2017 Annual Report

Alternative Energy Portfolio Standards Act of 2004

Prepared by the
PA Public Utility Commission
in cooperation with the
PA Department of Environmental Protection

PENNSYLVANIA PUC PUBLIC UTILITY COMMISSION

pennsylvania DEPARTMENT OF ENVIRONMENTAL PROTECTION

2017 Annual Report
Alternative Energy Portfolio Standards Act of 2004

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Executive Summary

The Alternative Energy Portfolio Standards Act of 2004[1] (AEPS) requires electric distribution companies (EDCs) and electric generation suppliers (EGSs) to ensure that by 2021 at least 18% of the total electricity supplied is generated from qualified alternative energy resources.

The Act identifies the energy resources that are eligible for consideration in the program. These resources are classified into two groups, Tier I and Tier II resources. Additionally, although solar photovoltaic is a Tier I resource, it has a standalone requirement. For each reporting period, the EDCs and EGSs are required to acquire and retire Alternative Energy Credits (AECs) in quantities equal to a percentage of their total retail sales of electricity to their retail electric customers. This percentage gradually increases each year, through 2021. Each successive 12-month reporting year begins on June 1 and concludes on the following May 31, and compliance is monitored during this period. Throughout this report, the terms "reporting year" and "compliance year" are synonymous and used interchangeably.

For the 2017 reporting year (June 1, 2016 through May 31, 2017) the Tier I requirement was 6% of all retail sales, of which at least 0.29% of all retail sales was to come from solar photovoltaic (PV) sources. The requirement for Tier II resources was 8.2% of all retail sales. In 2009, a few more alternative energy resources (as identified in the table in Section 3 of this report) were added to the Tier I group. To account for these additional resources, an annual adjustment to the non-solar portion of the Tier I requirement was added. For this reporting period that adjustment is 0.38% for a total Tier I requirement of 6.38%.

For the 2017 reporting year, all EDCs and all but two EGSs retired sufficient AECs to meet their AEPS requirements.

For the 2017 reporting year, all the EDCs and all but two EGSs met their requirements by acquiring and retiring sufficient AECs. Of the total number of AECs retired, 48.4% of AECs were generated within Pennsylvania and 51.6% of AECs were generated outside Pennsylvania. A more detailed breakdown of the retired AECs is provided in Chart 1, Section 4.

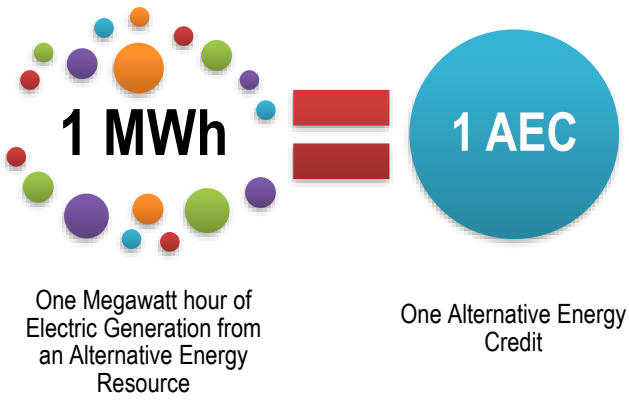
[1] *See generally* 73 P.S. § 1648.1 et seq.

Analysis of the existing and prospective resources, at the end of the program year, suggested that sufficient Tier I, Tier II and PV AECs will be available to meet the AEPS requirements through the 2021 reporting year. However, the AEPS was amended by Act 40 of 2017 that was signed into law October 30, 2017. This amendment may have an impact on the availability of AECs for Solar PV compliance depending on how the amendment is implemented.

1. AEPS Program

The Act requires that EDCs and EGSs obtain a prescribed percentage of their retail electric sales from qualified alternative energy resources. This is accomplished by procuring and retiring an equivalent number of AECs. AECs are a tradable instrument created as the qualified alternative energy resources generate electricity.

AECs are used to track and verify usage of electricity generated from qualified alternative energy resources. ***When an alternative energy resource, located within the PJM footprint, generates one megawatt hour (MWh) of electricity, one AEC is created.*** The AECs are created, serialized, tracked and verified via creation of certificates. The credit certificates are serialized for tracking purposes. The AECs can be used and retired by the generating entity itself, sold, or traded to another entity in the marketplace. PJM Environmental Information Services Inc.'s (PJM-EIS) Generation Attribute Tracking System (GATS) is the PUC designated AEC registry used to track generation, ownership and retirement of AECs. When an EDC or EGS is required to show that a certain percentage of their retail sales includes electricity generated from alternative energy resources, they may purchase AECs from the marketplace and retire them. The retirement of the AECs is necessary to ensure that the same AECs are not used again anywhere, by any other entity, for any other purpose. Retirement of the AECs removes them from the marketplace.



The EDCs and EGSs acquire sufficient amounts of AECs corresponding to the percentage of electricity generated from qualifying resources to meet their AEPS requirement. Pennsylvania EDCs and EGSs are permitted to obtain AECs from resources located within the entire PJM Interconnection, LLC (regional transmission organization) area.[2] Once credits are retired they are no longer

[2] PJM Interconnection, LLC is the regional transmission organization for all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia. http://www.pjm.com/about-pjm/who-we-are/territory-served.aspx.

available for use. AECs are eligible for use during the reporting year in which they were created. If unused, these AECs may be banked for later use during either of the following two reporting years. Unused AECs past their eligibility period ("old") cannot be used for AEPS obligations.

2. AEPS Resources

The qualifying alternative energy resources are grouped into two categories, namely Tier I and Tier II, as shown in the following table.

Alternative Energy Portfolio Standards Resources		
Tier I		**Tier II**
• Solar Photovoltaic (PV) (Solar PV is a Tier I resource but also has a stand-alone requirement)	• Wind power • Low-impact hydropower • Geothermal energy • Biologically derived methane gas • Fuel cells • Biomass energy • Solar thermal • Generation of electricity inside of Pennsylvania utilizing by-products of the pulping process and wood manufacturing process# • Certain muni and coop-owned hydropower#	• Waste coal • Distributed generation systems • Demand-side management • Large-scale hydropower • Municipal solid waste • Generation of electricity outside of Pennsylvania utilizing by-products of the pulping process and wood manufacturing process

#*These were added to the Tier I in 2009. To account for these additional resources, an annual adjustment is added to the non-solar portion of the Tier I requirement.*

Although Solar PV is a Tier I resource, it also has a standalone requirement for each reporting year.

The law establishes a 15-year phased-in schedule to reach the full standard at 18%, after which, the requirements are maintained at this level in perpetuity or until the law is changed.

The Pennsylvania Public Utility Commission (PUC) and the Pennsylvania Department of Environmental Protection (DEP) work cooperatively to monitor the performance of the AEPS program and prepare an annual report, which is provided to the Chairman and Minority Chairman of the Senate Environmental Resources and Energy Committee and the Chairman and Minority Chairman of the House Environmental Resources and Energy Committee.

The law provides for a three-month true-up period that runs from the conclusion of each reporting year until September 1 of the same calendar year. During the true-up period, EDCs and EGSs may acquire any additional alternative energy credits needed for compliance. After the conclusion of the true-up period, the PUC verifies compliance and imposes alternative compliance payments (ACPs), as appropriate, by providing notice of the payment as well an opportunity to challenge whether the ACP was appropriately applied.

The PUC is responsible for carrying out and enforcing the provisions of the law. DEP is charged with rendering determinations of resource eligibility and ensuring that AEPS-certified generating entities are in compliance with applicable environmental laws and standards. The PUC and DEP are charged with monitoring compliance with the Act, the development of the alternative energy market and its associated costs of energy generation and conducting an ongoing alternative energy planning assessment. The PUC and DEP are to report their findings and any recommendations for changes to the Act to the General Assembly via an annual report.

On July 19, 2007, Act 35 of 2007 was signed into law, amending the AEPS by changing the compliance schedule related to solar PV energy. Act 35 also amended other provisions of the law, including definitions for customer-generator and net metering. On December 20, 2008, a PUC rulemaking based on the Act 35 changes became effective.[3]

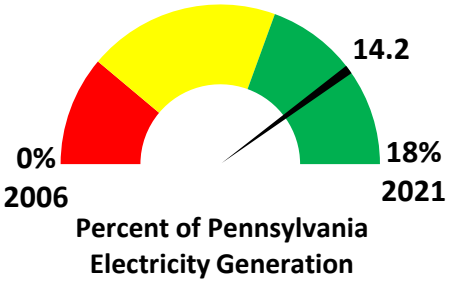
The 2008 final rule provides clarification of the solar PV obligation and includes the revised 15-year schedule for solar PV requirements. The clarification for solar PV obligation affirms that the percentage requirement is a percentage of all retail sales and that the solar percentage is a part of the total Tier I obligation. Table 1 in Appendix A provides an overview of the AEPS percentage sales requirements with the revised solar PV schedule.

[3] *See*, 38 Pa. B. 6908 at https://www.pabulletin.com/secure/data/vol38/38-51/2286.html

Table 1 in Appendix A shows the AEPS percentage sales requirements for each of the 15 compliance years mandated by the law. Appendix B provides general information about the Tier I and Tier II resources.

3. Compliance Summary

As of reporting year 2017, over 14% of electricity sold to retail customers was generated by qualifying alternative energy resources in all Tiers. The program target is to increase this percentage to 18% by reporting year 2021, which ends on May 31 of 2021.

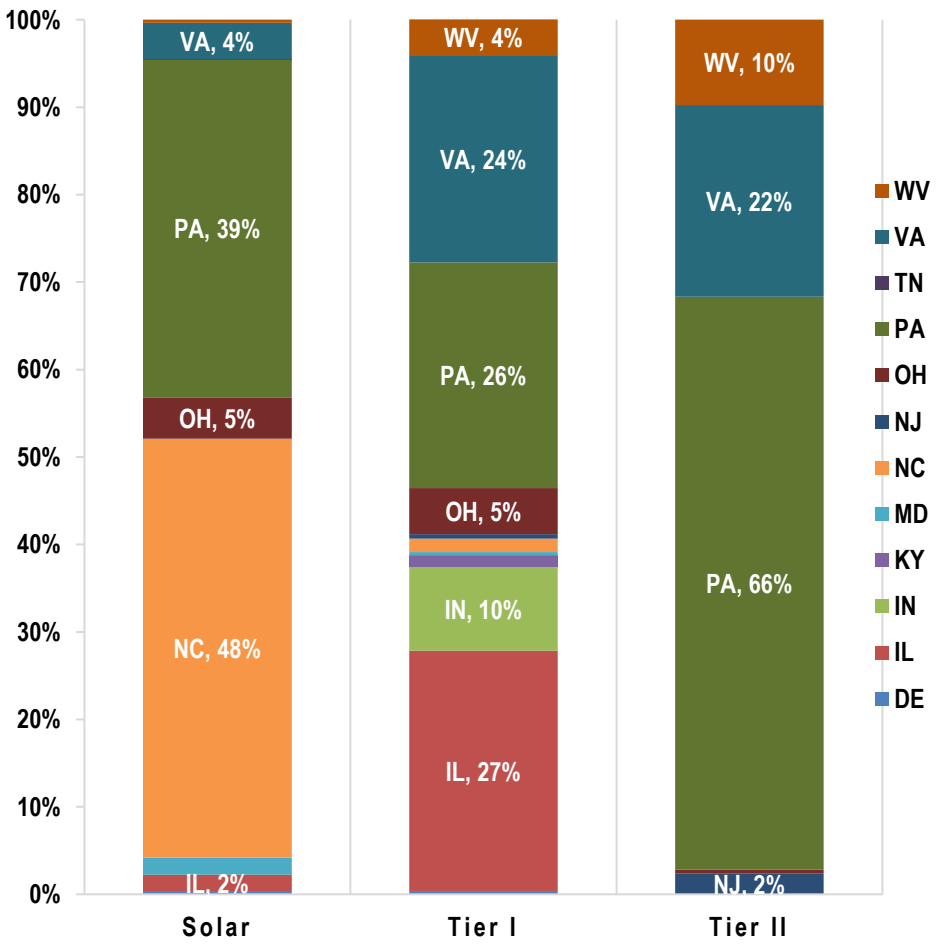


Of all the AECs retired for compliance, 48.4 percent were generated in Pennsylvania and the remaining 51.6 percent were generated from other states in the PJM territory.

Chart 1 shows the percentage of AECs that were retired in Pennsylvania in the 2017 reporting year and their states of origin.

For the Solar PV requirement, 39% of retired AEC credits originated in Pennsylvania, 48% came from North Carolina, 5% came from Ohio, 4% came from Virginia and the other 4% came from several other states.

Chart 1: Percentage of AECs Retired in Pennsylvania in 2017



For the Tier I requirement, exclusive of solar, 26% of retired AECs came from Pennsylvania. Another 27% came from Illinois and 24% came from Virginia.

For the Tier II requirement, 66% of retired AECs came from Pennsylvania. Another 22% came from Virginia and 10% came from West Virginia.

Table 2 in Appendix A shows a summary of compliance for the current reporting year and Table 4 shows the states that generated the retired AECs and the number of AECs.

All EDCs achieved compliance in the reporting year by retiring the requisite number of AECs. Two EGSs did not retire sufficient AECs and paid the required ACPs.

One EDC, Pike County Light and Power Company (Pike County) did not retire the requisite number of AECs by September 1, 2017. On October 3, 2017, Commission staff from the Bureau of Technical Utility Services sent a letter notifying Pike County that it was not in compliance and imposing the required alternative compliance payment. Pike County had fifteen days from the date of the letter to file a petition challenging the non-compliance. On October 18, 2017, Pike County filed a Petition, seeking an extension of its September 1, 2017, compliance deadline for the 2017 reporting year, or in the alternative, modification of the Non-Compliance letter. On December 7, 2018, by Opinion and Order at Docket Number P-2017-2629692, the Commission granted Pike County's petition, extending the compliance deadline and directing Pike County to substitute the required AECs into the correct account to satisfy its reporting year 2017 AEPS Act obligations. On December 19, 2017, Pike County filed a Certificate of Satisfaction confirming it satisfied its obligations consistent with and as required by the Commission's Opinion and Order. By Secretarial Letter dated January 18, 2018, Pike County was notified that Commission staff from Bureau of Technical Utility Services reviewed the certificate of satisfaction filed by Pike County, finding that Pike County complied with Ordering Paragraphs Nos. 2 and 3 of the Commission's December 7, 2017 Order and rescinded the Non-Compliance Letter issued October 18, 2017.

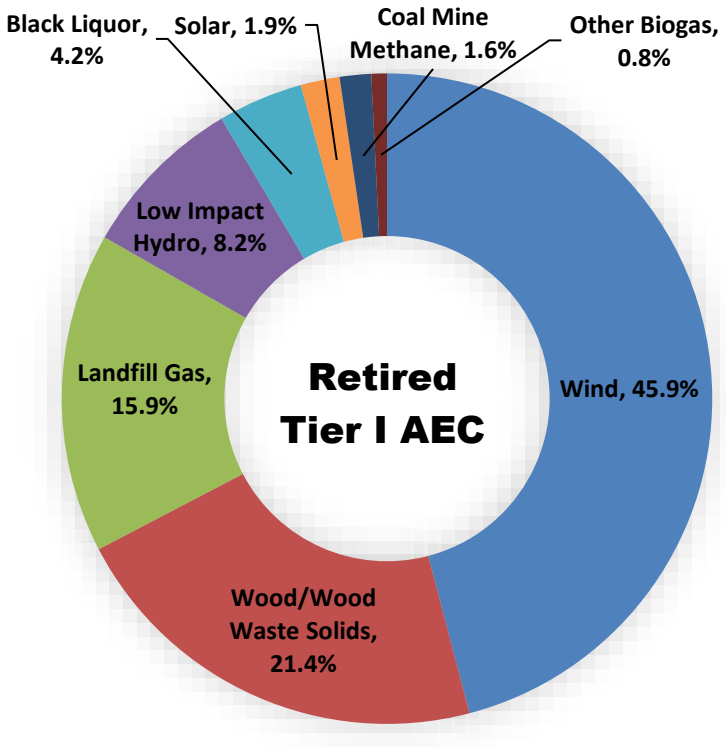
Table 3 in Appendix A presents the details of each EDC's compliance obligation and compliance status for the reporting year 2017. The table presents reporting year data on the number of AECs retired by tier in the EDC territories. Several EGSs retired excess credits beyond the required AEPS obligations and the overages are evident in Table 3 of Appendix A. Because specific EGS sales information is considered proprietary, their numbers were combined and are shown with the appropriate EDC in whose service territory the sales occurred.

During the 2017 reporting year, 11 EDCs and 117 EGSs had compliance obligations. Reporting year 2017 was the first year all EDCs had one or more EGSs providing service in their territories. Many EGSs provide service in more than one EDC territory. When an EGS retires too few or too many AECs, the excess or deficiency is not always connected to a specific EDC service area.

A. Tier I Compliance

Chart 2 shows the resource percentages of Tier 1 AECs retired in the 2017 reporting year. Wind energy produced almost half of the retired Tier 1 AECs, followed by Wood/Wood Waste Solids (biomass energy) and Landfill Gas (biologically derived methane) electricity generation.

*Chart 2: Sources and Percentages of Tier I AECs Retired in Pennsylvania for the 2017 Reporting Year**



*Total does not add to 100% due to rounding and because "Other Gases," at 0.027%, is not represented as it is less than one-tenth of a percent.

a. Solar Compliance

For the 2017 reporting year, the Solar PV obligation was 0.2933 percent. All EDCs and EGSs retired the requisite number of Solar AECs.

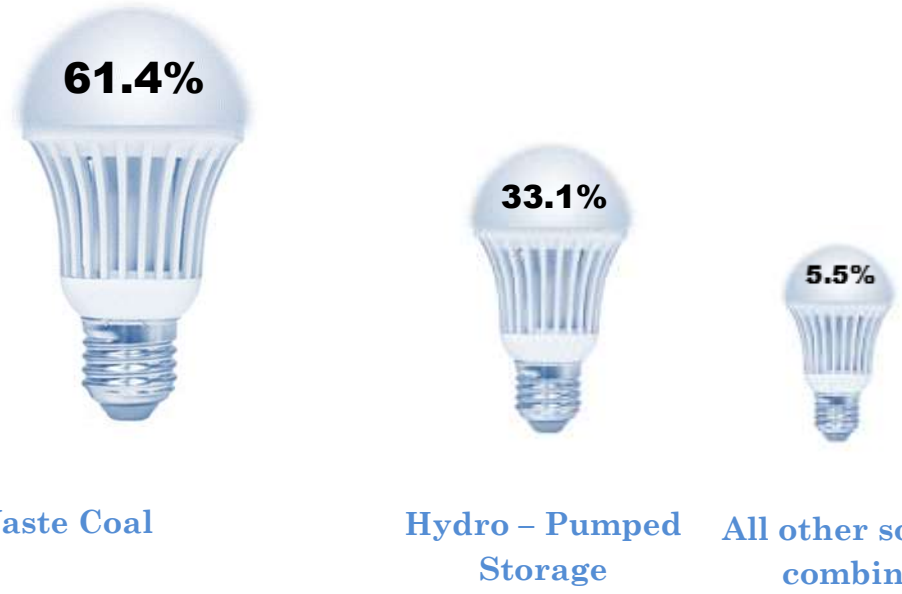
b. Non-Solar Compliance

For the 2017 reporting year, the base obligation for non-solar Tier I was 5.7067 percent. The Tier I quarterly adjustment, impacting only non-solar Tier I, added a quarterly increase of: 0.2848 percent; 0.2771 percent; 0.3982 percent; and 0.5270 percent, in quarters one through four, respectively. This resulted in 537,684 AECs added to the base obligation of 8,075,634. All EDCs and all EGSs achieved compliance by retiring the requisite number of Tier I AECs except for one EGS that paid ACPs to meet its obligations.

B. Tier II Compliance

For the 2017 reporting year, the base obligation for Tier II was 8.2 percent. All EDCs and all but two EGSs achieved compliance in the reporting year by retiring the requisite number of AECs; two EGSs paid ACPs. Chart 3 shows sources and percentages of Tier II AECs retired in Pennsylvania in the 2017 reporting year.

Chart 3: Sources and Percentages of Tier II AECs Retired in Pennsylvania for the 2017 Reporting Year



4. Costs and Benefits of Alternative Energy Generation

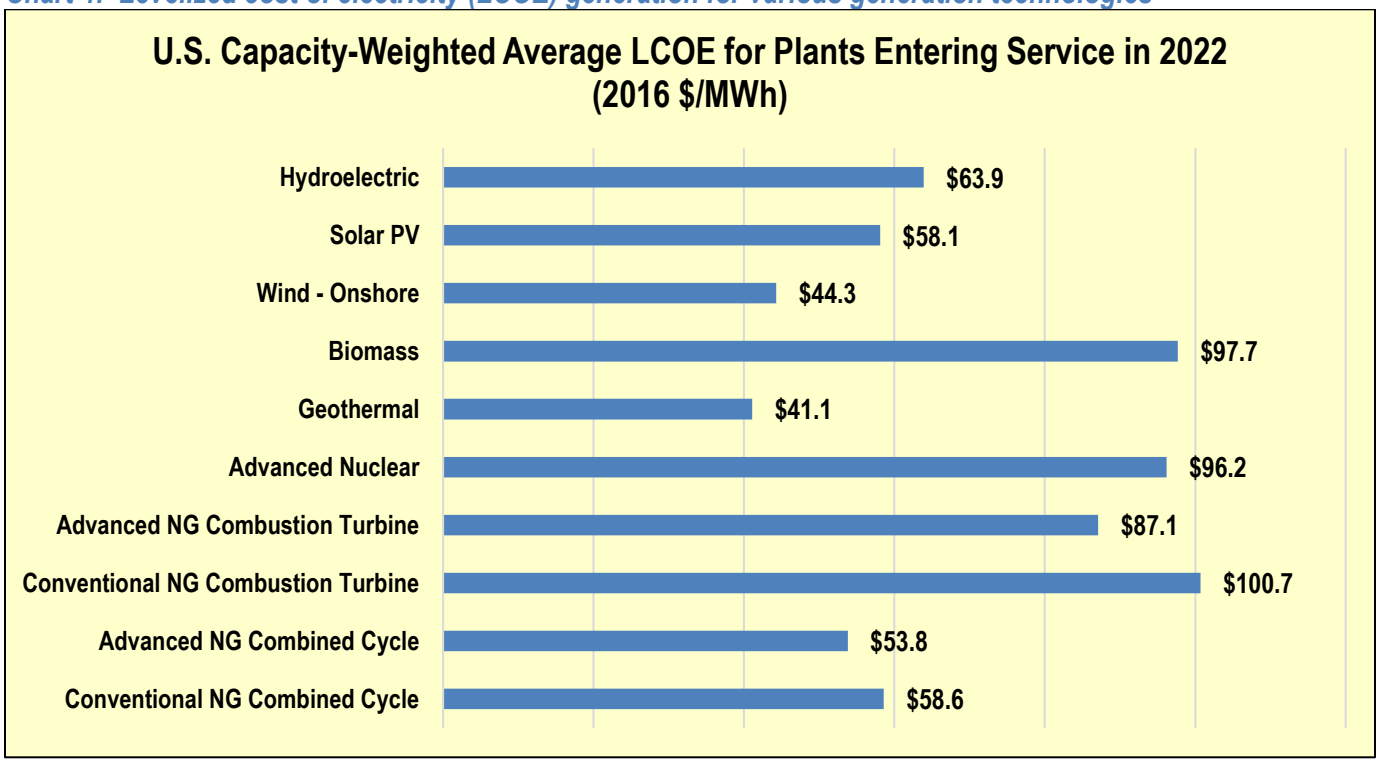
A. Current Estimated Costs of Future Alternative Energy Generation

The United States Energy Information Administration (EIA) provided estimated cost data for the construction and operation of utility-scale generation plants that may be brought online in 2022.[4] The EIA data is used as the most consistently reliable information available. In using this data, 2022 was selected to account for the lead time needed by some technologies to be brought online. EIA uses average data, including capacity factors, from across the country. Chart 4 compares these levelized costs, in 2016 dollars, for differing generation technologies on a dollar per

[4] U.S. Energy Information Administration document titled *Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2017*, April 2017. Available at https://www.eia.gov/outlooks/aeo/pdf/electricity_generation.pdf

megawatt-hour ($/MWh) basis over an assumed financial life of the plant. Levelized cost components include overnight capital costs, construction, operation and maintenance (O&M) costs, and an assumed utilization rate for each plant type. O&M costs include items such as fuel costs, maintenance, insurance, taxes and federal tax incentives, but do not include state or local incentives. EIA notes actual plant investment decisions are affected by the specific technological and regional characteristics of a project and levelized costs are a convenient summary measure of overall competitiveness of generation technologies.

Chart 4: Levelized cost of electricity (LCOE) generation for various generation technologies



B. Future Estimated Statewide AEPS Cost of Compliance

For analytical purposes, the Commission has estimated the statewide costs of AEPS compliance for 2021, the year of maturation for this standard. These cost projections are presented in 2017 dollars, using a six percent discount rate and projected AEC costs. The projected total compliance costs are expected to increase each year as the percentage requirements of alternative energy increase. Two key variables, however, have been shown to have a demonstrable beneficial impact on containing AEPS compliance costs. First, Pennsylvania's energy efficiency and conservation program, known as Act 129, coupled with higher energy efficiency standards for

appliances has curtailed the rate of energy consumption and therefore limits the number of AECs required for annual compliance. Electricity consumption, as reported by Pennsylvania's EDCs decreased from 146,229 gigawatt hours (GWh) in 2015 to 145,022 GWh in 2016, a 0.83% reduction.[5] Second, a large influx of out-of-state solar development that is eligible for use towards AEPS compliance has significantly impacted the solar AEC values in Pennsylvania, suppressing solar credit prices and therefore reducing the cost of compliance. As noted above in Section 1, the passage of Act 40 of 2017 is expected to impact the availability and cost of solar credits.

As shown in Table 5 in Appendix A, the estimated cost of AEPS compliance in 2021, as of the end compliance year 2017, is approximately $103.7 million. This decrease is primarily a reflection of significantly decreased credit price estimates. These estimates are based on monitored market trends and realized credit transactions. To put these figures in perspective, the annual statewide customer expenditures on electric service, across all sectors, was approximately $14.8 billion in 2016.[6] Therefore, approximately $0.007 (seven-tenths of one cent) of every dollar is spent on AEPS compliance. The cost estimates were broken down by the types of AECs, namely Solar, Tier I (non-solar) and Tier II. The AEC prices used in this analysis are based on historical pricing as reported by the AEPS Program Administrator (available on the PUC's website), as well as the results of EDC default service solicitations, with preferential weighting given to more recent solicitation results, and some assumptions as to the potential credit pricing into the near future.

C. Renewable Energy Economic Benefit – Jobs, Exports, Wages

Economic benefits associated with the development and deployment of renewable and alternative energy sources was a significant consideration in support of the passage of the AEPS. Since its inception, the AEPS has resulted in sustaining and creating thousands of jobs and business ventures associated with all aspects of renewable and alternative energy generation.

The *Clean Jobs Pennsylvania 2017* report cites that Pennsylvania has a renewable energy workforce of more than 10,062. The companies supporting these jobs are typically small businesses of 25 or fewer employees. The report also states that

[5] Electric *Power Outlook for Pennsylvania, 2015-2020,* http://www.puc.pa.gov/General/publications_reports/pdf/EPO_2017.pdf

[6] *See* U.S. Energy Information Association – Electric Power Annual 2015, published November, 2016, Table 2.9 http://www.eia.gov/electricity/annual/

55,513 Pennsylvanians are employed in the energy efficiency sector, a Tier II resource of the AEPS.[7]

In reporting year 2017, approximately 52 megawatts (MW) of solar-electric generating capacity was installed in PA, which brought the in-state total capacity to 285 MW. These installations, across Pennsylvania, at private residences, businesses and institutions help sustain a Pennsylvania workforce of slightly more than 3,800 that are engaged in all aspects of the solar industry, including manufacturing, sales, distribution and installation of solar power components and systems and related support services. Job growth in this sector increased 26 percent from the previous year. Nationally, the average hourly wage for those engaged in the actual installation of solar energy systems is $26, while wages are higher still for those involved in the installation of utility-scale solar farms.[8] Even beyond rooftop solar, Pennsylvania has abundant opportunities for solar development that exclude green spaces, including locations such as abandoned mine lands, closed landfills and parking lot/garage canopies.

As of the end of 2016, Pennsylvania ranked 18th in the country for installed wind capacity (1,369 MW) and 18th in the country for the number of wind turbines (726 installed); enough generation to power about 321,000 homes.[9] The 39.6 MW Ringer Hill Wind Farm in Somerset County was completed in December 2016. Iron Mountain Incorporated announced in April 2017 that its Data Center business is one hundred percent powered by renewable energy from this wind farm. This wind farm serves its data centers in three states, including Pennsylvania. Iron Mountain stated that the shift to wind power helps reduce their environmental impact and operating cost and provides long-term utility price stability and a carbon-neutral solution for its data center customers.[10] Additionally, Pennsylvania supports a number of wind energy jobs. For 2016, the American Wind Energy Association (AWEA) reports the total number of direct and indirect jobs supporting the wind industry in Pennsylvania was approximately 1,656.[11] This includes jobs at 27 in-state manufacturing facilities. More information about these facilities can be found on AWEA's new wind industry map.[12] Additionally, wind farm development employs hundreds of people and each wind farm typically requires a small, permanent crew of up to 15 people to oversee the maintenance and continued

[7] Clean Jobs Pennsylvania 2017 - https://www.e2.org/wp-content/uploads/2017/08/CleanJobsPennsylvania2017.pdf
[8] *National Solar Jobs Census 2016*, The Solar Foundation, available at: http://www.thesolarfoundation.org/
[9] American Wind Energy Association, *Pennsylvania Wind Energy*
[10] http://www.ironmountain.com/about-us/news-events/news-categories/press-releases/2017/april/iron-mountain-data-centers-offer-customers-100-percent-renewable-energy
[11] Clean Jobs Pennsylvania 2017 - https://www.e2.org/wp-content/uploads/2017/08/CleanJobsPennsylvania2017.pdf
[12] American Wind Energy Association, http://gis.awea.org/arcgisportal/apps/webappviewer/index.html?id=eed1ec3b624742f8b18280e6aa73e8ec

operation of the turbines. AWEA reports that every megawatt of installed wind generating capacity creates $1 million in economic development. Per AWEA, the total capital investment in Pennsylvania associated with wind power development is nearly $3 billion.[13]

During the 2017 compliance year, the Federal Energy Regulatory Commission (FERC) issued licenses authorizing the construction of three run-of-river hydropower projects, with an aggregate nameplate capacity of 53 MW, in the Allegheny and Ohio Rivers of Pennsylvania. During this same time period, FERC issued two preliminary permits for 449 MW of pumped storage hydropower capacity and had an additional 18 pending preliminary permits for pumped storage hydropower projects. Preliminary Permits are valid for three years to allow project developers to further study the merits of potential projects prior to and if a project advances to the full permit stage. In total, Pennsylvania has nearly 2,700 MW of FERC-licensed hydropower generating capacity with nearly half of that total coming from two pumped storage hydropower projects. During the 2017 compliance year, the generation from non-pumped storage hydropower resources was slightly more than 2.4 million MWh or enough to power about 240,000 homes. Supporting the growth of hydropower in Pennsylvania and globally are two of the world's largest turbine manufacturers, Voith Hydro and Weir American Hydro, both headquartered in Pennsylvania. According to the National Hydropower Association, approximately 325 Pennsylvania businesses are part of the hydropower supply chain. The largest of these businesses is Voith Hydro whose York County manufacturing facility employs more than 550 people. Given the attention to large-scale hydropower, it is important to note that there is interest in the significant potential to develop low-impact hydropower resources, many of which can simply take advantage of existing infrastructure. Analysis of a 2014 study issued by the Oak Ridge National Laboratory indicates that more than 600 MW of potential hydropower could be developed at sites with existing water control infrastructure.[14] An earlier Navigant Consulting study indicates that for every 1 MW of hydropower generating capacity developed, the equivalent of 5.3 full-time jobs is created.[15] The passage of the federal Hydropower Regulatory Efficiency Act of 2013 helps to streamline some of the FERC permitting/licensing requirements for smaller hydropower projects and may help facilitate the development of smaller projects in Pennsylvania.

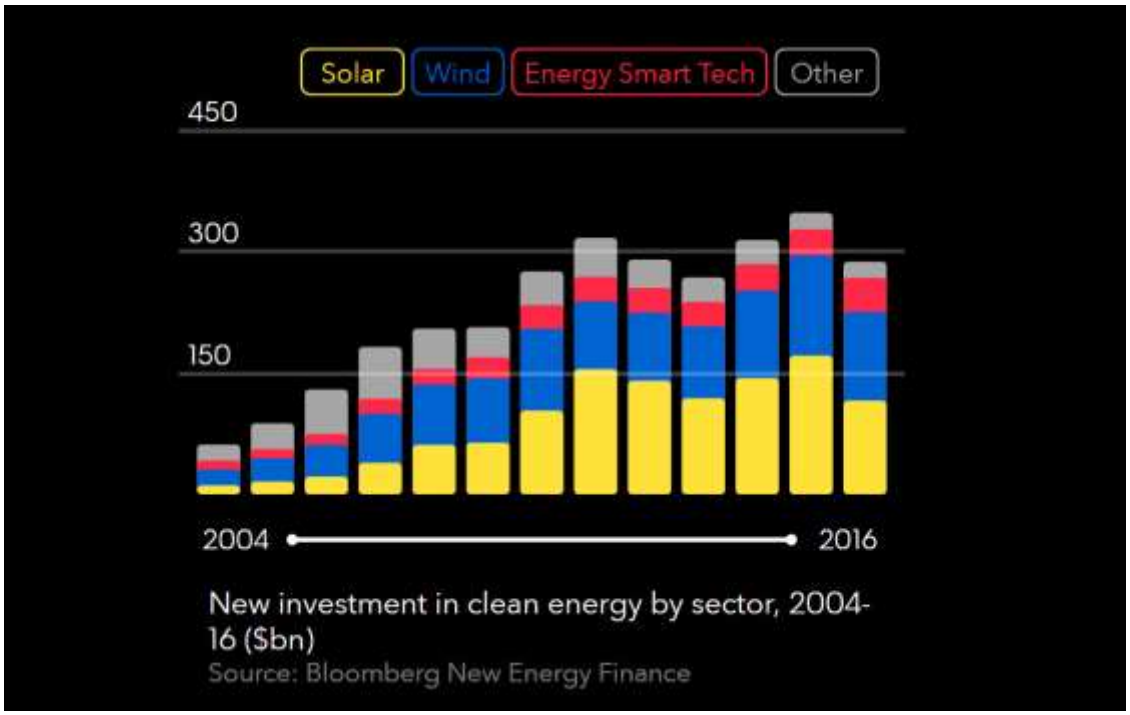
[13] American Wind Energy Association, *Pennsylvania Wind Energy*
[14] *New Stream-reach Development: A Comprehensive Assessment of Hydropower Energy Potential in the United States, 2014*
[15] *Job Creation Opportunities in Hydropower, 2009*

Pennsylvania continues to invest in renewable and alternative energy projects. In the 2017 reporting year, the Commonwealth Financing Authority approved more than $10.1 million in loans and grants to twelve alternative and renewable energy projects. The project types funded include hydropower, anaerobic digesters, landfill gas and CHP projects. Funding was not available from the Pennsylvania Energy Development Authority (PEDA) during this time. However, 19 of 21 approved projects from 2014 are now in full operation; the two remaining projects are currently under construction. For the 21 projects from 2014, the total anticipated savings / generation benefits equal 85,843,883 kWh/yr. Projected carbon dioxide emissions reductions from the projects are approximately 55,369 tons each year.

5. Market Trends

The renewable energy industry is becoming one of the most transformative sectors of the global economy. Through technology improvements, cost declines, new financing structures, and regulatory policy, the sector has driven economic growth around the world including in the United States. Chart 5 shows the new global investments in clean energy from 2004 through 2016. Investments in clean energy projects totaled 287.5 billion dollars in 2016, which was 18% lower than the investment in 2015.

Chart 5: New Investment in Clean Energy by Sector (2004-2016)

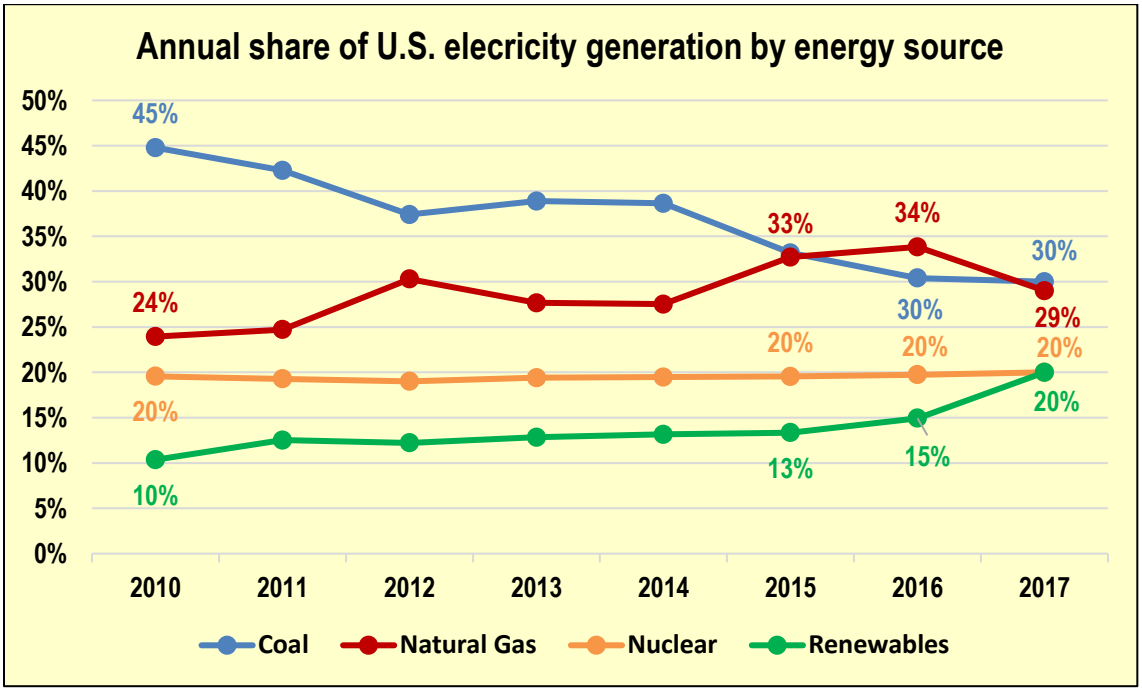


Globally, in 2016, almost 165 gigawatts (GW) of renewable energy production capacity came online.[16]

The United States ranks second in the world for renewable energy capacity. Wind power generating capacity now slightly edges out conventional hydropower generating capacity as the largest renewable resource in the U.S. Chart 6 shows the average yearly U.S. electricity generation by energy source.

[16] International Energy Agency, *Renewables 2017, Analysis and Forecasts to 2022*.

Chart 6: U.S. Electricity Generation by Energy Source



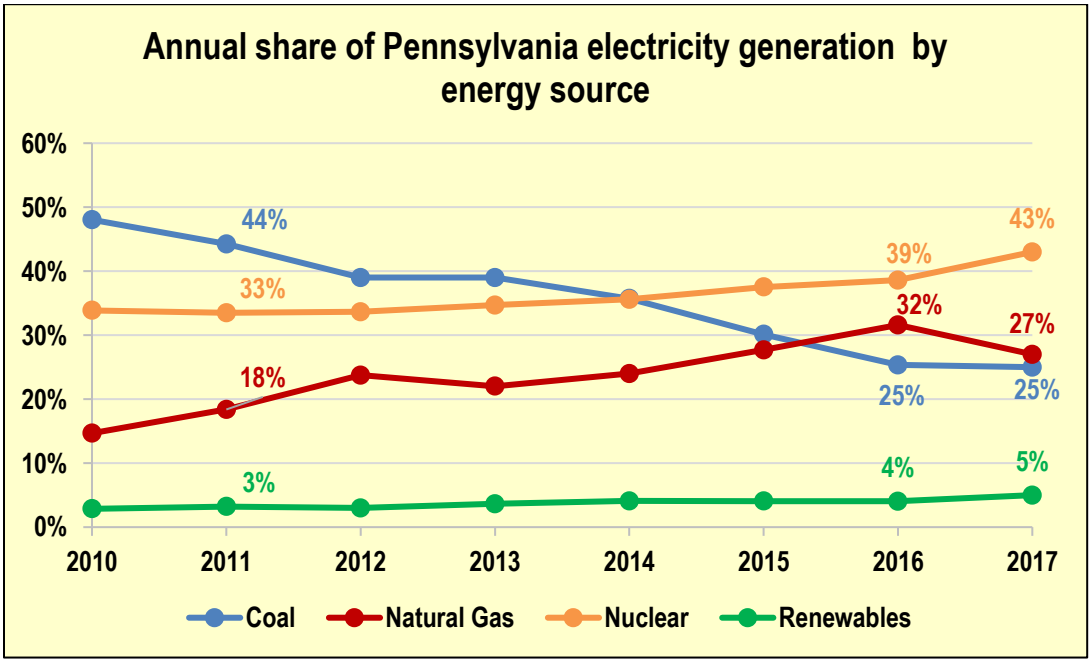
Source: ***Energy Information Administration Electricity Data Browser***

(Note: For 2017, only data for first half of the year is included)

Pennsylvania's AEPS, which requires that 18% of electric power sold in the state come from cleaner alternative energy sources like wind, solar and hydropower by 2021, has also helped to grow the renewable energy industry, while providing cleaner energy options to the state's businesses and homeowners. More than 1,300 megawatts of wind power at 24 wind farms have been installed as of the end of 2016 and has brought over $2.8 billion in capital investment into the state.[17]

[17] https://www.awea.org/state-fact-sheets

Chart 7: Pennsylvania Annual Electric Generation by Energy Source



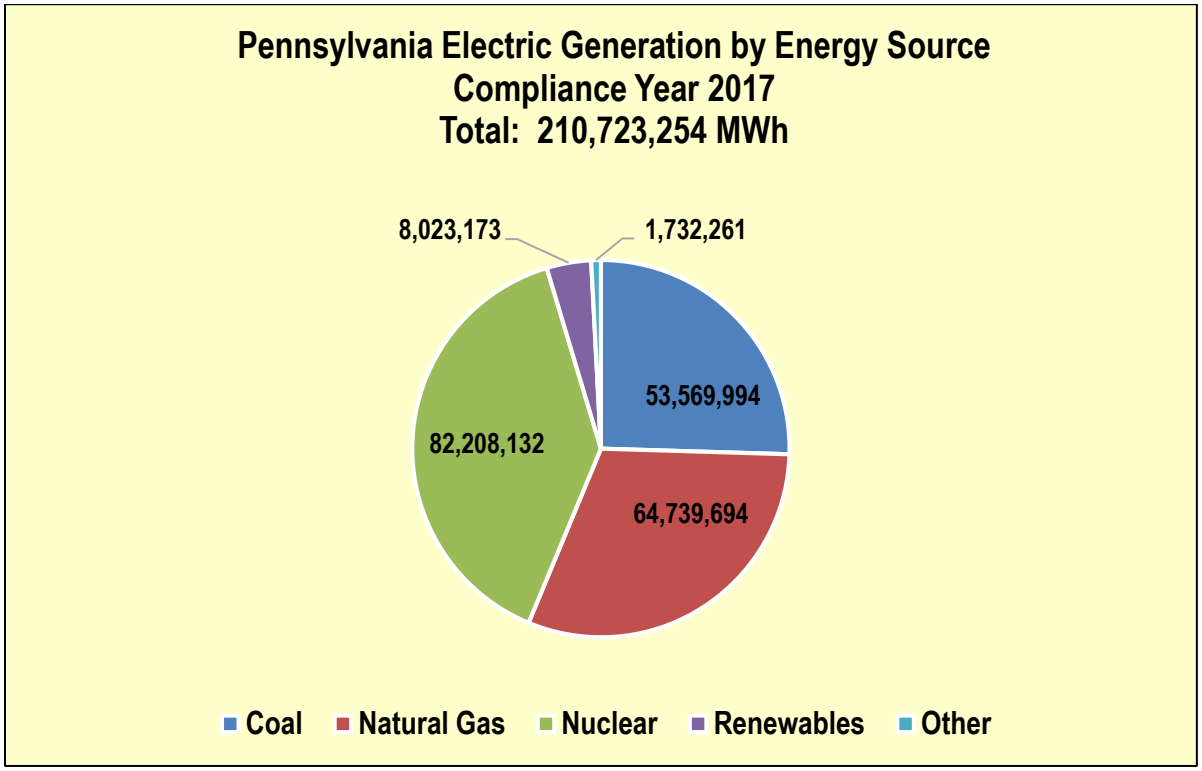
Source: ***Energy Information Administration Electricity Data Browser***
(Note: For 2017, only data for first half of the year is included)

Chart 7 shows the annual Pennsylvania electric generation by energy source. In 2017, approximately 5% (semi-annual data) of the state's electricity generation was from renewable energy sources.[18] The chart mimics the general trends in the U.S. electricity generation (Chart 6), where electricity generation from coal is steadily decreasing and natural gas electricity generation steadily increasing. While U.S. electricity generation from renewable sources has grown, Pennsylvania's electricity generation from renewable sources has not kept pace. A major reason for this is that the broad geographic scope of the AEPS allows for compliance to come from credits generated from out-of-state resources.

Chart 8 shows the breakdown of the total electricity generation in Pennsylvania by source for the compliance year 2017.

[18] Energy Information Administration Electricity Data Browser

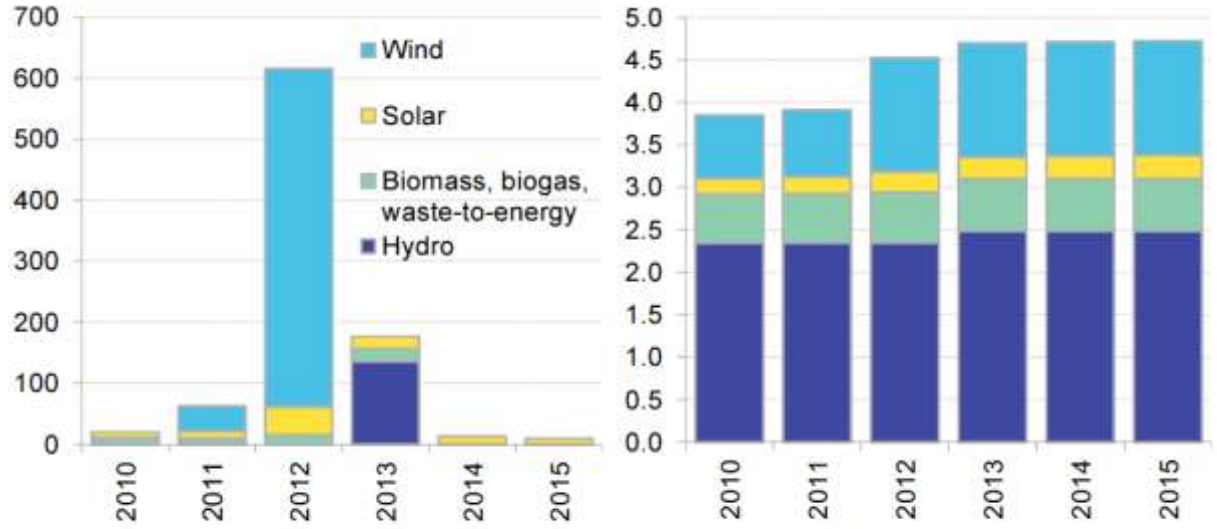
Chart 8: Pennsylvania Compliance Year Electric Generation by Energy Source



Alternative energy policy and federal policies such as the Business Energy Investment Tax Credit (ITC) and the Renewable Electricity Production Tax Credit (PTC) helped accelerate renewable energy investments and developments in the United States. The PTC for wind and the ITC for solar were extended at the end of 2015. The tax credits include an eventual decline in value for both technologies with the PTC for wind expiring in 2020 and the ITC for large-scale solar declining from 30% to a permanent 10% and expiring for residential projects in 2022.[19] Any policy changes affecting the incentive programs, either positively or negatively, may have an almost immediate impact on the market's attractiveness and AEC prices for solar and wind.

[19] http://www.eia.gov/todayinenergy/detail.php?id=29492&src=email

Chart 9: PA Renewable Capacity Additions and PA Renewable Capacity – 2010-2015 (MW)



Source: Bloomberg New Energy Finance, EIA Note: includes BNEF data on distributed (ie, residential, commercial, and industrial) solar capacity.

As shown in Chart 9, from 2010 – 2015, Pennsylvania added 836 MW of utility-scale renewable energy capacity, including 596 MW of onshore wind and 138 MW of hydropower. In addition, 155 MW of commercial and industrial and over 70 MW of residential solar PV was installed in PA by the end of 2015.[20]

A. Solar

In the second quarter of 2017, approximately 2,387 MW of solar PV was installed in the U.S. bringing the total installed capacity of solar electricity generation to 47,100 MW, enough to power 9.1 million average American homes. This is an 8% increase over the same period last year, and the industry is on track to install more than 12 GW of solar capacity by the end of 2017.[21]

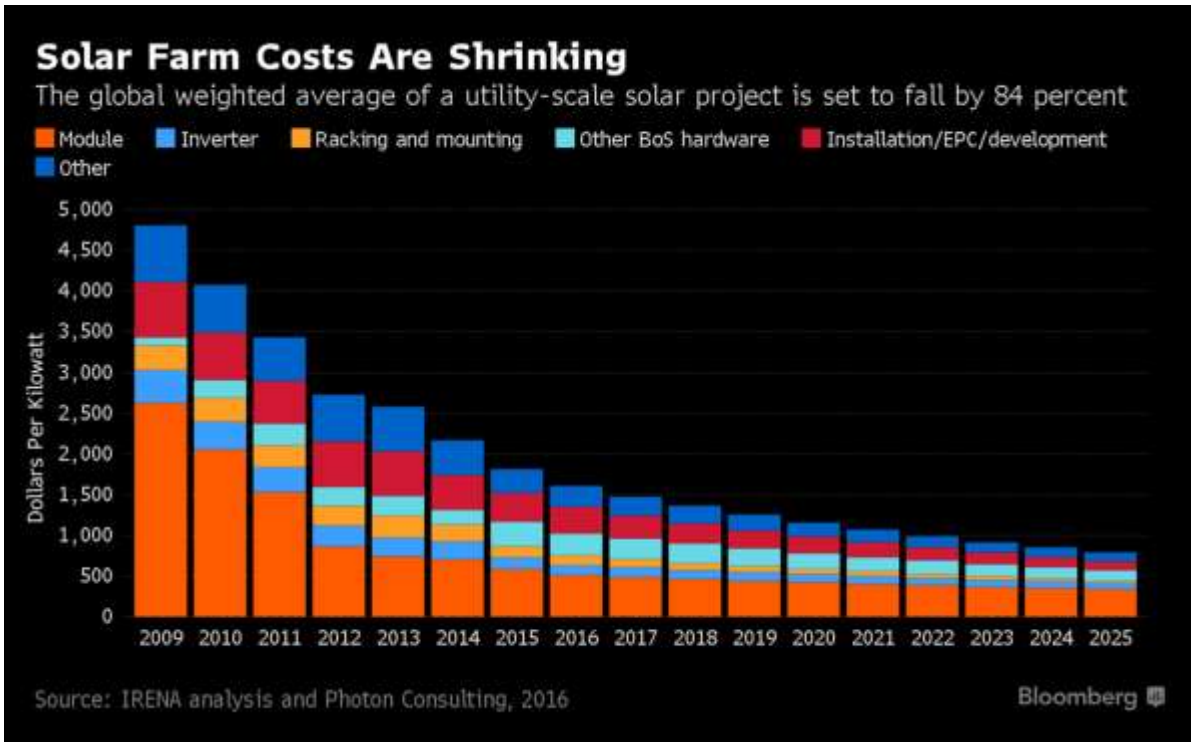
Nationally and within the PJM service area, the rapid growth in solar capacity has been driven by utility-scale and commercial projects, particularly in states with very favorable incentives.[22] Conversely, Pennsylvania has been realizing significant growth in the number of residential solar installations. Nationally, the non-residential sector grew 31% year-over-year. [23]

As shown in Chart 10, since 2009, solar prices are down 62 percent globally, with costs decreasing in every part of the supply chain and projected to continue to fall

[20] Bloomberg New Energy Finance and Business Council for Sustainable Energy, State energy factsheet: Pennsylvania
[21] https://www.seia.org/us-solar-market-insight
[22] Bloomberg New Energy Finance, United States country profile.
[23] https://www.seia.org/research-resources/solar-market-insight-report-2017-q3

through 2025.[24] In the first two quarters of 2017, the installed system cost for a fixed-tilt utility-scale system was under $1/Wdc.[25] Solar panels produce direct current (DC) and are rated in terms of the power output expressed in watts(W). In many cases, system cost is expressed as $/Wdc(direct current watts).

Chart 10: Solar Farm Cost Trend



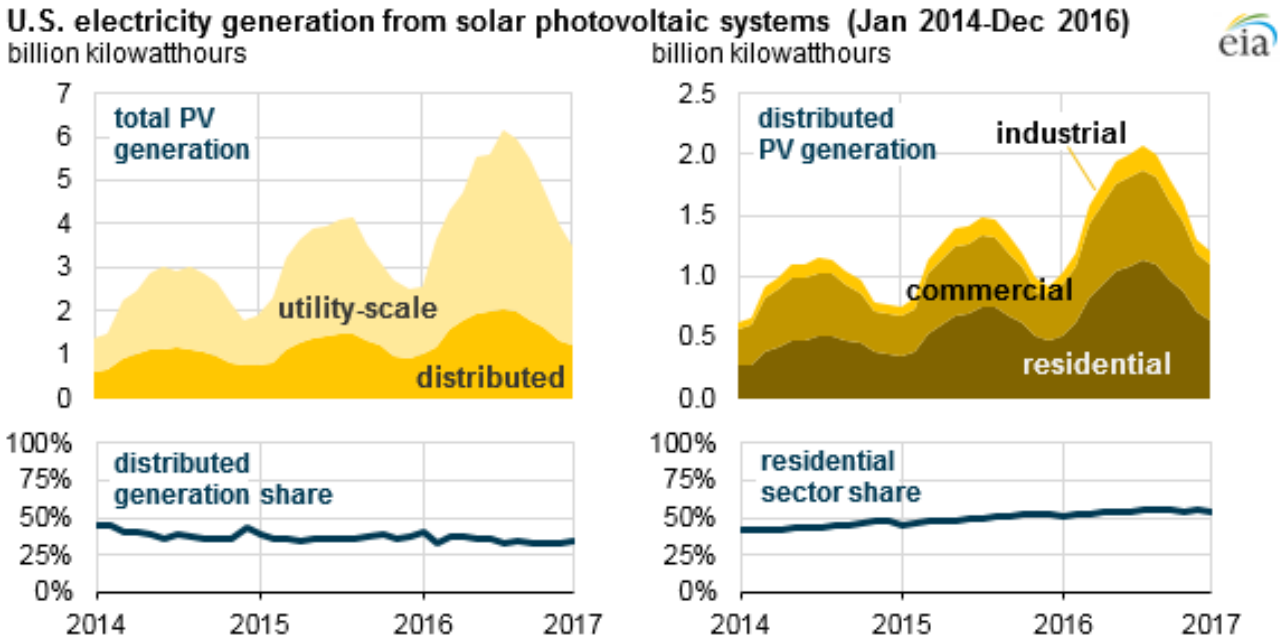
As of October 2016, the United States had a total of 12.6 GW of distributed solar PV installed at customer locations. Of this capacity, 56% was in the residential sector, 36% in the commercial sector, and 8% in the industrial sector. It is important to note that technologies such as solar and wind are non-dispatchable and generate power only when the respective resources are available (sun shining or wind blowing). Therefore, the capacity factors[26] for these resources are typically lower than those of the other resources.[27] Per EIA data, in 2015 the capacity factor for utility scale solar was 25.8%.[28] In Pennsylvania, 15% is a more realistic capacity factor. Adding energy storage to these resources does not increase the capacity

[24] https://www.bloomberg.com/news/articles/2017-01-03/for-cheapest-power-on-earth-look-skyward-as-coal-falls-to-solar
[25] https://www.seia.org/research-resources/solar-market-insight-report-2017-q3
[26] A ratio of the actual power output for a time period to the maximum possible power output if the plant was operating at full name plate capacity for the same time period.
[27] U.S. Energy Information Administration, Electric Generators Report - 2016
[28] U.S. Energy Information Administration Electric Power Monthly - https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_b

factor, but it does allow for more consistent and reliable dispatching of these resources.

Chart 11 below shows the U.S. electricity generation from utility-scale and distributed solar photovoltaic systems. The chart also shows the sector specific distributed PV generation.

Chart 11. U.S. electricity generation from solar PV systems (billion kWh)



Source: *U.S. Energy Information Administration, Monthly Electric Utility Sales and Revenue*

In Pennsylvania, 311 MW of solar electric capacity has been installed as of the end of the first quarter of 2017. $102 million was invested in Pennsylvania in 2016 for solar installations, and approximately 36,000 homes are powered by electricity from solar energy.[29]

As of the end of the compliance year, Chart 12 shows that most of the solar installation in Pennsylvania are in the residential and commercial sectors. Chart 13 shows the top five counties for solar installations and Chart 14 shows the percentage of retired solar AECs used for AEPS compliance that originated in Pennsylvania. 2017 data shows a significant reduction in the number of retired solar AECs that originated in Pennsylvania.

[29] Solar Energy Industry Association (SEIA) - http://www.seia.org/state-solar-policy/pennsylvania. The installed capacity reported by SEIA, which is included here for reference, is higher than the number reported by the state AEPS administrator.

Chart 12: Number of Distributed (≤5 MW) PA Solar Installations Through May 31, 2017[30]

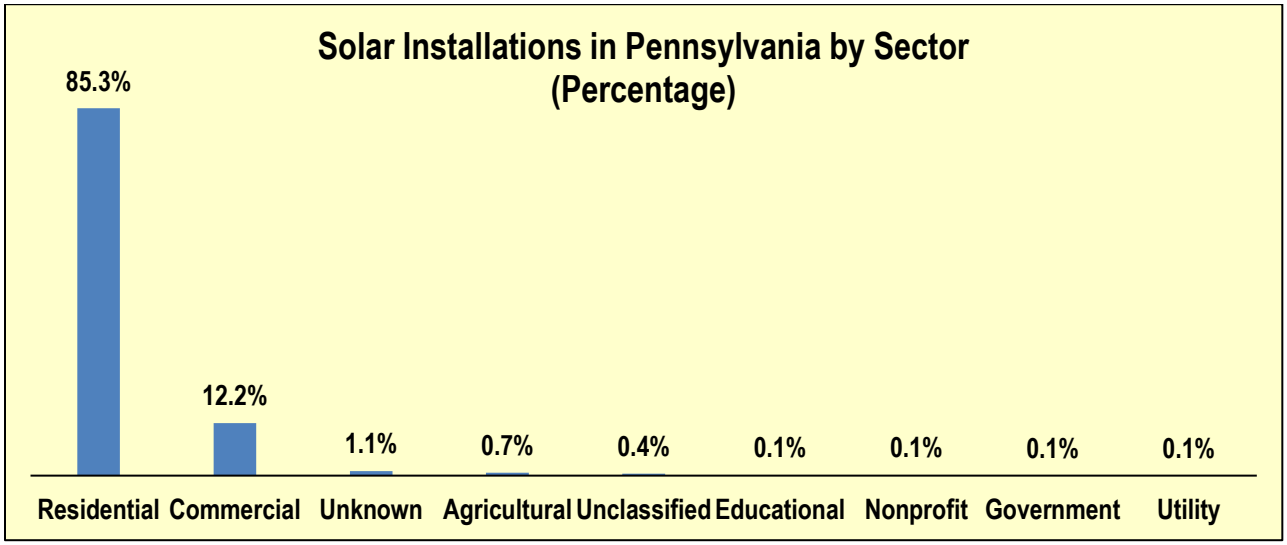
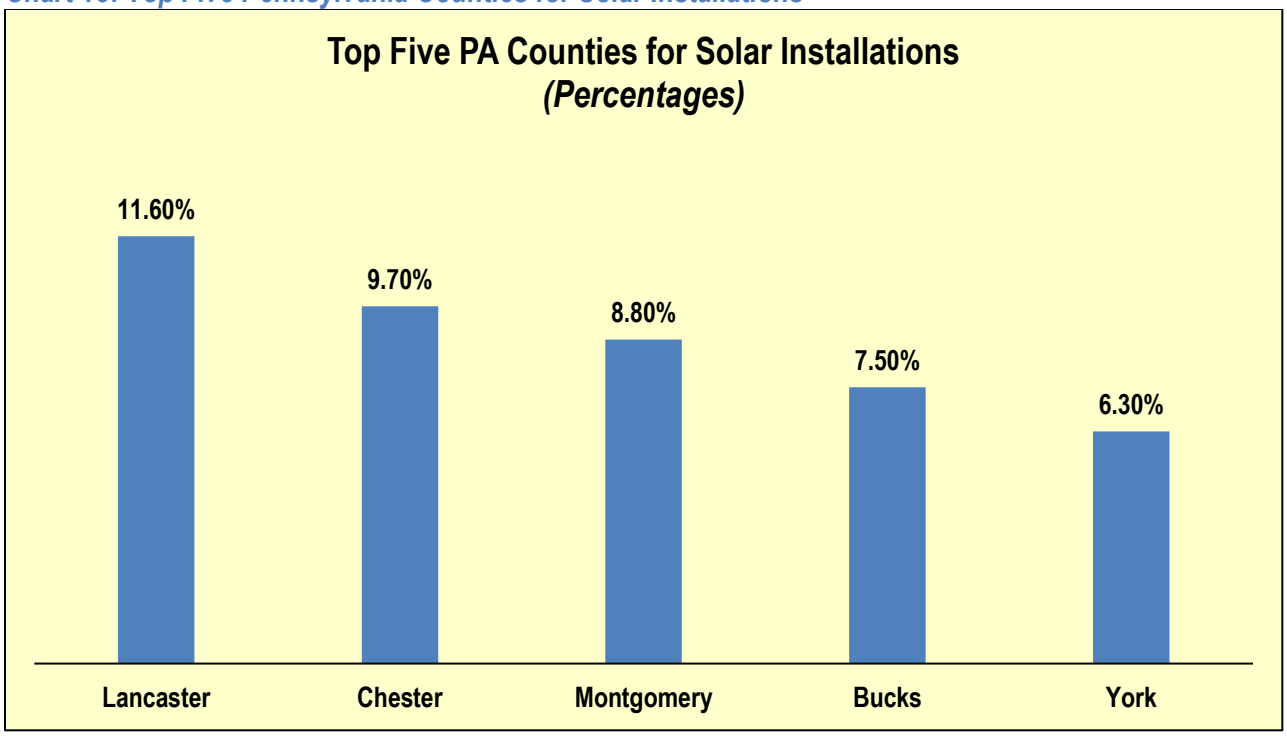
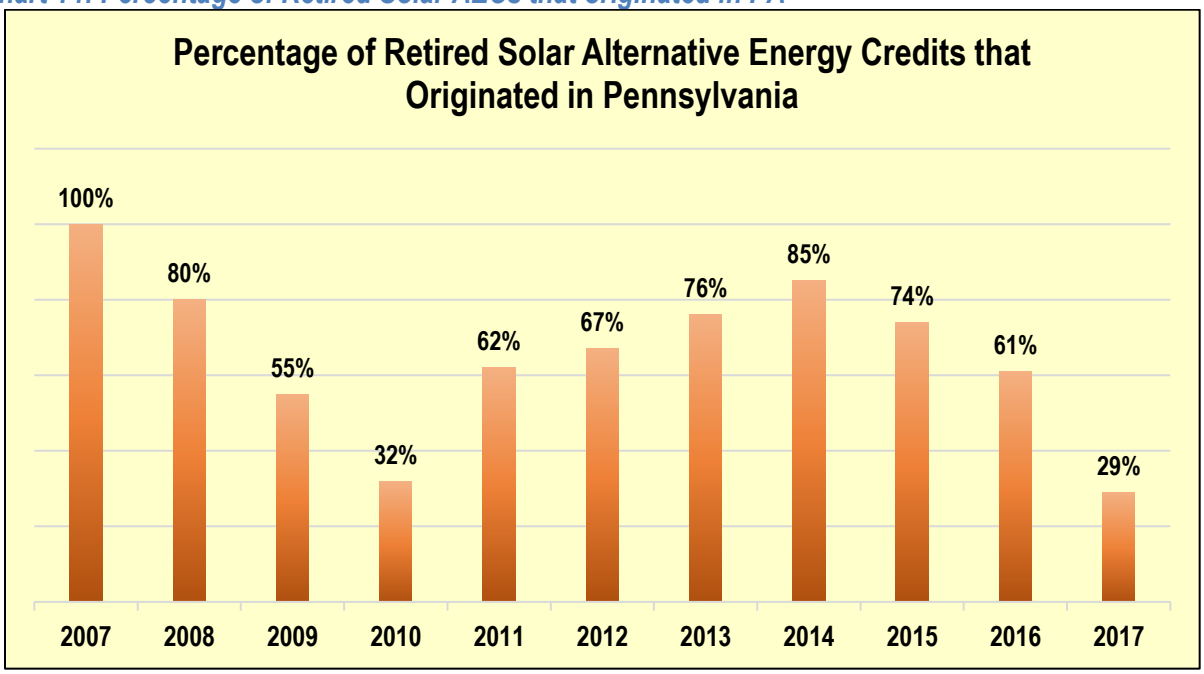


Chart 13: Top Five Pennsylvania Counties for Solar Installations



[30] Charts 12 and 13: NREL Open PV Project- https://openpv.nrel.gov/. There is a lag in the data reported by NREL. As of the end of the compliance year, Pennsylvania's AEPS administrator reported a total of 13,342 solar installations in the state where as the NREL data represented above is based on 11,408 installations. The NREL data is included in this report to show the leading sectors and counties for solar installations.

Chart 14: Percentage of Retired Solar AECs that originated in PA



In January 2017, the Department of Environmental Protection began a 30-month stakeholder engagement and modeling initiative, "Finding Pennsylvania's Solar Future," aimed at finding ways to increase Pennsylvania's in-state solar generation to 10% of PA retail sales by 2030. By the end of the initiative, a plan will be presented that will include strategies involving markets, policy, technology, and finance aimed at helping to achieve this goal. The plan will be provided to the public, the legislature, and the Governor to be used as a guide for policy making.

The plan may be published in mid-2018. An Implementation Report that identifies ways to enact strategies from the plan may be published in late 2018.

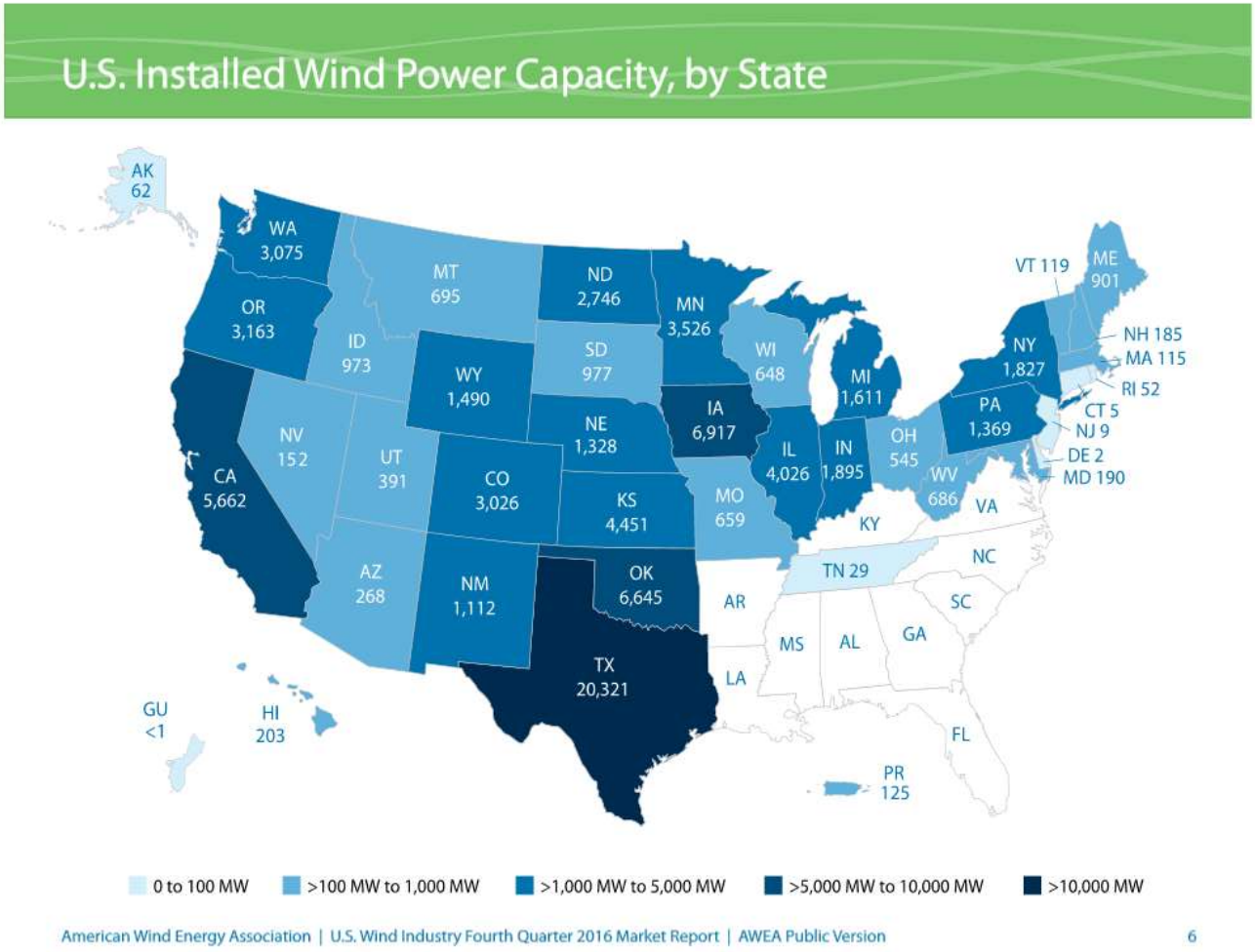
B. Wind

In calendar year 2016, the United States saw a total of 8,203 MW of wind electricity generation capacity installed and an additional 2,357 MW was installed in the first half of 2017, bringing the cumulative installed capacity to 84,405 MW.[31]

The average capacity factor of projects has been increasing over the years. In 2016, the average capacity factor for wind turbines installed in 2014 and 2015 was 42.6%, an increase from an average 32.1% for wind turbines installed from 2004 to 2011. Technological improvements, particularly, increased blade length, contributed to

[31] American Wind Energy Association, U.S, Wind Industry Second Quarter 2017 Market Report

the increase in capacity factor. [32]



During 2016, wind energy provided 2% of all in-state electricity production, enough electricity to power over 321,000 average American homes.[33]

Per the Department of Energy's Wind Vision projections, Pennsylvania has the potential to generate enough wind electricity to power the equivalent of 1.6 million average American homes. The report projects electricity generation potential of 878 MW at a hub height of 80 meters and 43,565 MW at a hub height of 110 meters.

As of May 31, 2017, Pennsylvania had 1,369 MW of installed wind capacity which is roughly 3.1% of the potential capacity and supports between 1,000 and 2,000 direct

[32] US Department of Energy, 2016 Wind Technologies Market Report
[33] American Wind Energy Association, Statewide Facts, Pennsylvania

and indirect jobs. In Pennsylvania, the average capacity factor for all wind turbines installed beginning in 2002 through the end of 2016, is approximately 30%.

C. Hydropower

The United States has 79 GW of installed hydropower capacity; the third largest installed capacity in the world, behind China and Brazil, respectively. Hydropower had been the second largest source of non-fossil fuel generation, behind nuclear power, but has very recently been eclipsed by the growth of wind power. Since the 1960s, major hydropower development has essentially stopped. Only three percent of domestic hydropower capacity has been installed since 1990, with just one GW of new capacity added since 2000. Most future domestic capacity growth is expected to occur in the form of efficiency improvements at existing dams and the installation of power generating equipment at small dams that were constructed for some other purpose, *i.e.*, river navigation, flood control, etc.[34] A prime example of this a 5.2 MW low-impact hydropower project to be located at the U.S. Army Corps of Engineers Braddock Locks and Dam on the Monongahela River. This project, funded by PEDA, is anticipated to generate 32,263 MWh/yr. In Pennsylvania, with 83,000 miles of streams and rivers, hydropower accounts for about 1% of our state's total electricity generation.[35]

[34] 2016 International Trade Administration (ITA) Energy Top Markets Report

[35] Low Impact Hydropower in Pennsylvania: Financial Feasibility Assessment September 2015, prepared by PALOALTO partners for Pennsylvania Environmental Council

6. Status of Pennsylvania's Alternative Energy Portfolio Standards Marketplace

This section discusses renewable and alternative energy data trends and generation capacity both in Pennsylvania and in the PJM region. Specifically, this section compares the amount of renewable and alternative energy generation available and which will be needed to meet future AEPS requirements.

The following graphs illustrate the growth of AEPS resources, within Pennsylvania, from 2011 through May 31, 2017, and the AEC price trend through this same time-period. Chart 15 provides the cumulative number of Pennsylvania customers who received electrical interconnections for their Solar PV systems, as well as the total Tier I (inclusive of solar PV) systems. Chart 16 provides the cumulative number of customers who received electrical interconnections for their Tier II systems. Charts 17 and 18 show the cumulative nameplate electric generating capacities for Solar, Tier I non-solar, and Tier II installations.

Chart 15: Cumulative Number of Tier I and Solar PV Customers Interconnected by Year

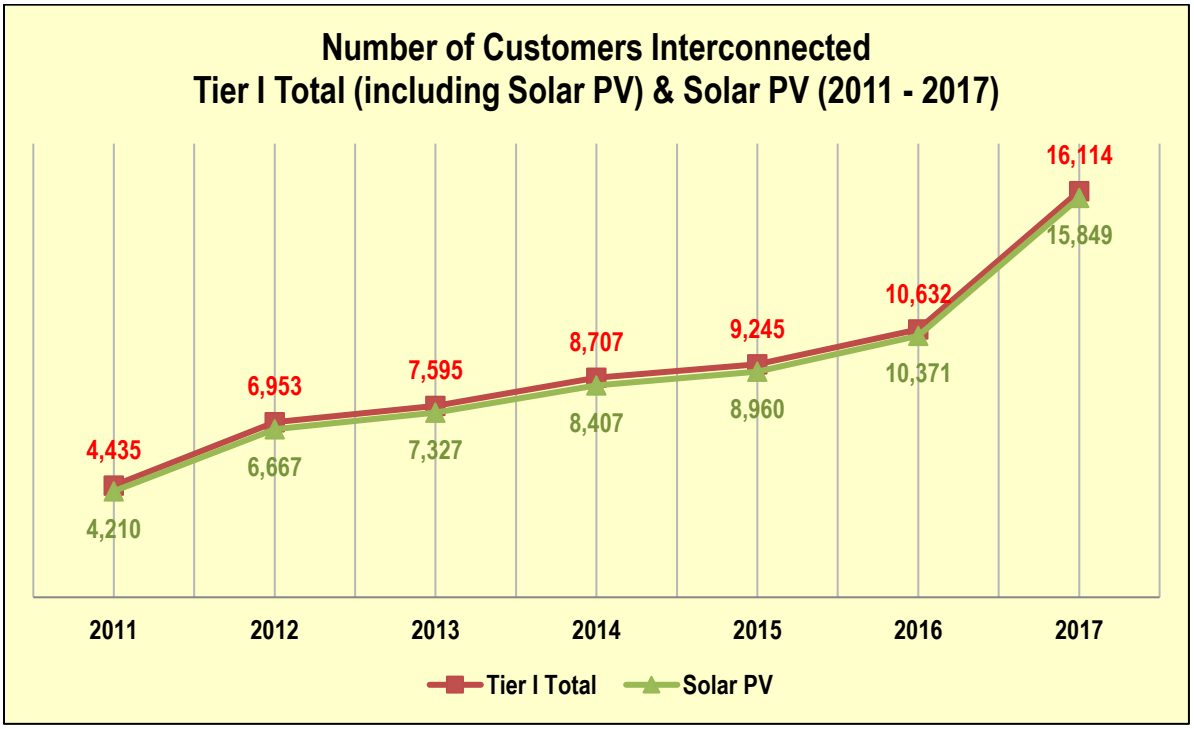


Chart 16: Cumulative Number of Tier II Customers Interconnected by Year

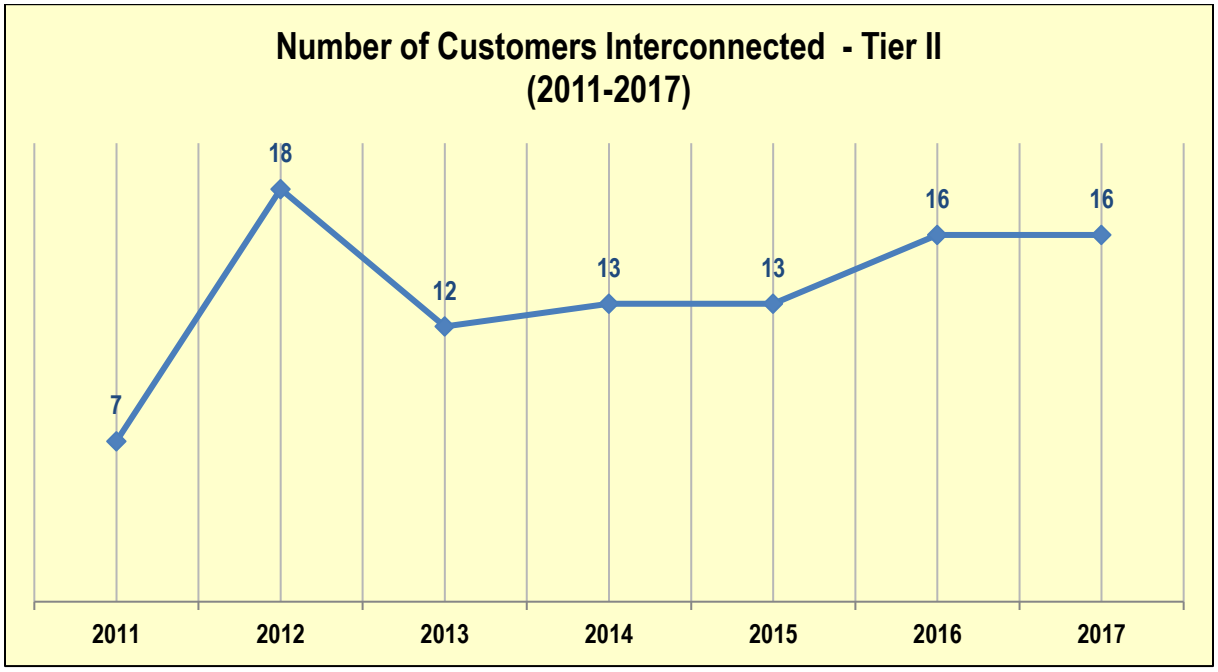


Chart 17: Cumulative Tier I and Solar Nameplate Capacity Installed by Year

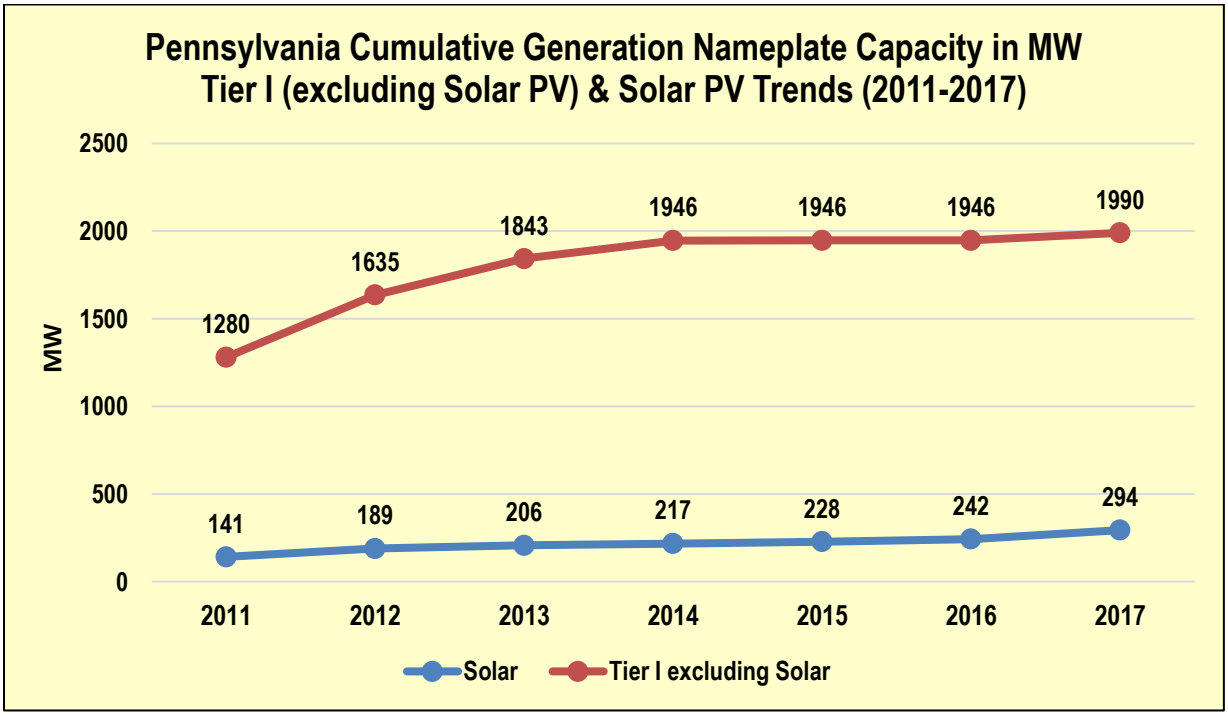
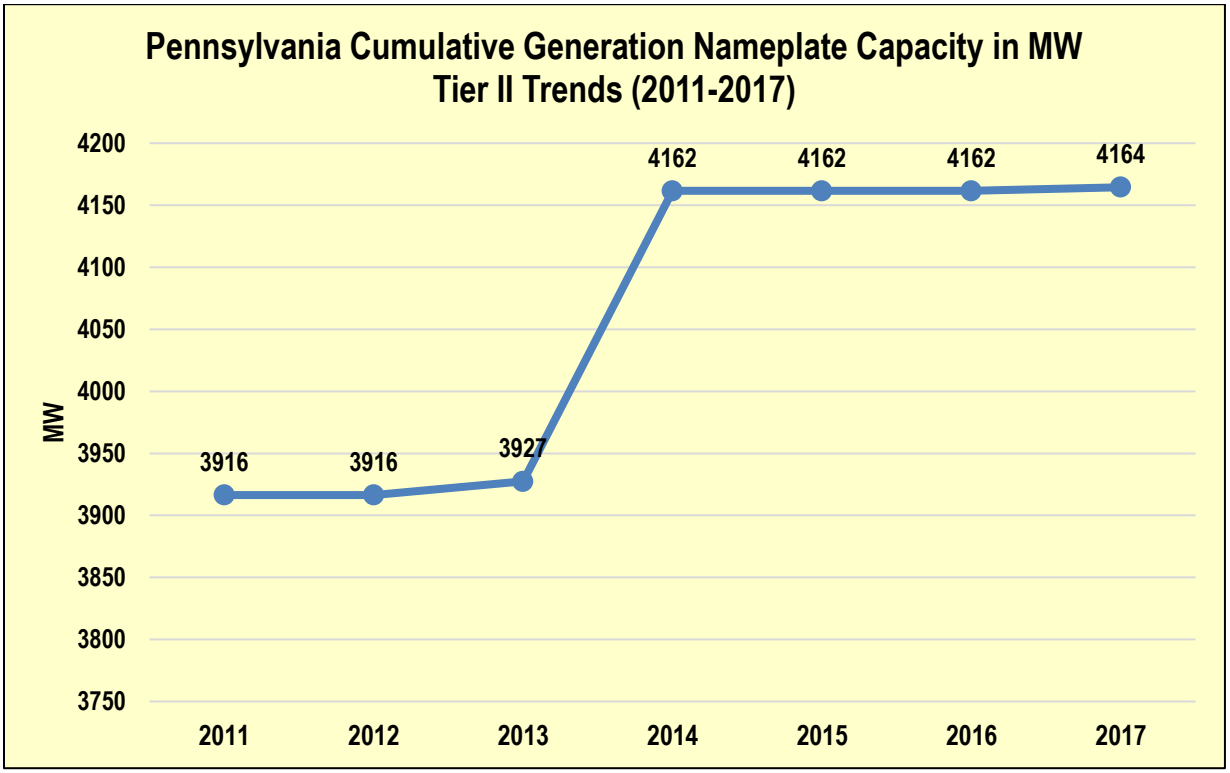


Chart 18: Cumulative Tier II Nameplate Capacity Installed by Year



Charts 19, 20 and 21, on the following pages, provide a comparison of average annual (compliance year) spot market prices[36] for the given AEPS tiers, as compared to the weighted average credit prices that have been retired for AEPS compliance. These graphs illustrate the differences between average spot market prices that most readers may be accustomed to seeing and the weighted average price of credits retired for AEPS compliance. The reason for this difference is because a significant volume of credits retired for AEPS compliance are purchased as part of long-term procurement processes.

[36] Spot prices from S&P Global Market Intelligence

Chart 19: Solar Average Spot Market VS. Weighted Average AEC Credit Prices

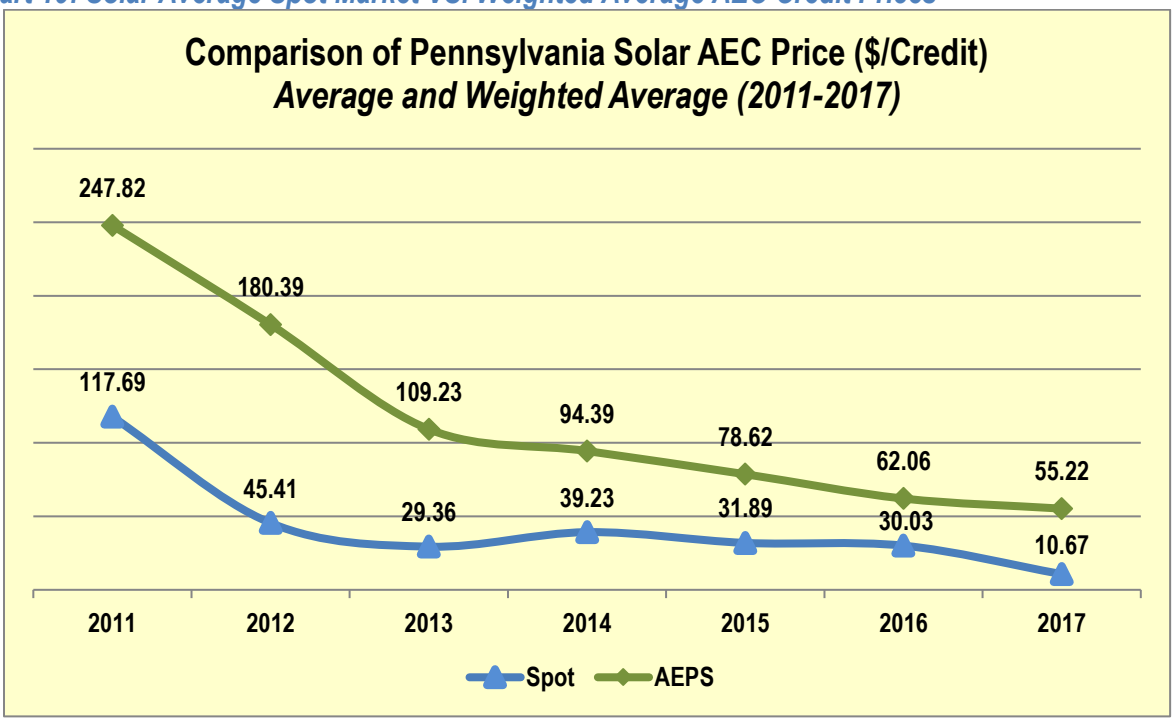


Chart 20: Tier I Average Spot Market vs. Weighted Average AEC Credit Prices

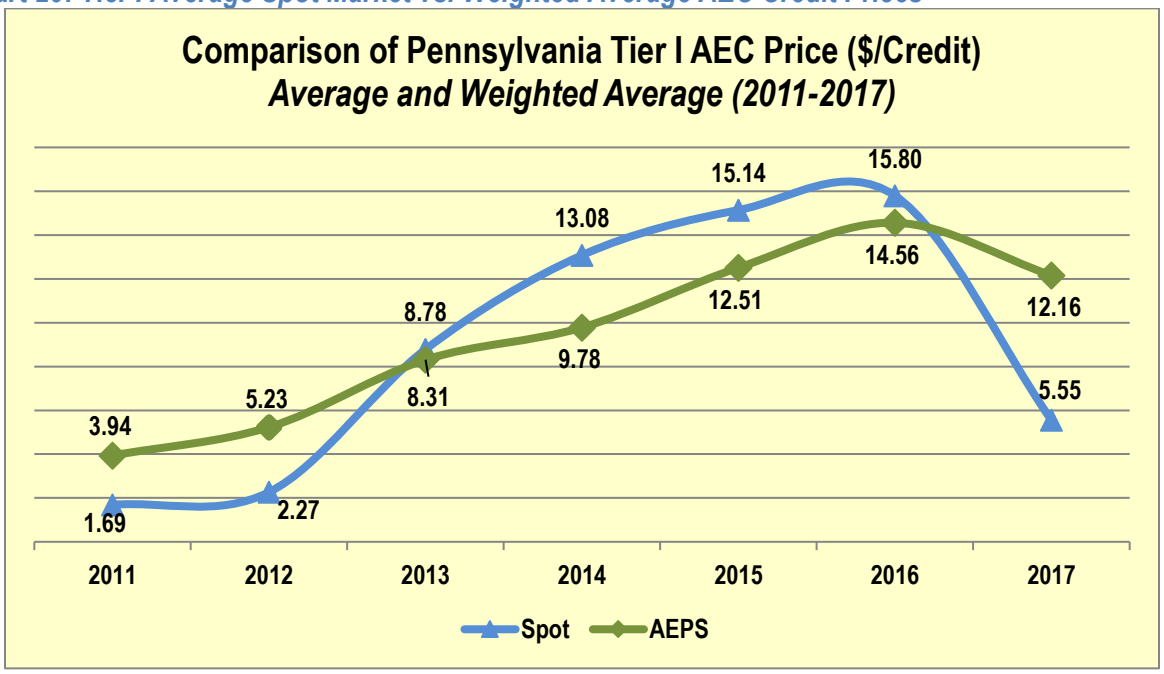
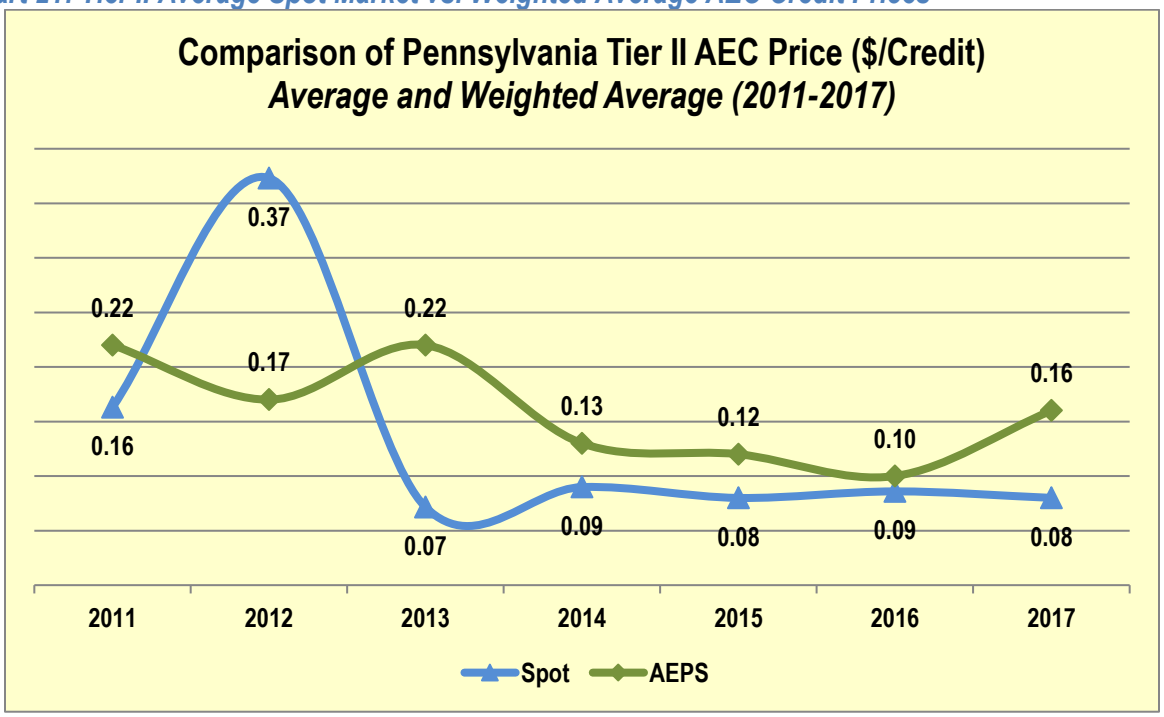
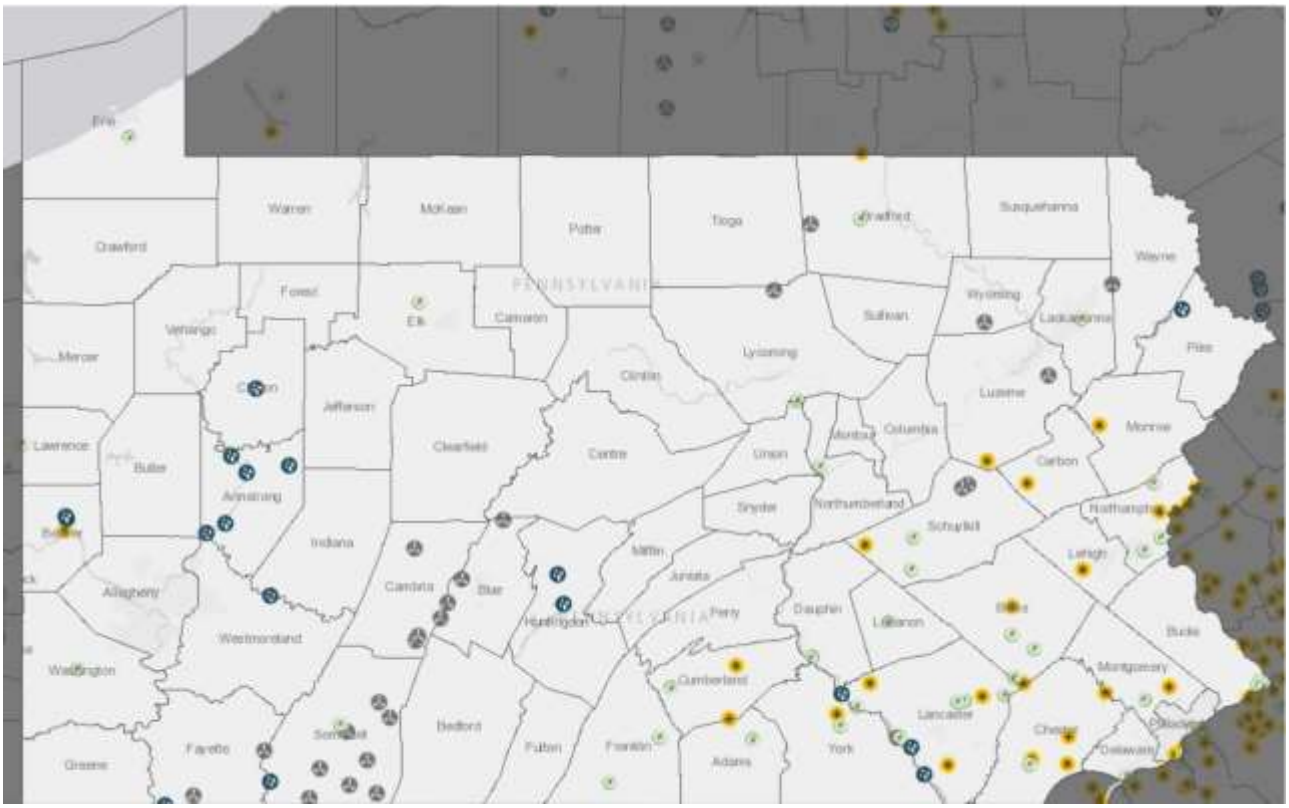


Chart 21: Tier II Average Spot Market vs. Weighted Average AEC Credit Prices



7. Renewable and Alternative Energy Generation Capacity in Pennsylvania and PJM

The following map shows utility scale alternative energy resources in Pennsylvania, primarily wind, solar PV, hydro and biomass plants.[37]



The Pennsylvania AEPS website[38] maintains a summary of all AEPS-qualified generation facilities and qualified energy efficiency and demand-side management (EE/DSM) resources. There were 19,021 qualified generation facilities certified as of May 31, 2017. Of those qualified generation facilities, 13,524 facilities (71 percent) are located in Pennsylvania and 5,497 facilities are located outside of Pennsylvania.

Statistics for AEPS-registered generators, as of May 31, 2017, include:

- 13,524 generators located in Pennsylvania with a total nameplate generating capacity of 7,146 MW
- 5,497 generators located outside of Pennsylvania with a total nameplate generating capacity of 14,826 MW
- 13,342 solar facilities in Pennsylvania with a total nameplate generating capacity of 285 MW

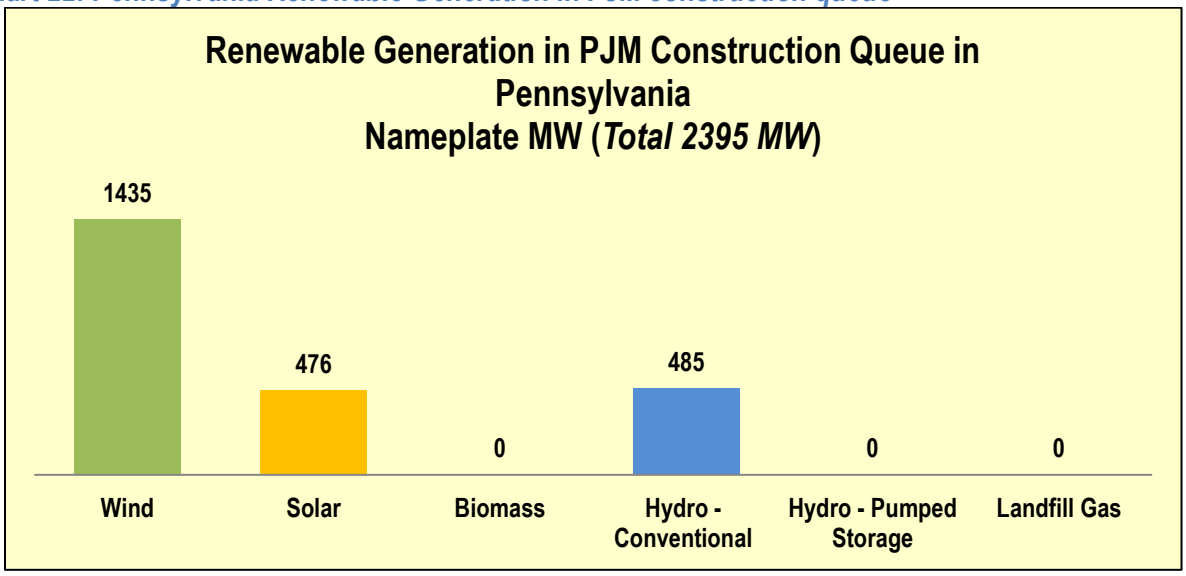
[37] https://www.eia.gov/state/?sid=PA
[38] http://www.pennaeps.com/reports/

- 5,295 solar facilities outside of Pennsylvania with a total nameplate generating capacity of 1,210 MW

Table 6 in Appendix A summarizes the active, certified alternative energy resources by type, as defined within the AEPS, and the capacity of each type in and outside of Pennsylvania. Generator facilities using biomass are further disaggregated by those using cellulosic or woody biomass and those using black liquor, a by-product of the wood pulping industry. Similarly, biologically derived methane gas is separated into anaerobic digester gas and landfill gas. In some instances, a qualifying AEPS fuel may not be the primary fuel used at a facility for generating electricity. In such cases, listing the nameplate capacity of the generator can cause confusion so we have indicated when an AEPS fuel resource is not the primary fuel used in electricity generation.

PJM manages grid interconnection requests in construction queues. Not all projects submitted to PJM for interconnection are constructed. Chart 22 summarizes the proposed renewable generation projects in the queue for Pennsylvania as of the end of the compliance year, with expected completion dates through fourth quarter of 2021.[39] Withdrawn projects and projects that are in service are not included.

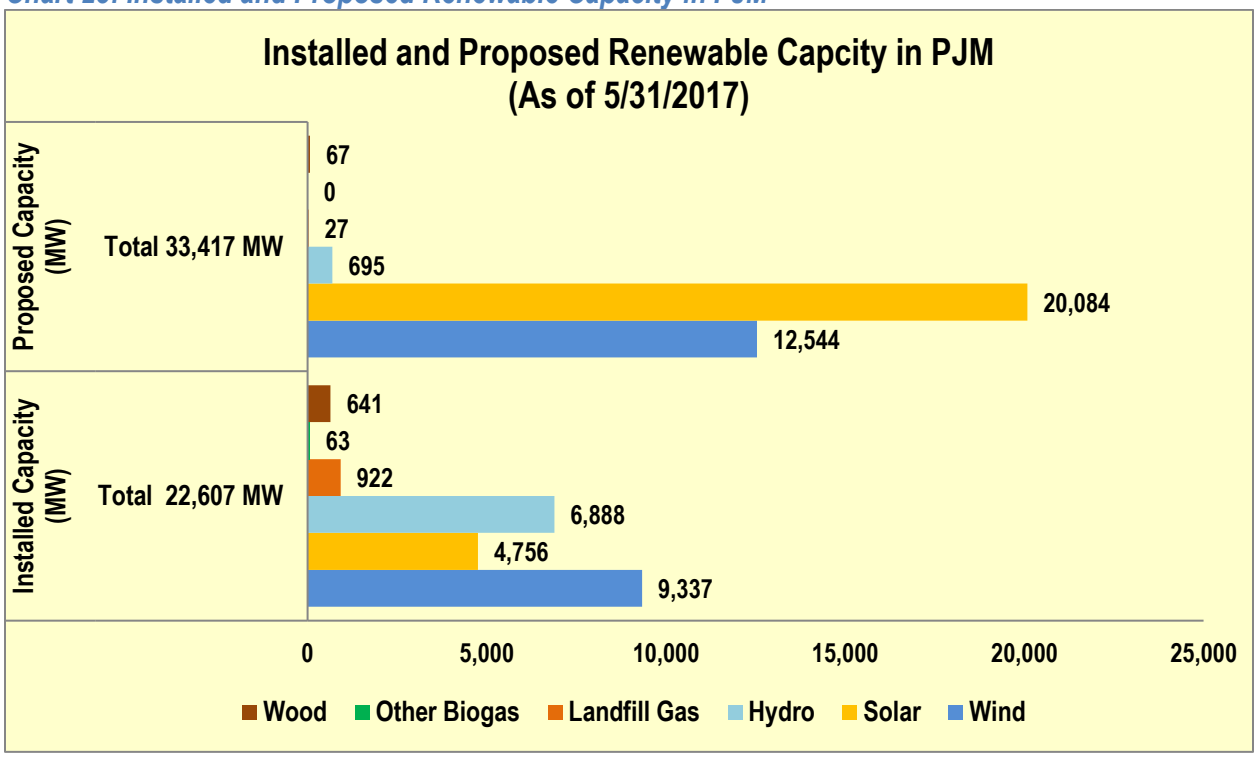
Chart 22: Pennsylvania Renewable Generation in PJM construction queue



[39] http://www.pjm.com/planning/generation-interconnection/generation-queue-active.aspx

Pending guidance on Act 40 implementation, the AEPS allows Pennsylvania EDCs and EGSs to purchase AECs from the entire PJM region. PJM has substantial existing and proposed renewable generation capacity as detailed in Chart 23.[40]

Chart 23: Installed and Proposed Renewable Capacity in PJM



PJM states with renewable portfolio standards (RPS) include Pennsylvania, Michigan, Ohio, North Carolina, Illinois, Delaware, District of Columbia, Maryland, and New Jersey. Virginia and Indiana have RPS goals and Tennessee and Kentucky do not yet have a final RPS. In states with RPS requirements, the final requirements range from 12.5 percent of sales of electricity in Ohio by 2020 to 25 percent in Delaware and Illinois by 2026.[41]

The RPS requirements of the PJM states and the District of Columbia vary considerably regarding generation resources eligible to meet the requirements. Differences are found in the types of renewable and/or alternative energy generation resources that qualify. Some states allow resources that are not permitted by other states. Also, some states use credit multipliers for certain generation resources, allowing certain resources to earn double or triple the amount

[40] PJM-EIS Public Reports, Renewable Generators Registered in GATS and PJM queue. Includes "Active" and projects "Under Construction"
[41] EIA Annual Energy Outlook 2016 – Published August 2016

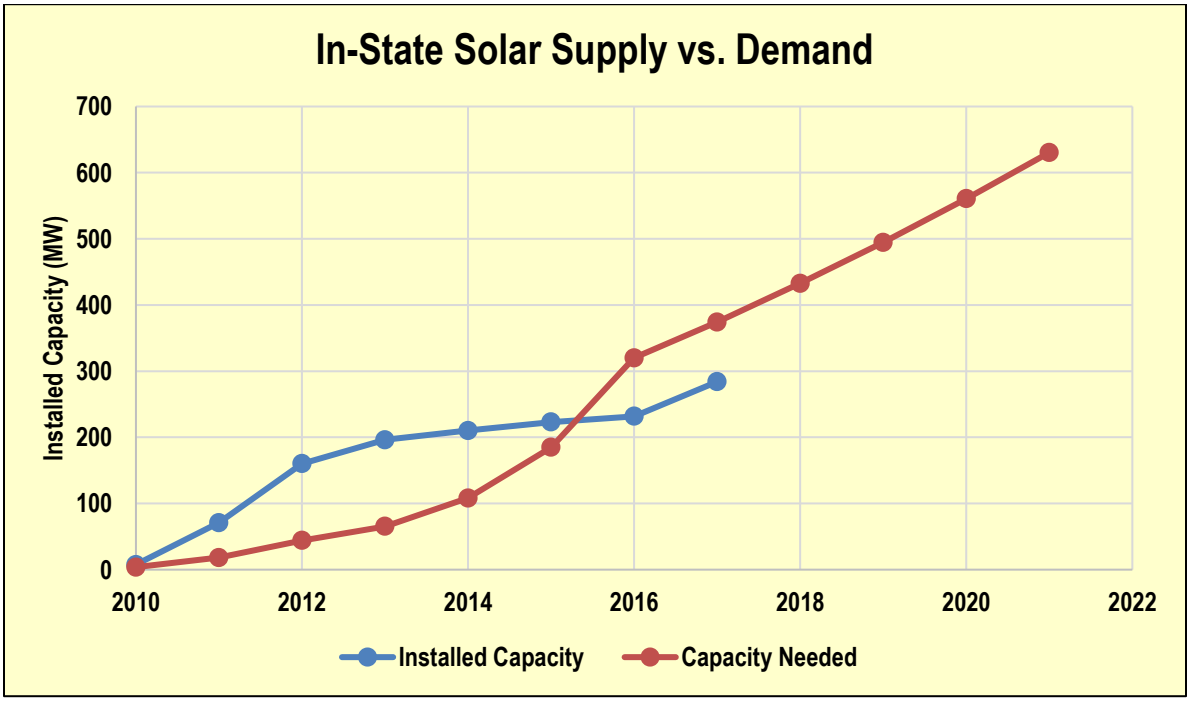
of credits per MWh of generation. Generation facility location is another matter where the states differ. Some states require acceptable generation facilities to be located within that state. Other states allow resources originating from the whole of PJM and others allow resources outside of PJM to qualify. Also, within some states, EDCs, EGSs and municipal utilities have different requirements under their RPS.

The AEPS marketplace for Pennsylvania is quite complex due to numerous factors which must be considered, such as those previously referenced. To meet the AEPS requirements, EDCs and EGSs can purchase AECs from sources outside of Pennsylvania but that are still within the PJM region. Based on existing resources within PJM, staff estimates that adequate Tier I, including solar, and Tier II supply exists through 2021.

Chart 24 provides a comparison of Pennsylvania's solar requirement to in-state installed capacity. The graph shows that Pennsylvania will not be able to meet its solar requirement without drawing from resources in other states, unless significant increases in Pennsylvania installed capacity are realized in each of the next few years. If all the solar projects proposed for Pennsylvania in the PJM planning queue came to fruition, it would add an additional 476 MW of installed capacity between 2017 and 2021. The PJM queue however, is not a good indicator of solar development given that most solar development tends to be small, distributed and behind-the-meter projects that are not tracked by the queue. In addition, only a small percentage of the projects currently in the queue may come into service. The graph illustrates that a significant and increasing percentage of in-state solar credits would be necessary if compliance with the annual solar obligations of the AEPS was based on solar AECs from only in-state resources.

It is likely that many of the qualified AECs currently available in GATS may not be available for use in Pennsylvania as many of the PJM states have closed their borders and may require credits generated in those states to be retired in those states. For the same reason, it is likely that most of the qualified AECs currently available in GATS, that originated in Pennsylvania, may be available for use in Pennsylvania. Pennsylvania's Act 40 of 2017, which was signed into law on October 30, 2017, may further reduce the available solar AECs for use in Pennsylvania depending on how it is implemented.

Chart 24: Pennsylvania In-State Solar Supply vs. Demand



Note: Solar PV supply in Chart 24 includes existing supply and 25 percent of the new capacity in the PJM construction queues. It does not account for small, behind the meter systems.

Projected solar demand sufficient to meet the AEPS requirements is summarized in Table 7 in Appendix A. Please note that in estimating the needed capacity, a capacity factor[42] of 13 percent had been applied for years prior to 2016. A capacity factor of 15 percent is used for years 2016 and later, which is more reflective of the current systems being installed in Pennsylvania.

[42] The relative percentage of time a generator actually produces electricity

8. Recent Activity Since End of Compliance Year

Pennsylvania House Bill 118 was signed into law as Act 40 of 2017 on October 30, 2017. Act 40 among other things, modifies the AEPS Act. Details on how the Act is to be implemented will be determined by the Pennsylvania Public Utility Commission. A Tentative Implementation Order was issued on December 21, 2017, seeking stakeholder comments, with February 6, 2018, as the closing date of the 30-day comment period.[43] After a review and consideration of the comments, a Final Implementation Order will be issued.

The impact of this law on the Solar AECs generated within Pennsylvania's borders and outside Pennsylvania's borders will depend on the Final Implementation Order.

[43] *See Implementation of Act 40 of 2017*, Docket No. M-2017-2631527 (Tentative Order entered December 21, 2017).

Appendices

Appendix A

Table 1: Overview of AEPS Percentage Sales Requirements

Year	Period	Tier I			Tier II
		Total	Solar PV	Non-Solar	
1	June 1, 2006 – May 31, 2007	1.50%	0.0013%	1.4987%	4.20%
2	June 1, 2007 – May 31, 2008	1.50%	0.0030%	1.4970%	4.20%
3	June 1, 2008 – May 31, 2009	2.00%	0.0063%	1.9937%	4.20%
4	June 1, 2009 – May 31, 2010	2.50%	0.0120%	2.4880%	4.20%
5	June 1, 2010 – May 31, 2011	3.00%	0.0203%	2.9797%	6.20%
6	June 1, 2011 – May 31, 2012	3.50%	0.0325%	3.4675%	6.20%
7	June 1, 2012 – May 31, 2013	4.00%	0.0510%	3.9490%	6.20%
8	June 1, 2013 – May 31, 2014	4.50%	0.0840%	4.4160%	6.20%
9	June 1, 2014 – May 31, 2015	5.00%	0.1440%	4.8560%	6.20%
10	June 1, 2015 – May 31, 2016	5.50%	0.2500%	5.2500%	8.20%
11	June 1, 2016 – May 31, 2017	6.00%	0.2933%	5.7067%	8.20%
12	June 1, 2017 – May 31, 2018	6.50%	0.3400%	6.1600%	8.20%
13	June 1, 2018 – May 31, 2019	7.00%	0.3900%	6.6100%	8.20%
14	June 1, 2019 – May 31,2020	7.50%	0.4433%	7.0567%	8.20%
15	June 1, 2020 – May 31, 2021	8.00%	0.5000%	7.5000%	10.00%

Table 2: 2017 AEPS Compliance Report by Tier

MWhs	Alternative Energy Requirement		Number of Credits Reserved	Weighted Average Credit Price	Cost of Purchased Credits	Alternative Compliance Payments Required
	Tier	Percent of Total Energy Sold				
141,511,559	Solar	0..2933	415,195	$55.20	$22,162,834	0
	I	5.7067	8,614,994	$12.16	$98,783,650	6
	II	8.2	11,604,122	$0.16	$1,771,147	14
	Total	14.2	20,634,311	N/A	$122,717,631	20

The weighted average credit prices reflected above are calculated using data for credits that have a known cost. Some credits that are retired to meet obligations are self-generated or purchased bundled with the electricity and a cost for those credits is not available. Therefore, dividing the cost of purchased credits by the number of credits reserved will not yield the weighted average credit price reflected in the table. The weighted average credit price is used to calculate the solar ACP. The solar ACP, as established in statute, is 200 percent of the sum of the weighted average credit price of solar AECs sold during the reporting year plus the value of any in-state and out-of-state solar rebates. The statutorily established ACP for Tier I and Tier II is $45.

Table 3: 2017 AEPS Compliance Report by EDC Service Territory

Distribution Service Territory	Total Energy Sold (MWhs)	Alternative Energy Requirement	Credits Required	Credits Retired	Compliance Status
Citizens' Electric and EGS	172,259				
Solar		0.2993%	506	506	In Compliance
Tier I (non-solar)		5.7067%	10,485	10,485	In Compliance
Tier II		8.20%	14,126	14,126	In Compliance
Duquesne Light and EGSs	13,116,885				
Solar		0.2993%	38,475	38,481	In Compliance
Tier I (non-solar)		5.7067%	798,380	798,380	In Compliance
Tier II		8.20%	1,075,585	1,075,588	In Compliance
Met Ed and EGSs	14,181,418				
Solar		0.2993%	41,598	41,609	In Compliance
Tier I (non-solar)		5.7067%	863,170	863,170	In Compliance
Tier II		8.20%	1,162,878	1,162,872	In Compliance After ACP
PECO and EGSs	38,034,202				
Solar		0.2993%	111,554	111,595	In Compliance
Tier I (non-solar)		5.7067%	2,315,010	2,315,057	In Compliance After ACP
Tier II		8.20%	3,118,803	3,118,900	In Compliance After ACP
Penelec and EGSs	13,673,251				
Solar		0.2993%	40,104	40,104	In Compliance
Tier I (non-solar)		5.7067%	832,246	832,300	In Compliance
Tier II		8.20%	1,121,208	1,121,210	In Compliance
Penn Power and EGSs	4,630,975				
Solar		0.2993%	13,580	13,579*	In Compliance
Tier I (non-solar)		5.7067%	281,869	281,857*	In Compliance
Tier II		8.20%	379,738	379,722*	In Compliance
Pike County and EGSs	74,081				
Solar		0.2993%	218	218	In Compliance
Tier I (non-solar)		5.7067%	4,509	4,509	In Compliance
Tier II		8.20%	6,075	6,075	In Compliance
PPL and EGSs	36,757,957				

Distribution Service Territory	Total Energy Sold (MWhs)	Alternative Energy Requirement	Credits Required	Credits Retired	Compliance Status
Solar		0.2993%	107,814	107,890	In Compliance
Tier I (non-solar)		5.7067%	2,237,330	2,237,327	In Compliance
Tier II		8.20%	3,014,154	3,014,246	In Compliance
UGI Electric and EGSs	985,063				
Solar		0.2993%	2,887	2,887	In Compliance
Tier I (non-solar)		5.7067%	59,959	59,959	In Compliance
Tier II		8.20%	80,775	80,775	In Compliance
Wellsboro Electric and EGS	112,091				
Solar		0.2993%	329	329	In Compliance
Tier I (non-solar)		5.7067%	6,823	6,823	In Compliance
Tier II		8.20%	9,192	9,192	In Compliance
West Penn Power and EGSs	19,773,377				
Solar		0.2993%	57,993	57,997	In Compliance
Tier I (non-solar)		5.7067%	1,203,537	1,205,127	In Compliance
Tier II		8.20%	1,621,416	1,621,416	In Compliance

*One EGS retired its AECs for obligations in Penn Power into another EDC territory; the EGS did meet its total obligations on a statewide basis.

Table 4: AEC State of Origin – Used for compliance in 2017

Tier	PA	NJ	MD	VA	WV	IL	OH	DE	NC	IN	MI	KY	TN
Solar	160,670	8	8,042	17,451	1,402	8,192	19,176	1,164	199,054	12	10	0	12
Tier I	2,220,295	43,483	35,381	2,043,305	351,938	2,365,089	453,897	31,271	131,273	824,302	0	114,760	0
Tier II	7,599,819	272,344	0	2,545,901	1,131,195	0	54,810	0	53	0	0	0	0
Total	**9,980,784**	**315,835**	**43,423**	**4,606,657**	**1,484,535**	**2,373,281**	**527,883**	**32,435**	**330,380**	**824,314**	**10**	**114,760**	**12**

Table 5: Estimated Statewide AEPS Cost of Compliance in 2021 (2017 Dollars) *

EDC	Solar Credits		Tier I Credits		Tier II Credits		Total Cost
	Credits Needed	Solar Credits @ $40	Credits Needed	Tier I Credits @ $10	Credits Needed	Tier II Credits @ $0.20	
Duquesne	63,270	$ 1,891,169	949,054	$ 7,091,884	1,265,405	$ 189,117	$ 9,172,170
Met-Ed	69,713	$ 2,083,741	1,045,693	$ 7,814,028	1,394,258	$ 208,374	$ 10,106,142
Penelec	77,634	$ 2,320,506	1,164,510	$ 8,701,898	1,552,680	$ 232,051	$ 11,254,455
Penn Power	22,879	$ 683,865	343,187	$ 2,564,495	457,583	$ 68,387	$ 3,316,746
PECO	185,216	$ 5,536,174	2,778,243	$ 20,760,651	3,704,325	$ 553,617	$ 26,850,442
PPL	187,814	$ 5,613,811	2,817,205	$ 21,051,792	3,756,273	$ 561,381	$ 27,226,984
UGI	101,965	$ 3,047,772	1,529,477	$ 11,429,144	2,039,303	$ 304,777	$ 14,781,693
West Penn	4,935	$ 147,498	74,020	$ 553,118	98,693	$ 14,750	$ 715,366
Citizens'	885	$ 26,465	13,281	$ 99,245	17,708	$ 2,647	$ 128,356
Pike County	398	$ 11,903	5,973	$ 44,635	7,964	$ 1,190	$ 57,728
Wellsboro	569	$ 16,999	8,531	$ 63,746	11,374	$ 1,700	$ 82,444
Totals	**715,278**	**$21,379,902**	**10,729,175**	**$ 80,174,634**	**14,305,566**	**$2,137,990**	**$103,692,527**

* Estimated costs reflect the application of a 6% discount rate

Note: Table 5 in the 2016 Annual Report included an error that overestimated the Total Cost of Compliance.

Table 6: AEPS Existing Capacities of certified, active facilities

AEPS Tier	Alternative Energy Resource Types	Nameplate Capacity of Facilities in PA (MWs)	Nameplate Capacity of Facilities Outside of PA (MWs)	Total Nameplate Capacity (MWs)
I	Biomass Energy			
	Cellulosic (woody) Biomass	387.2	1285.4	1672.6
	Black Liquor	163.7	0.0	163.7
I	Coal Mine Methane (primary fuel source)	0.8	0.0	0.8
I	Coal Mine Methane (secondary fuel source)	0.0	88.0	88.0
I	Low-Impact Hydropower	178.7	2.2	180.9
I	Biologically Derived Methane Gas			
	Other Biomass Gas	16.2	6.3	22.4
	Anaerobic Digester Gas (primary fuel source)	0.0	0.0	0.0
	Anaerobic Digester Gas (secondary fuel source)	0.0	446.0	446.0
	Landfill Gas (primary fuel source)	267.8	449.7	717.5
	Landfill Gas (secondary fuel source)	540.0	698.0	1,238.0
I	Solar PV	284.6	1,209.5	1,494.1
I	Wind	1369.0	5807.1	7176.1
I	**TOTAL of Tier I**	**3207.9**	**9992.2**	**13200.1**
II	Biomass Energy			
	Cellulosic (woody) Biomass	0.0	131.0	131.0
	Black Liquor	0.0	402.9*	402.9
II	Distributed Generation	4.8	0.0	4.8
II	Hydropower			
	Conventional, Non-Low Impact	712.3	1079.0	1791.3
	Pumped Storage	1269.0	5253.0	6522.0
II	Municipal Solid Waste	181.8	432.2	614.0
II	Demand Side Management			
	Energy Efficiency	2.9	0.0	2.9
	Blast Furnace Gas	55.5	67.0	122.5
	Other Gases	86.2	0.0	86.2
	Waste Heat	5.0	0.0	5.0
	Industrial By-product	0.0	7.2	7.2
II	Waste Coal	1620.4	245.0	1865.4
II	**TOTAL of Tier II**	**3937.9**	**4,833.0**	**8770.9**
I & II	**TOTAL of Tiers I & II**	**7145.8**	**14825.2**	**21971.0**

* Several facilities have the capability of utilizing multiple fuel sources that may include a combination of Tier I, Tier II or even non-eligible AEPS fuels to generate electricity. For example, a facility may co-fire coal and biomass or blend landfill gas and natural gas. Methodologies are in place to ensure that only AEPS-qualified generation is awarded AEPS credits but it is not possible to designate a single, static AEPS nameplate capacity associated with these generators.

Table 7: Solar Demand for Pennsylvania and installed capacity

Year	Generation Requirement (MWh)	Estimated Needed Capacity (MW)	Capacity Installed in Pennsylvania
2015	204,255	179	223
2016	364,442	320	232
2017	419,460	368	294
2018	488,333	429	
2019	562,615	494	
2020	647,152	568	
2021	734,469	645	

Table 8: Snapshot of the key chronology of events to date

Event	Date
Act 213 of 2004	Nov. 30, 2004
Act 213 of 2004 Effective Date	Feb.28, 2005
PUC Adopts Implementation Order I (M-00051865)	March 23, 2005
PUC Adopts Implementation Order II (M-00051865)	July 14, 2005
PUC Adopts Order: Standards for DSM Resources (M-00051865)	Sept. 25, 2005
PUC Adopts Order: Designates PJM GATS Registry (M-00051865)	Jan. 27, 2006
Final Net Metering/Interconnection Regulations in the *Pennsylvania Bulletin*	Dec. 16, 2006
PUC Contracts with Clean Power Markets as Program Administrator	March 28, 2007
Compliance Required for Pennsylvania Power Co. & UGI Utilities Inc.	May 31, 2007
Act 35 of 2007	July 19, 2007
Compliance Required for Citizens' Electric Co., Duquesne Light Co., Pike County Light & Power, and Wellsboro Electric Co.	Jan. 1, 2008

Event	Date
PUC Adopts Final Rulemaking Implementation Order (L-00060180)	Sept. 25, 2008
Act 129 of 2008	Oct. 15, 2008
Final Omitted Rulemaking Order (Net Metering) – Published in *PA Bulletin* (L00050174)	Nov. 29, 2008
PUC Adopts Act 129 Implementation Order – Relating to AEPS	May 28, 2009
Compliance Required for PPL Electric Utilities	Jan.1, 2010
PUC Adopts Solar Policy Statement	Sept. 16, 2010
PUC adopts Second Amended Final Rulemaking Order (L-2014-2404361)	October 27, 2016

Appendix B

a. Tier I Resources

i. Solar Photovoltaic (PV)

A solar PV System[44] generates electricity from sunlight. A solar photovoltaic cell is made of semiconductor material and can generate 1 to 2 watts of power. To increase the power output, multiple cells are connected together to form modules or panels. These modules or panels may be connected together to form arrays. A solar photovoltaic system consists of the PV panels, mounting structures, inverter that converts the direct current (DC) generated by the system to alternating current (AC).

ii. Solar Thermal

Solar thermal power plant[45] technology uses heat from the sun's rays to generate electricity. The heat from the sun's rays is collected and used to heat a fluid to high temperatures. This high temperature fluid is used to heat water and generate steam. The steam is then used to spin a turbine that turns a generator attached to its drive shaft and generate electricity.

iii. Wind Power

Wind power generation technology uses energy from the wind to turn large blades of a wind turbine which are connected to a drive shaft that turns a generator to generate electricity.

iv. Low-Impact Hydropower

Low-impact hydropower consists of any technology that produces electric power and that harnesses the hydroelectric potential of moving water impoundments provided such incremental hydroelectric development:

(i) does not adversely change existing impacts to aquatic systems;

(ii) meets the certification standards established by the Low Impact Hydropower Institute and American Rivers, Inc., or their successors;

(iii) provides an adequate water flow for protection of aquatic life and for safe and effective fish passage;

(iv) protects against erosion; and

[44] Solar Photovoltaic Technology Basics at www.energy.gov
[45] Solar Thermal Power Plants at www.eia.gov

(v) protects cultural and historic resources.

v. Geothermal Energy

Geothermal electricity generation extracts hot water or steam from geothermal reserves in the earth's crust and supplies it to steam turbines that drive generators to produce electricity. The three commercial types of conventional geothermal power plants are flash, dry steam, and binary.

In a geothermal flash power plant, high pressure geothermal water and steam are extracted, and the steam is separated and delivered to a turbine that drives a generator.

In a dry steam geothermal power plant, steam alone is extracted from a geothermal reservoir and is used to drive the turbine and generator.[46]

In a binary plant, the geothermal fluid heats and vaporizes a separate working fluid with a lower boiling point than water, which drives a turbine for power generation. Each fluid cycle is closed, and the geothermal fluid is re-injected into the heat reservoir. The binary cycle allows an effective and efficient extraction of heat for power generation from relatively low-temperature geothermal fluids.[47]

vi. Biologically Derived Methane Gas

Biologically derived methane gas is produced from the anaerobic digestion of organic materials from yard waste such as grass clippings and leaves, food waste, animal waste and sewage sludge. It also includes landfill methane gas. Biologically derived methane gas is used as fuel to power engines that drive generators to generate electricity.

vii. Fuel Cells

Fuel cells are electrochemical devices that convert chemical energy in a hydrogen-rich fuel directly into electricity, heat, and water without combustion.

viii. Biomass Energy

Biomass energy electricity that is generated utilizing the following:

(A) Organic material from a plant that is grown for the purpose of being used to produce electricity or is protected by the Federal Conservation Reserve Program (CRP) and provided further that crop production on CRP lands does not prevent the

[46] Geothermal Energy Association – Geothermal Basics Q&A, 2012
[47] Renewable Energy Policy Network (REN21) – Renewables 2016 Global Status Report

achievement of the water quality protection, soil erosion prevention or wildlife enhancement purposes for which the land was primarily set aside.

(B) Solid nonhazardous, cellulosic waste material that is segregated from other waste materials, such as waste pallets, crates and landscape or right-of-way tree trimmings or agricultural sources, including orchard tree crops, vineyards, grain, legumes, sugar and other byproducts or residues.

b. Tier II Resources

i. Waste Coal

Waste coal facilities generate electricity by combusting waste coal that was disposed or abandoned prior to July 31, 1982, or disposed of thereafter in permitted coal refuse disposal sites or other waste coal combustion meeting alternate eligibility requirements established by regulation.

ii. Distributed generation systems

Distributed generation systems are small-scale and generate electricity and useful thermal energy (*i.e.*, combined heat and power plants).

iii. Demand-side management

Demand-side management consisting of the management of customer consumption of electricity or the demand for electricity through the implementation of:

(A) Energy efficient technologies, management practices or other strategies in residential, commercial, industrial, institutional and government customers that shift electric load from periods of higher demand to periods of lower demand.

(B) Load management or demand response technologies, management practices or other strategies in residential, commercial, industrial, institutional and government customers that shift electric load from periods of higher demand to periods of lower demand.

(C) Industrial by-product technologies consisting of the use of a by-product from an industrial process, including reuse of energy from exhaust gases or other manufacturing by-products that are used in the direct production of electricity at the facility of a customer.

iv. Large-scale hydropower

Large-scale hydropower plants produce electricity by harnessing the hydroelectric potential of moving water impoundments that does not meet the requirements of low-impact hydropower. The term also applies to pumped storage hydropower

which is electricity produced by the force of rushing water released from an upper reservoir. That water is temporarily stored in a lower elevation reservoir and later returned to the upper reservoir when electricity is least expensive.

v. Municipal solid waste

Municipal solid waste is burned at special waste-to-energy plants that use the heat to make steam to generate electricity or to heat buildings.

vi. Generation of Electricity Utilizing by-products of the Pulping Process and Wood Manufacturing Process

In the wood pulping process, a liquid containing dissolved wood and spent chemicals is produced. This liquid is called black liquor. It is further concentrated and the organic compounds in the black liquor are used as a fuel to generate steam and produce electricity. Similarly, byproducts of the wood manufacturing process such as sawdust, wood chips and bark are used as fuel to generate steam and produce electricity.

Glossary

Alternative Compliance Payments (ACP): A payment made by non-complying EDCs and EGSs. These payments are made available to the sustainable energy funds established through the Commission's orders, and are utilized solely for projects that increase the amount of electric energy generated from alternative energy resources.

Business Energy Investment Tax Credit (ITC): The Investment Tax Credit (ITC) reduces federal income taxes for qualified tax-paying owners based on capital investment in renewable energy projects.

Capacity Factor: A ratio of the actual power output for a time period to the maximum possible power output if the plant was operating at full name plate capacity for the same time period.

Demand Side Management: The process of managing the consumption of energy, generally to optimize available and planned generation resources.

Dispatchable Sources of Electricity: Power plants that can be turned on or off as needed; adjust their output supplied to the electrical grid based on demand. Conventional power plants using coal and natural gas can adjust their output to meet the always changing electricity demands of the consumers.

Non-Dispatchable Sources of Electricity: Power plants that use some renewable energy sources such as wind and solar cannot be turned on or off as needed or adjust their output supplied to the electrical grid based on demand.

Renewable Electricity Production Tax Credit (PTC): The Production Tax Credit (PTC) reduces the federal income taxes of qualified tax-paying owners of renewable energy projects based on the electrical output, measured in kilowatt-hours, of grid-connected renewable energy facilities.

Utility-scale Wind Turbines: Individual turbines that exceed 100 kW in size.

Utility-scale Solar Plants: EIA defines utility scale solar plants as plants with a capacity of at least one megawatt.

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