26.68
Current commercial electricity rate	18.12¢/kWh
Percentage change in average LMP in the past 3 years (\$23.74 in 2021)	+12.4%
Commercial electricity rate change since January 2020 (January 2022 rate 8.58)	+111%

Average LMP Prices: Historical & Forecasts

Year	Avg LMP Price (\$/MWh)
2019	\$27.18
2020	\$22.56
2021	\$30.07
2022	\$75.22
2023	\$29.95
2024	\$38.71
2025 (est.)	\$36.27
2026 (est.)	\$40.81

Based on the LMP and ISOs data in Pennsylvania, the 2024 average LMP is estimated to be \$38.71/MWh, increasing by 29.2% compared to 2023.

Pennsylvania PPA Data

Utility-scale solar can be integrated into the grid and electricity can be sold at a predetermined price thanks to PPAs (Power Purchase Agreements) with utilities or power purchasers. Even if they are unable to put solar panels on their own homes, PPAs for community-scale solar projects allow local participants to profit from solar energy generation. The time and amount of power sales are governed by the PPA's terms, which guarantees a steady market for the solar installation.

The average Estimated Utility-Scale PPA price in Pennsylvania is \$95.45 \$/MWh. This demand influences PPA prices as developers strive to meet regulatory requirements while remaining profitable. Additionally, limited land availability poses challenges for large-scale renewable projects, increasing costs associated with land acquisition and development, thus impacting PPA prices.

In Pennsylvania, Power Purchase Agreement (PPA) prices are influenced by a diverse array of factors. The state's energy mix, comprising coal, natural gas, nuclear, hydroelectric, and wind energy, along with the increasing competitiveness of renewable sources like wind power due to technological advancements, significantly impacts PPA rates. As Pennsylvania's energy landscape evolves, with a growing emphasis on renewables and technological innovation, the dynamics driving PPA prices continue to evolve, reflecting the complexities of the state's energy market.

Furthermore, Pennsylvania's low development costs have contributed to falling PPA prices. Advancements in solar technology have led to increased efficiency and lower manufacturing costs, making solar panels more affordable to install and maintain. These technological innovations have also improved the overall performance and reliability of solar systems, reducing operational expenses and enhancing long-term cost competitiveness.

Additionally, economies of scale and growing market maturity have contributed to declining PPA prices in Pennsylvania. As the solar industry expands and more projects come online, developers benefit from economies of scale in manufacturing, installation, and project development, driving down overall costs. Moreover, increased competition among solar developers and suppliers has spurred innovation and efficiency improvements throughout the value chain, further driving down PPA prices.

Pennsylvania PPA Scorecard



Average PPA price 2024:	\$95.45 (Utility Scale)
Average Utility-Scale PPA price change in the last 3 years	-41.20%
Largest PPA buyer:	Amazon

Average PPA Prices:

Year	Price (\$/MWh)
2020	\$118.67
2021	\$120.20
2022	\$116.37
2023	\$97.73
2024	\$95.45

Federal & Pennsylvania State Tax Incentives for Solar Developers

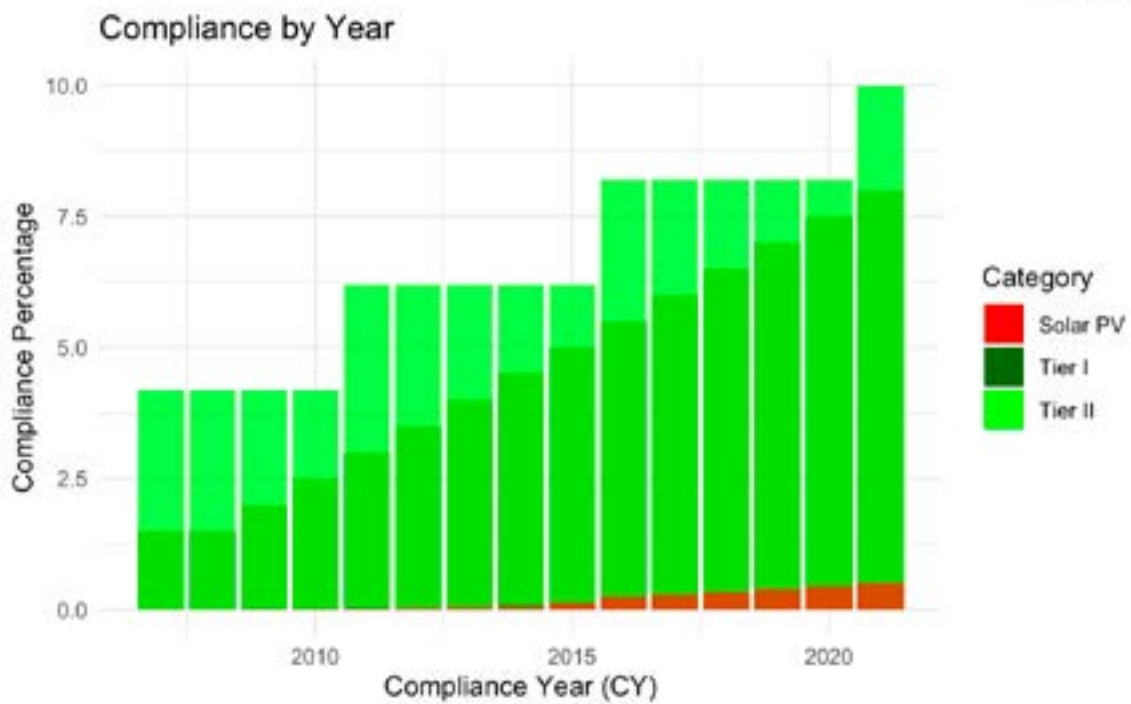
There are several federal and state incentives available for solar development in Pennsylvania, intended to encourage the use of solar energy by making solar power more affordable for businesses and organizations that install solar systems. These incentives can improve the financial viability of solar projects since they lower the initial costs and increase the return on investment. Solar project incentives aid in the switch to clean, renewable energy sources, which lower greenhouse gas emissions and slow climate change. Incentives aid in increasing the deployment of solar projects by making solar energy more financially appealing, replacing fossil fuel-based power and lowering the environmental effects related to traditional energy sources.

PA Solar Development Incentive	Type	About
Federal Solar Tax Credit, Solar Tax Credit (ITC)	Federal	Developers can claim 30% of the installation cost as a credit on their federal income taxes.
Net Metering	State	With net metering, consumers are allowed to get retail credit for the surplus electricity generated from local power systems that are sent back to the grid.
Solar Incentives and Legislation in Pennsylvania	State	<ul style="list-style-type: none"> - Federal and state incentives, including SRECs, drove significant solar development in Pennsylvania. - Until 2017, out-of-state solar systems could participate in the PA SREC market, impacting supply. - In 2017, Act No. 40 restricted eligibility for the PA SREC market to Pennsylvania-based solar systems, potentially affecting previously certified out-of-state systems. - The Pennsylvania Public Utilities Commission is reviewing the Act and will issue an Order on program eligibility soon. - Market SREC's latest bid price is \$33.00.

Inflation Reduction Act	Federal	This bill passed in 2022 and became effective at the beginning of 2023 provides incentives to reduce renewable energy costs for organizations on a business, educational institution, and state level. More specifically, in Pennsylvania, solar energy is eligible for a tax credit.
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NE Additional Key Incentives & Programs (Residential and Commercial)	Type	About
Alternative Clean Energy Program (ACE)	State	Administered by the Commonwealth Financing Authority and relevant departments, provides financial assistance via grants and loans.
High Performance Building Program (HPB)	State	Offers financial support for high performance building projects through grants and loans.

Renewable Portfolio Standard (RPS) Goal: Pennsylvania's Alternative Energy Portfolio Standard (AEPS), established by S.B. 1030 in November 2004, mandates that electric distribution companies (EDCs) and electric generation suppliers (EGSs) supply approximately 18% of electricity from alternative-energy sources to retail electric customers in the state by 2021, divided into 8% from Tier I technologies and 10% from Tier II technologies. Tier I sources encompass various renewable technologies such as photovoltaic, wind, biomass, and geothermal, while Tier II includes a broader range including waste coal, distributed generation systems, and useful thermal energy derived from electricity production, allowing for technologies like combined heat and power (CHP) facilities to qualify.



At the current state level in Pennsylvania, discussions are underway that align with the topics previously outlined. These discussions likely involve policymakers, stakeholders, and experts deliberating on various aspects of the state's energy policies, including renewable energy incentives, regulatory frameworks, and future initiatives.

Looking ahead, several future incentives and initiatives are being considered to further promote renewable energy adoption and address environmental concerns in Pennsylvania. One proposal involves advancing a cap-and-invest program, which aims to regulate greenhouse gas emissions and align with initiatives like the Regional Greenhouse Gas Initiative (RGGI). Additionally, there's the possibility of enacting community solar programs, which would enable broader access to solar power for residents and businesses, particularly those unable to install solar infrastructure on their own properties.

Proposed amendments to the Alternative Energy Portfolio Standards Act are also on the agenda, with a focus on incentivizing the development of local, grid-scale solar projects. This could involve adjustments to existing regulations and incentives to encourage greater investment in solar energy infrastructure within the state. Furthermore, discussions include the potential re-capitalization of the Pennsylvania Energy Development Authority and increasing the borrowing authority for the Redevelopment Assistance Capital Program. These measures aim to provide financial support for energy efficiency retrofits and other sustainable development projects.

In addition to these initiatives, plans are being made to expand funding for various programs aimed at supporting small businesses and promoting energy efficiency. This includes expanding funding for DEP's Small Business Advantage program, which provides grants and technical assistance to help small businesses implement pollution prevention and energy efficiency measures. Similarly, funding for the Small Business Pollution Prevention Assistance Account and DCED's Weatherization Assistance Program is expected to be increased, furthering efforts to enhance energy efficiency and environmental sustainability across Pennsylvania.



With such a wealth of new data on the state of Solar Development in Pennsylvania, we imagine you might have questions about how to apply these trends, data, and tools to your own solar development efforts in Pennsylvania. Our dedicated energy markets team can help walk you through how to access and interpret this information in a way that is relevant to your business needs. Schedule time with our team here to talk one on one.



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