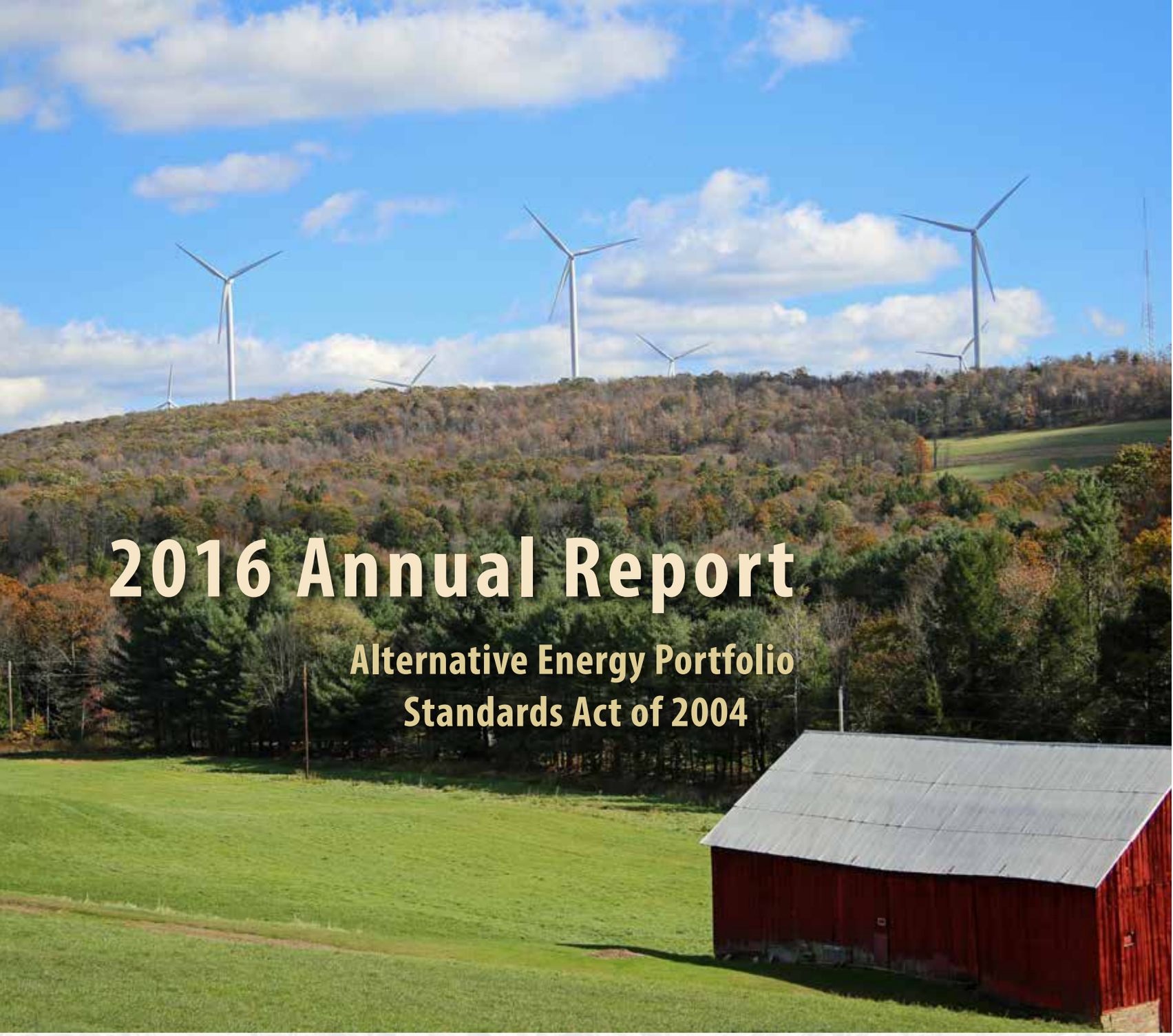

2016 Annual Report

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

2016 Annual Report
Alternative Energy Portfolio Standards Act of 2004

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Front, back covers and title page: Twin Ridges Wind Farm, Somerset County
Photos: Joseph Sherrick

Contents

1. 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 all retail electric customers. This percentage gradually increases over this period. Each successive 12-month reporting year begins on June 1 and concludes on the following May 31, and compliance is monitored during this period.

For the 2016 reporting year, all EDCs and all but three EGSs retired sufficient AECs to meet their AEPS requirements.

For the 2016 reporting year (June 1, 2015, through May 31, 2016) the Tier I requirement was 5.5% of all retail sales, of which at least 0.25% 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 indicated in Section 9A 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 0.37% for a total Tier I requirement of 5.87%.

From 2010 through 2015, when this adjustment to the Tier I requirement was calculated, there was an error in the calculations which resulted in a lower adjustment percentage. In 2016, this error was discovered and the correct adjustment percentage was used for this reporting period.

For this reporting period, all the EDCs and all but three EGSs met their requirements by acquiring and retiring sufficient AECs. Of the number of AECs retired, 54.6% of AECs were generated within Pennsylvania and 45.4% of AECs were generated outside Pennsylvania.

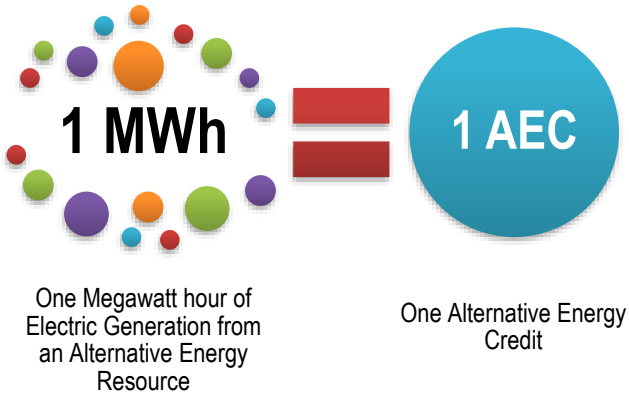
[1] *See generally* 73 P.S. § 1648.1 et seq.

Analysis of the existing and prospective resources suggests that sufficient Tier I, Tier II and PV AECs will be available to meet the AEPS requirements through the 2021 reporting year.

2. AEPS Program

The Act requires each EDC and each EGS to obtain a prescribed percentage of electricity generated by qualified alternative energy resources in their sales to retail customers. 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.

The concept of AECs is used to track and verify usage of electricity generated from alternative energy resources. ***When an alternative energy resource, located within the PJM footprint, generates one megawatt hour of electricity, one AEC is created.*** The AECs are created, 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 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 within the entire PJM Interconnection, LLC (regional transmission organization)

area.[2] These credits are retired and no longer 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.

3. 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 1		Tier II
• Solar Photovoltaic (PV) (Solar PV is a Tier 1 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

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

[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.

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 state Department of Environmental Protection (DEP) work cooperatively to monitor the performance of all aspects of the AEPS 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 compliance with applicable environmental laws and standards relevant to the implementation of the AEPS. 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 Act 213 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 Dec. 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

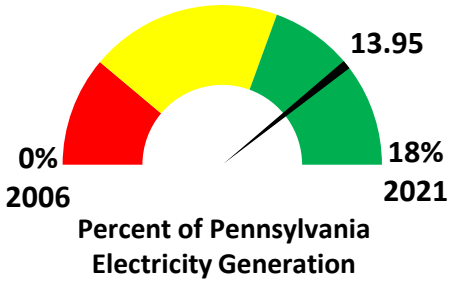
[3] *See*, 38 Pa. B. 6908 at https://www.pabulletin.com/secure/data/vol38/38-51/2286.html.

provides an overview of the AEPS percentage sales requirements with the revised solar PV schedule.

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.

4. Compliance Summary

As of reporting year 2016, over 13%[4] 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.



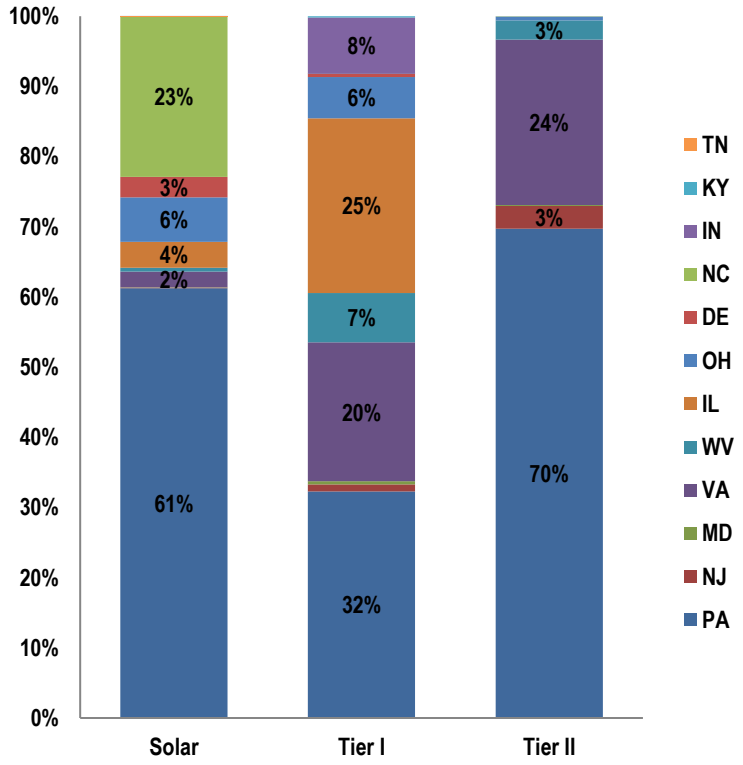
Of all the AECs retired for compliance, 54.6 percent were generated in Pennsylvania and the remaining 45.4 percent were generated from other states in the PJM territory.

Chart 1 shows the percentage of AECs that were retired in Pennsylvania in the 2015-2016 reporting period and their states of origin.

For the Solar requirement, 61% of retired AEC credits originated in Pennsylvania, 23% came from North Carolina, 6% came from Ohio and the other 10% came from several other states.

[4] AEPS website - http://www.pennaeps.com/

Chart 1: Percentage of AECs Retired in Pennsylvania in 2016



For the Tier I requirement, exclusive of solar, 32% of retired AECs came from Pennsylvania. Another 25% came from Illinois and 20% came from Virginia.

For the Tier II requirement, 70% of retired AECs came from Pennsylvania. Another 24% came from Virginia and 6% came from New Jersey and West Virginia.

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

A. Tier I Compliance

All EDCs achieved compliance in the reporting year by retiring the requisite number of AECs. Three EGSs did not retire sufficient AECs and, as a result, were required to pay ACPs. One EGS paid the required ACPs. The PUC attempted to contact the other two EGSs that owed a total of nine ACPs. However, those two EGSs are in bankruptcy and responsible parties were unreachable.

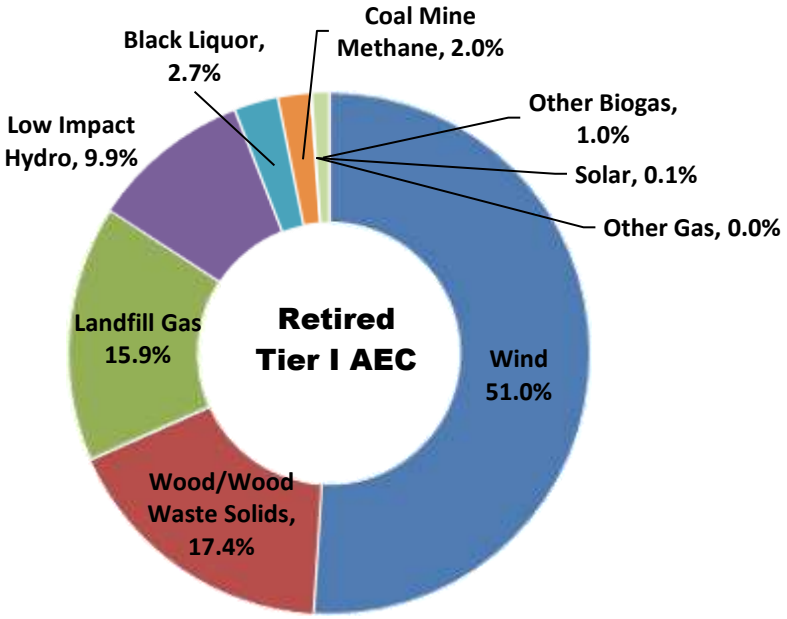
Table 3 in Appendix A presents the details of each EDC's compliance obligation and compliance status for the reporting year 2016. The table presents reporting year data on the number of AECs retired by tier in the EDC territories. Several EGSs

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 2016 reporting year, 11 EDCs and 110 EGSs had compliance obligations and Wellsboro was the only EDC that did not have EGSs provide service in its territory. 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.

Chart 2 shows the source percentages of AECs retired in the 2016 reporting year. Wind energy produced over 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 2016 Reporting Year



a. Solar Compliance

For the 2016 reporting year, the solar obligation was 0.25 percent. All EDCs and EGSs retired the requisites number of Solar AECs.

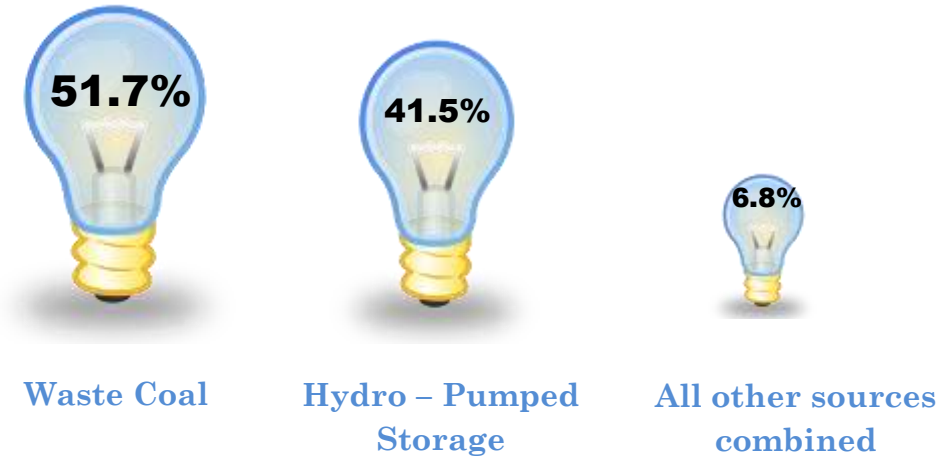
b. Non-Solar Compliance

For the 2016 reporting year, the base obligation for non-solar Tier I was 5.25 percent. The Tier I quarterly adjustment, impacting only non-solar Tier I, added a quarterly increase of: 0.325990 percent; 0.361422 percent; 0.351293 percent; and 0.460964 percent in quarters one through four, respectively. This resulted in 513,757 AECs added to the 7,253,795 credits that were required without the adjustment.

B. Tier II Compliance

For the 2016 reporting year, the base obligation for non-solar Tier II was 8.2 percent. All EDCs and EGSs achieved compliance in the reporting year by retiring the requisite number of AECs. Chart 3 shows sources and percentages of Tier II AECs retired in Pennsylvania in the 2016 reporting year.

Chart 3: Sources and Percentages of Tier II AECs Retired in Pennsylvania for the 2016 Reporting Year



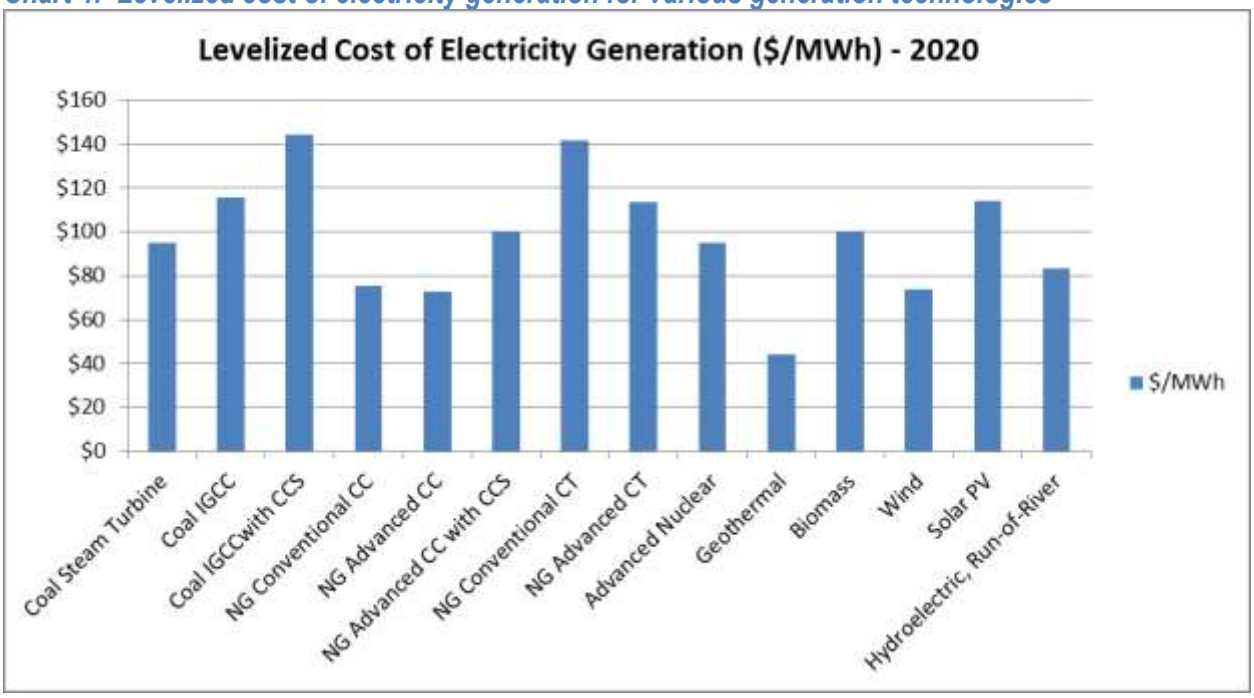
5. Costs and Benefits of Alternative Energy Generation

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 2020.[5] It should be noted however, that most of the resources used to comply with the AEPS are smaller than utility-scale (generation capacity exceeds one megawatt [MW]). The EIA data is used as the most consistently reliable information available. In using this data, 2020 was selected to account for the lead time needed by some technologies to be brought on line. EIA uses average data, including capacity factors, from across the country. Chart 4 compares these levelized costs, in 2013 dollars, for differing generation technologies on a dollar per 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 and taxes and do not include state or federal 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.

[5] *See* EIA document titled *Levelized Cost of New Generation Resources in the Annual Energy Outlook 2015* from EIA *Annual Energy Outlook 2015 with Projections to 2040*, April 2015, DOE/EIA-0383(2015). Available at http://www.eia.gov/forecasts/aeo/index.cfm

Chart 4: Levelized cost of electricity 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 2016 dollars, using a 6 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 146,516 gigawatt hours (GWh) in 2014 to 146,229 GWh in 2015, a 0.2% reduction.[6] 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.

[6] Electric *Power Outlook for Pennsylvania, 2015-2020,* http://www.puc.pa.gov/General/publications_reports/pdf/EPO_2016.pdf

As shown in Table 5 in the Appendix A, the estimated cost of AEPS compliance in 2021, as of the end compliance year 2016, is approximately $163.2 million. To put these figures in perspective, the annual statewide customer expenditures on electric service, across all sectors, was approximately $15.1 billion in 2015.[7] Therefore, approximately 1.08 cents 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 development 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 2014 *Clean Jobs Pennsylvania* report cites that Pennsylvania has a renewable energy workforce of 13,345. The companies supporting these jobs are typically small businesses of 25 or fewer employees. The report also states that 37,468 Pennsylvanians are employed in the energy efficiency sector, a Tier II resource of the AEPS.[8]

In reporting year 2016 approximately 18 MW of solar-electric generating capacity was installed in PA, which brought the in-state total capacity to 243 MW; enough to fully power about 27,000 homes. These installations at private residences, businesses and institutions help sustain a Pennsylvania workforce of nearly 3,061[9] 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 23 percent from the previous year. Nationally, the average hourly wage for those engaged in the actual installation of solar energy systems is $26; higher still for those involved in the

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

[8] Clean Jobs Pennsylvania – Sizing Up Pennsylvania's Clean Energy Jobs Base and its Potential, 2014 http://www.cleanjobspa.com/

[9] Thesolarfoundation.org National Solar Jobs Census-2016

installation of utility-scale solar farms.[10] 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.

At the end of 2016, Pennsylvania ranked 16th 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.[11] No new in-state commercial wind capacity came online during this reporting year. Despite this, Pennsylvania still supports many 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 in excess of 1,000. This includes jobs at 26 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 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 2016 compliance year, the Federal Energy Regulatory Commission (FERC) issued Preliminary Permits for the feasibility of three hydropower projects to be studied. These three projects include 11.5 MW of traditional hydropower and one 250 MW pumped storage hydropower project. 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. In 2016 the generation from non-pumped storage hydropower resources generated nearly 2.4 million MWh or enough to power about 238,000 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

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[10] *National Solar Jobs Census 2016*, The Solar Foundation, available at: http://www.thesolarfoundation.org/
[11] American Wind Energy Association, *Pennsylvania Wind Energy*
[12] American Wind Energy Association, http://gis.awea.org/arcgisportal/apps/webappviewer/index.html?id=eed1ec3b624742f8b18280e6aa73e8ec
[13] American Wind Energy Association, *Pennsylvania Wind Energy*

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.

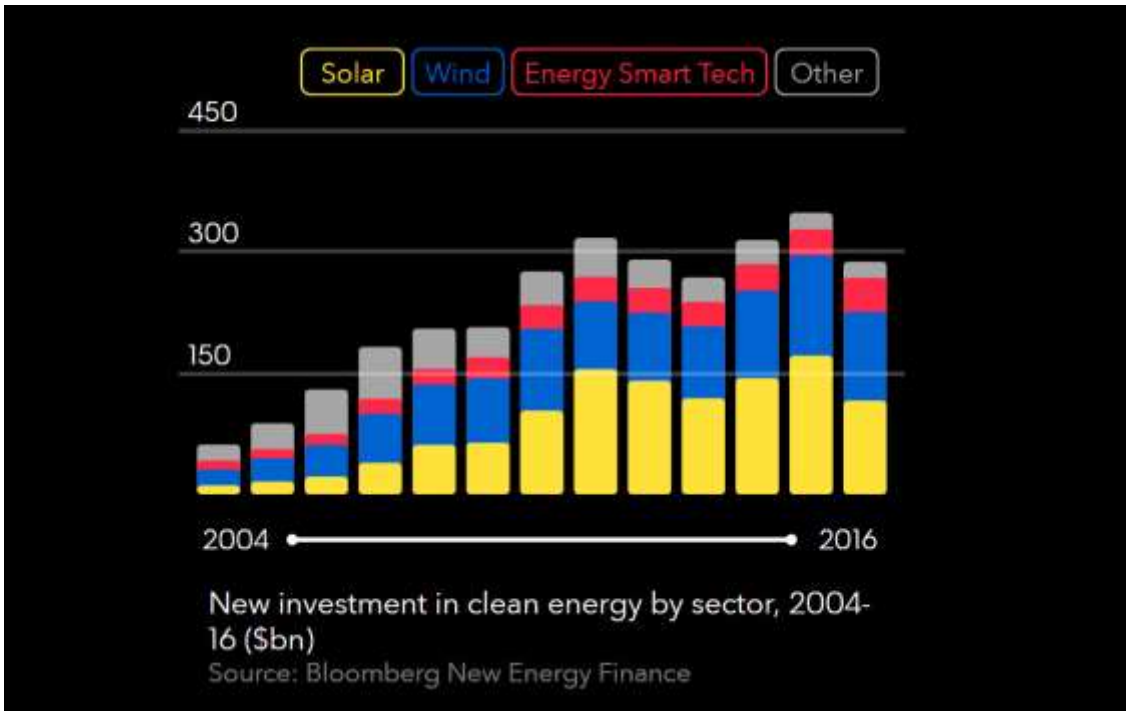
Pennsylvania continues to invest in renewable and alternative energy projects. In the 2016 reporting year, 22 alternative energy Pennsylvania Energy Development Authority (PEDA) projects awarded in 2014 continued to be deployed. Seven projects have been completed and are operating. Nine projects were nearly completed and most were operating with only administrative reporting and final payments to be made. Six projects were still under construction with no current issues. For the 22 projects, the anticipated energy savings (through fuels switching and reduced consumption) are 13,840,945 kilowatt hours per year (kWh/yr), with an additional savings of 72,145 thousand cubic feet (Mcf) of natural gas each year. Projected new alternative energy generation is estimated to be 64,873,111 kWh/yr. The combined energy savings and new generation equals to 99,843,883 kWh/yr. As projects are completed and operating, PEDA will receive at least one follow-up annual report which will detail actual alternative energy generation and energy savings from this suite of projects.

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

6. 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: New Investment in Clean Energy by Sector (2004-2016)

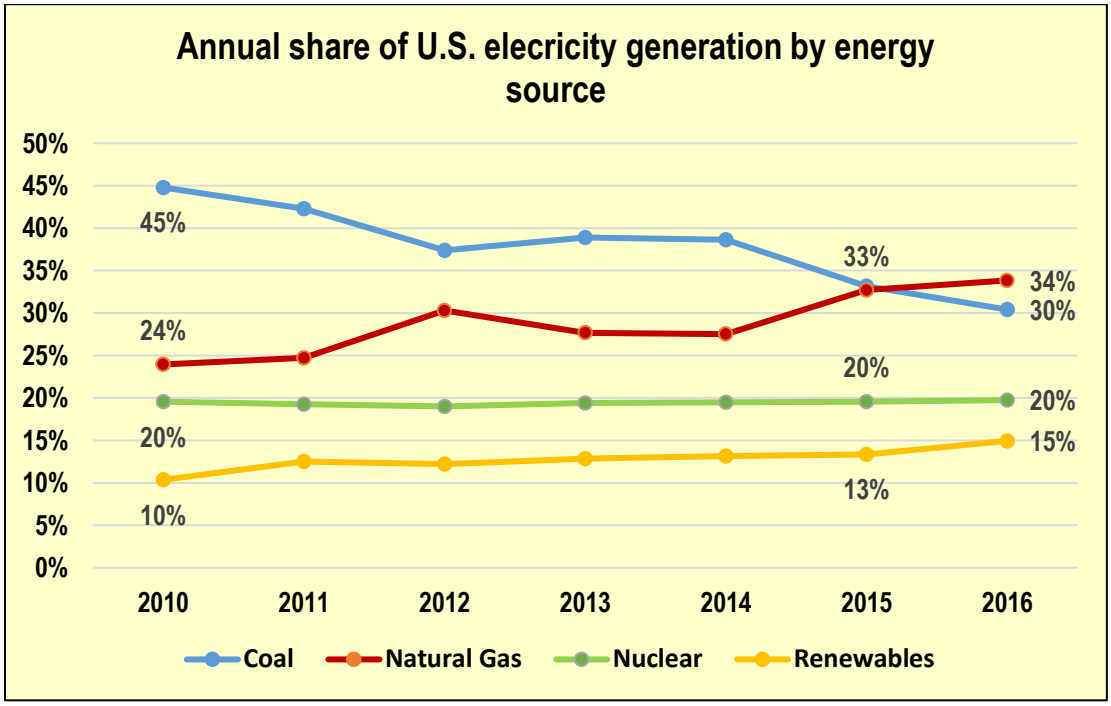


In 2015, clean energy investments, including renewable energy, topped $329 billion, globally. Over 1,000 GW of capacity in the four subsectors (geothermal, hydro, solar, and wind) was added globally between 2005 and 2015.[16]

The United States ranks second in the world for renewable energy capacity, and has a mature hydro industry that will soon be overtaken by wind power generation. Chart 6 shows the average yearly U.S. electricity generation by energy source.

[16] Geothermal Energy Association, *2016 Annual U.S. & Global Geothermal Power Production Report.*

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

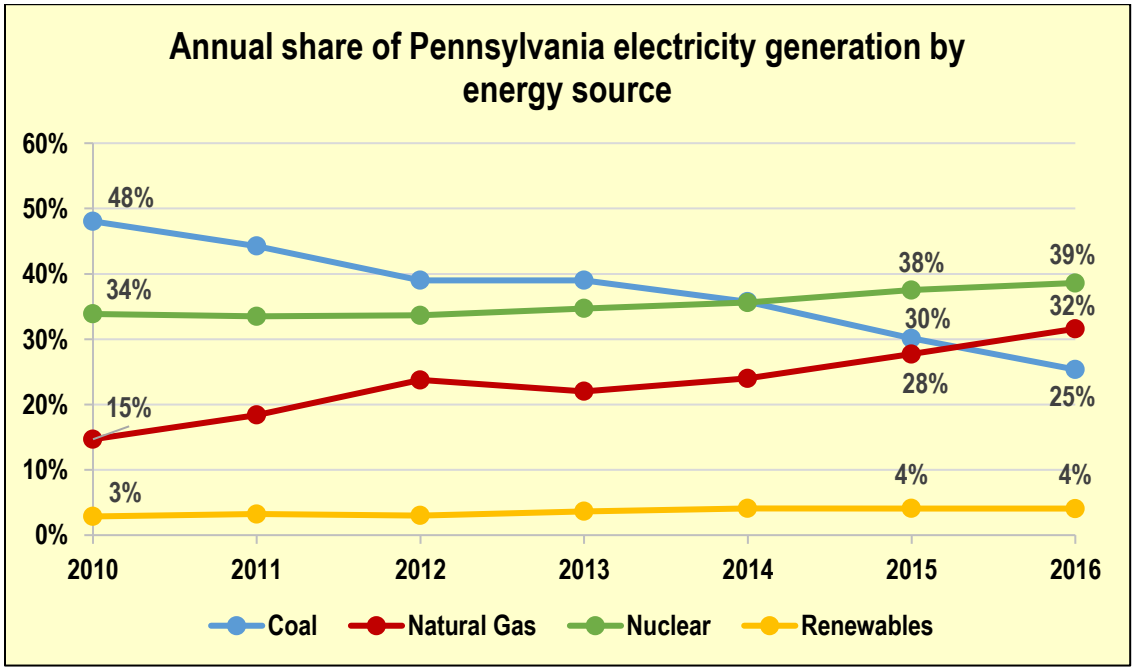


Source: *Energy Information Administration Electricity Data Browser*

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 third quarter of 2016 and has brought over $2.7 billion in capital investment into the state.[17]

[17] http://www.nrel.gov/docs/fy17osti/67624.pdf

Chart 7: Pennsylvania Annual Electric Generation by Energy Source



Source: *Energy Information Administration Electricity Data Browser*

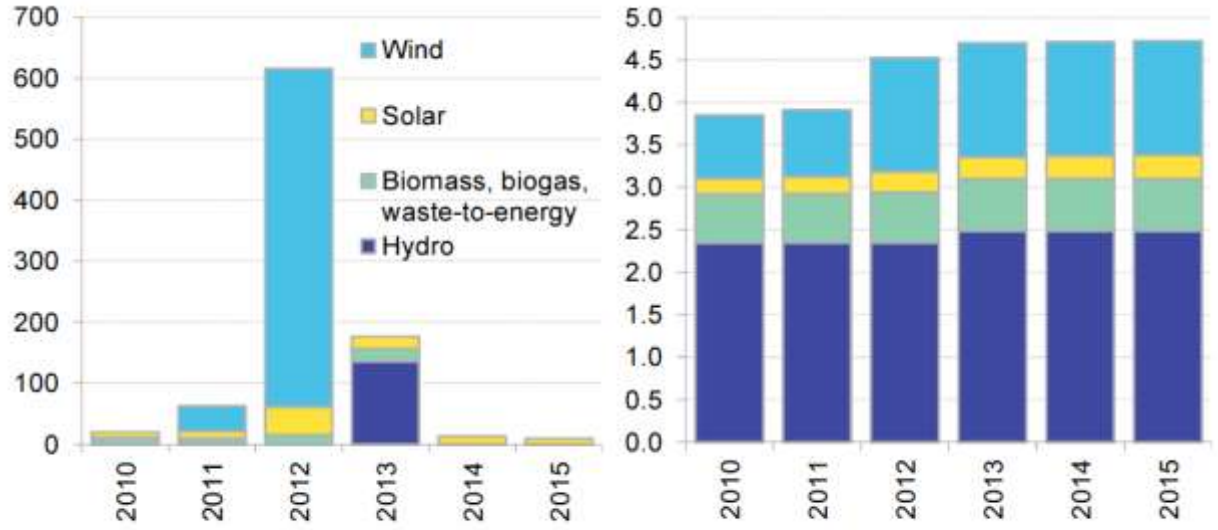
Chart 7 shows the annual Pennsylvania electric generation by energy source. In 2016, approximately 4% the state's electricity generation was from renewable energy sources.[18] The chart mimics the general trends in the U.S. electricity generation (Chart 6), where electricity generation from coal is steadily 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.

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

[18] Energy Information Administration Electricity Data Browser
[19] http://www.eia.gov/todayinenergy/detail.php?id=29492&src=email

changes affecting the incentive programs, either positively or negatively, may have an almost immediate impact on the market's attractiveness for solar and wind.

Chart 8: PA Renewable Capacity Additions (MW) and PA Cumulative Renewable Capacity (GW)



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

As shown in Chart 8, from 2010 – 2015, Pennsylvania added 836 MW of utility-scale renewable energy capacity, including 596 MW of onshore wind and 138 MW of hydro. 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]

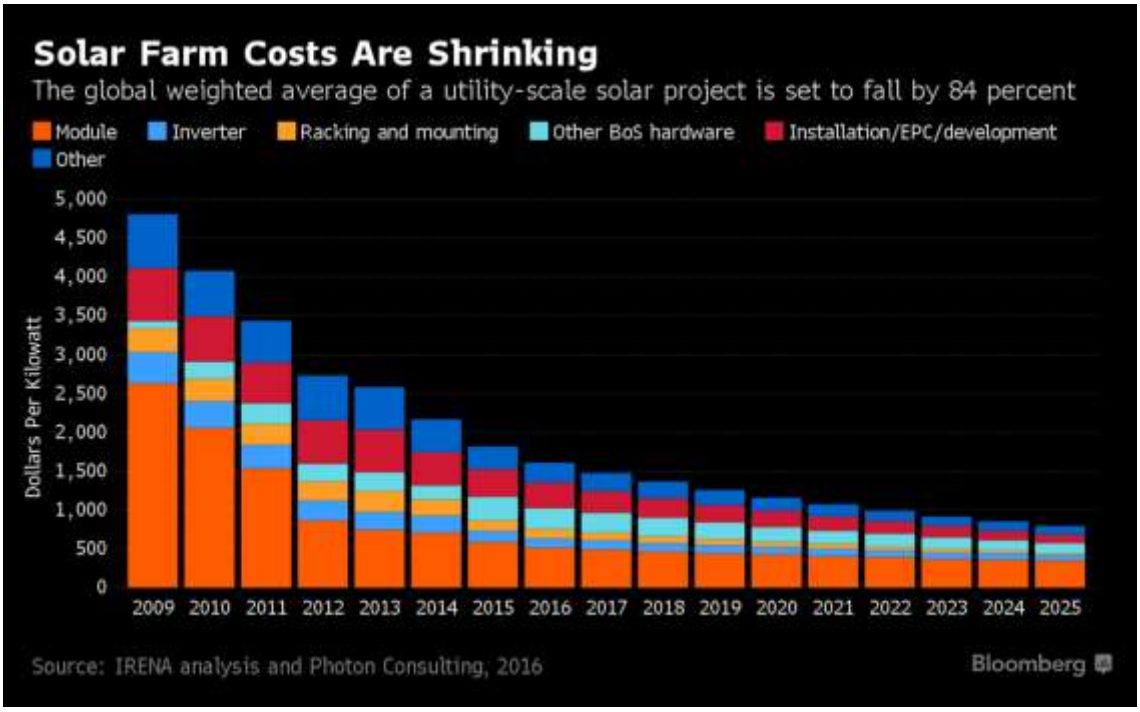
A. Solar

Nationally and within the PJM service area, the rapid growth in the deployment of solar has been almost entirely driven by utility-scale and commercial projects, particularly in states with very favorable incentives; although the residential solar segment has also seen installations continue to increase at a steady pace.[21]

As shown in Chart 9, 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 through 2025.[22]

[20] Bloomberg New Energy Finance and Business Council for Sustainable Energy, State energy factsheet: Pennsylvania
[21] Bloomberg New Energy Finance, United States country profile.
[22] https://www.bloomberg.com/news/articles/2017-01-03/for-cheapest-power-on-earth-look-skyward-as-coal-falls-to-solar

Chart 9: Solar Farm Cost Trend



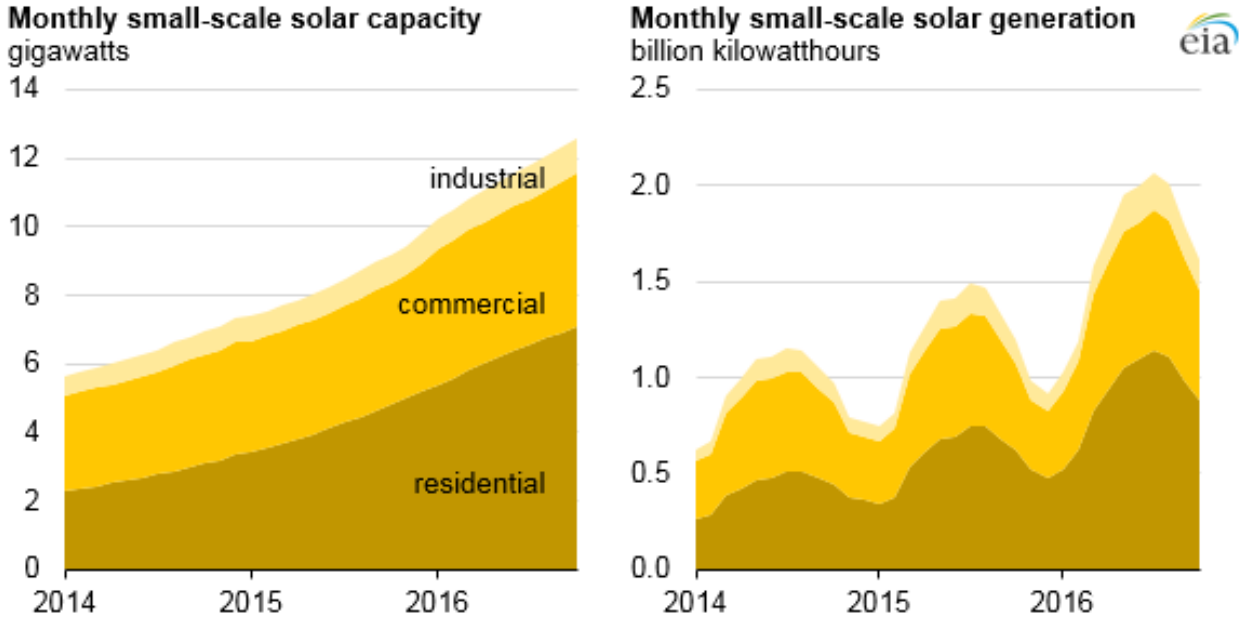
As shown in Chart 10, as of October 2016, the United States had a total of 12.6 GW of small-scale solar PV installed. Of this capacity, 56% was in the residential sector, 36% in the commercial sector, and 8% in the industrial sector. It is important to note that technologies such as solar and wind are non-dispatchable and generate power only when the respective resources are available (sun shining or wind blowing). Therefore, the capacity factors[23] for these resources are typically lower than those of the other resources.[24] Per EIA data, in 2015 the capacity factor for utility scale solar was 25.8%.[25] In Pennsylvania, 15% is a more realistic capacity factor. Adding energy storage to these resources does not increase the capacity factor, but it does allow for more consistent and reliable dispatching of these resources.

[23] 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.

[24] U.S. Energy Information Administration, Electric Generators Report - 2016

[25] U.S. Energy Information Administration Electric Power Monthly - https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_b

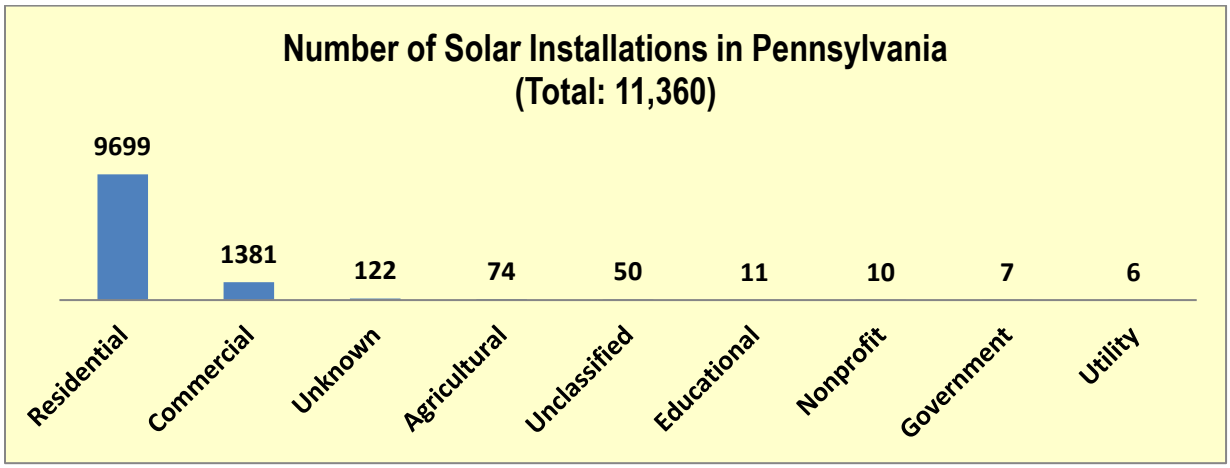
Chart 10. U.S. Monthly Small Scale Solar Capacity (GW) and Monthly Small Scale Solar Capacity Generation (billion kWh)



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

In Pennsylvania, 295.7 MW of solar electric capacity has been installed as of the end of the 2016, and is expected to grow to 572 MW of installed capacity over the next five years. $98.10 million was invested in Pennsylvania in 2016 for solar installations, and 34,000 homes are powered by electricity from solar energy.[26]

Chart 11: Number of PA Solar Installations



(The above data excludes utility scale projects larger than 5MW)

[26] Solar Energy Industry Association - http://www.seia.org/state-solar-policy/pennsylvania

As shown in Chart 11, most of the solar installation in Pennsylvania are in the residential and commercial sectors. Chart 12 shows the top five counties for solar installations and Chart 13 shows the percentage of retired solar AECs that originated in Pennsylvania.

Chart 12: Top Five Pennsylvania Counties for Solar Installations

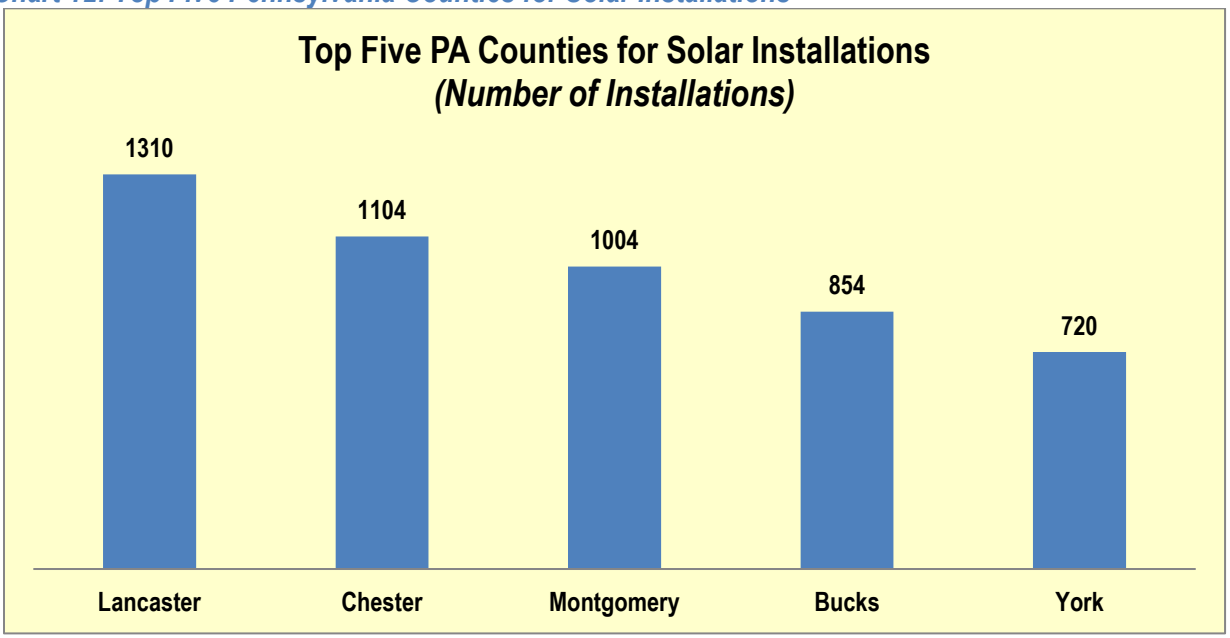
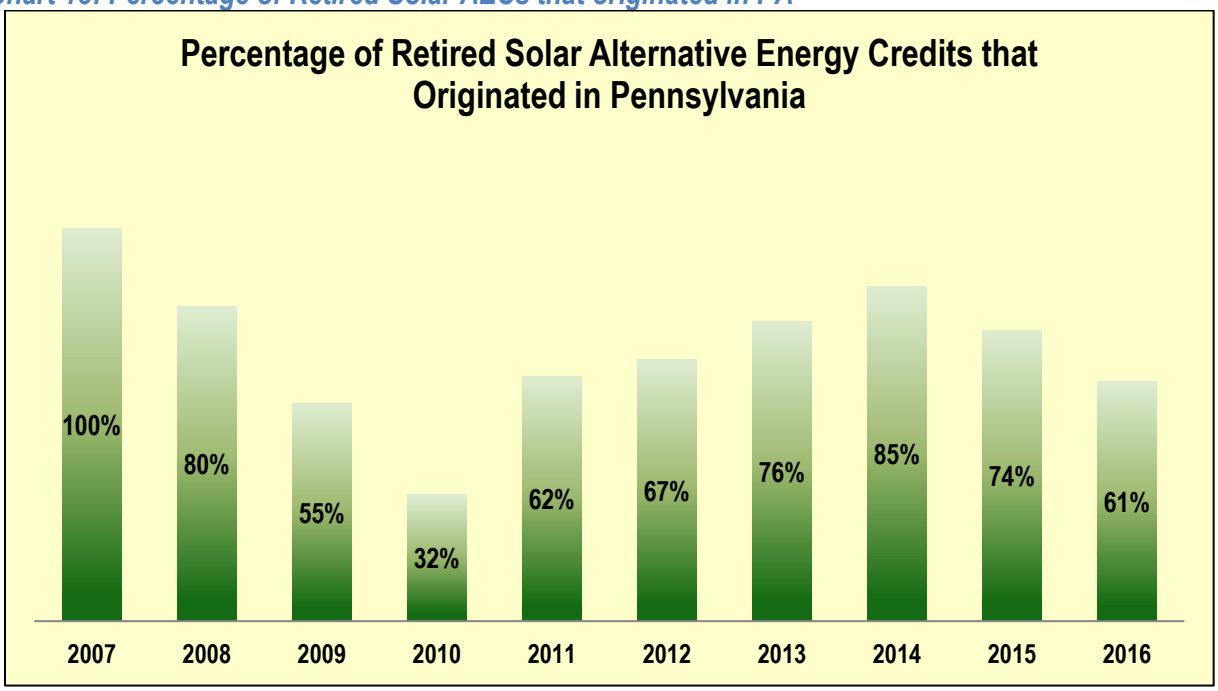
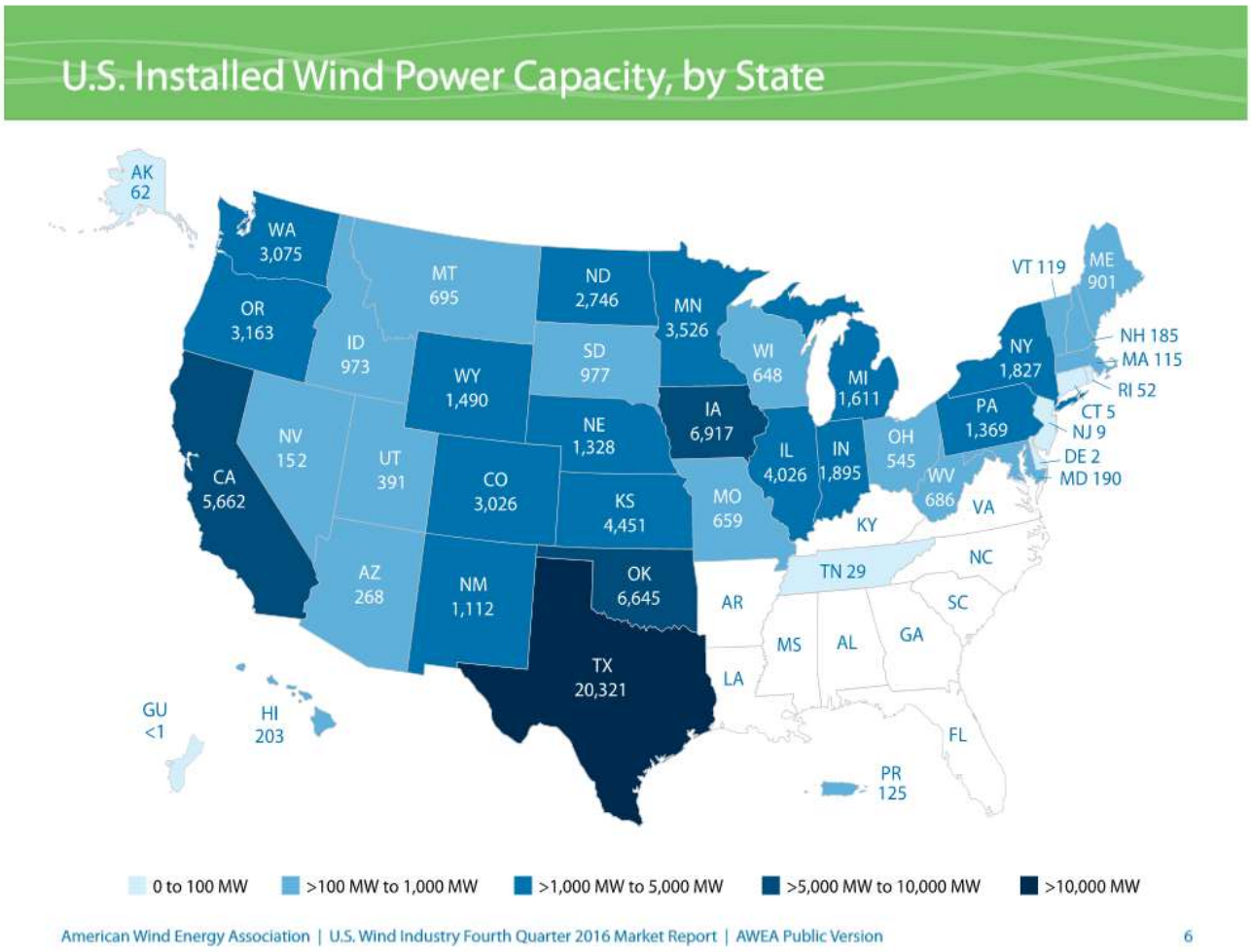


Chart 13: Percentage of Retired Solar AECs that originated in PA



B. Wind

In 2016, the United States saw a total of 8,029 MW of wind electricity generation capacity installed. More than 59,000 MW of wind capacity was under development in the U.S. at the beginning of February 2017.



Wind speed is critical to making a wind electricity generation project viable. In Pennsylvania, the best wind resource is typically found at higher elevations and along the shore of Lake Erie. Approximately 0.56% (661 square kilometers (221 square miles)) of the state's land is suitable for wind generation with a gross capacity factor of 30% at a height of 80 meters (262 feet). A report from 2010 suggests that Pennsylvania has an installed wind capacity potential of 3,307 MW

with an estimated generation potential of 9,673 GWh, based on a 33% capacity factor.[27]

As of May 31, 2016, Pennsylvania had 1,346 MW of installed wind capacity which is roughly 41% of the potential capacity. This amount of development equates to a $2.7 billion capital investment and supports between 1,000 and 2,000 direct and indirect jobs. Total in-state power generation from wind energy is about 2%.[28]

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. Today, the sector is the second largest source of non-fossil fuel generation behind nuclear 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.[29] 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.[30]

7. 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 that 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, 2016, and the AEC price trend through this same time-

[27] Estimate of Windy Land Area and Wind Energy Potential, for areas >=30% Capacity Factor at 80M, February 4, 2010

[28] American Wind Energy Association 2016a

[29] 2016 International Trade Administration (ITA) Energy Top Markets Report

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

period. Charts 14 and 15 reveal the cumulative number of Pennsylvania customers who received electrical interconnections for their Solar, total Tier I (inclusive of solar) and Tier II generation systems. Charts 16 and 17 show the cumulative nameplate electric generating capacities for Solar, Tier I non-solar, and Tier II installations.

Chart 14: Number of Tier I and Solar PV Customers Interconnected Per Year

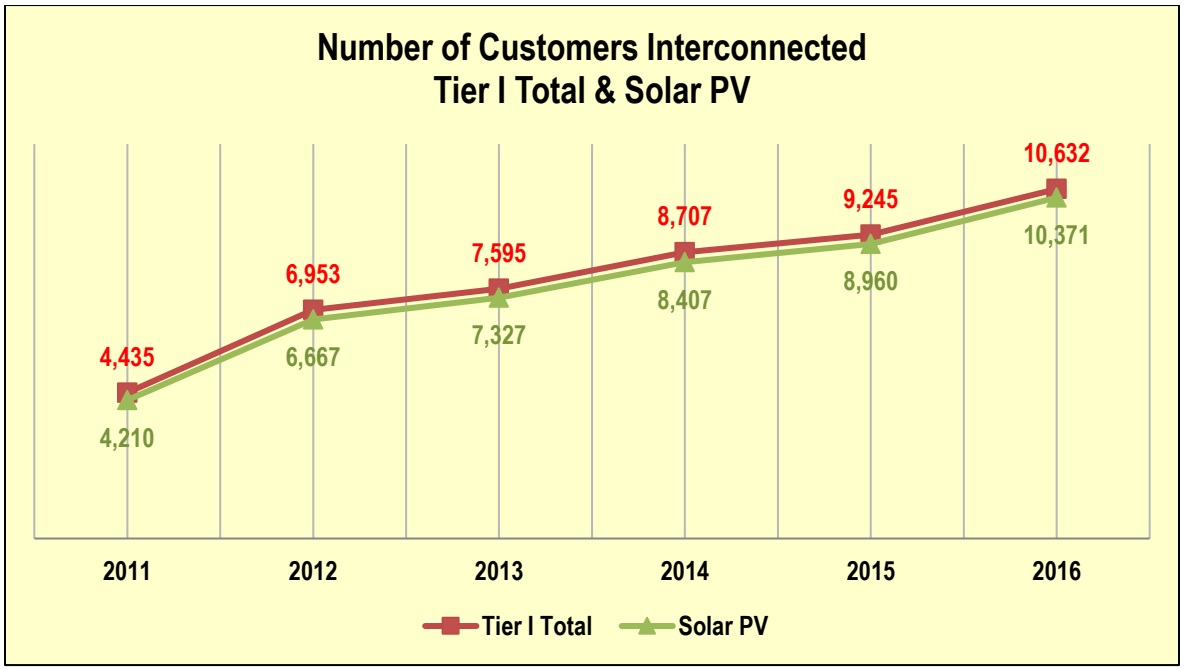


Chart 15: Number of Tier II Customers Interconnected Per Year

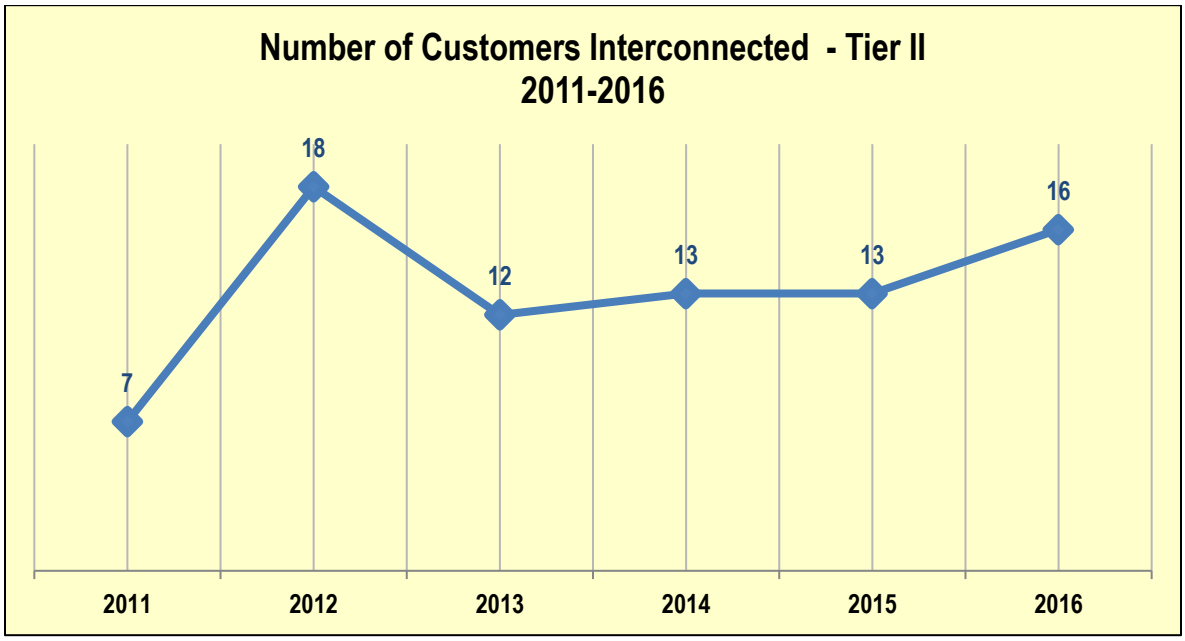


Chart 16: Cumulative Tier I and Solar Nameplate Capacity

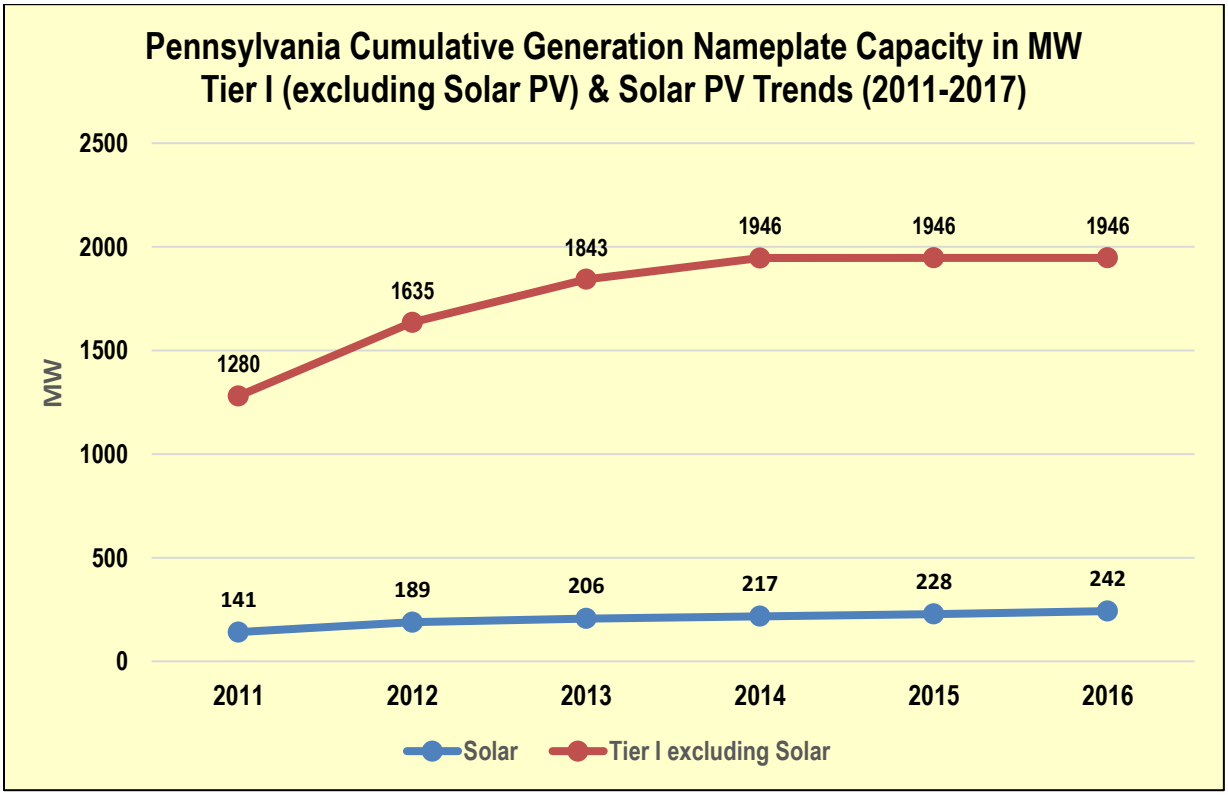
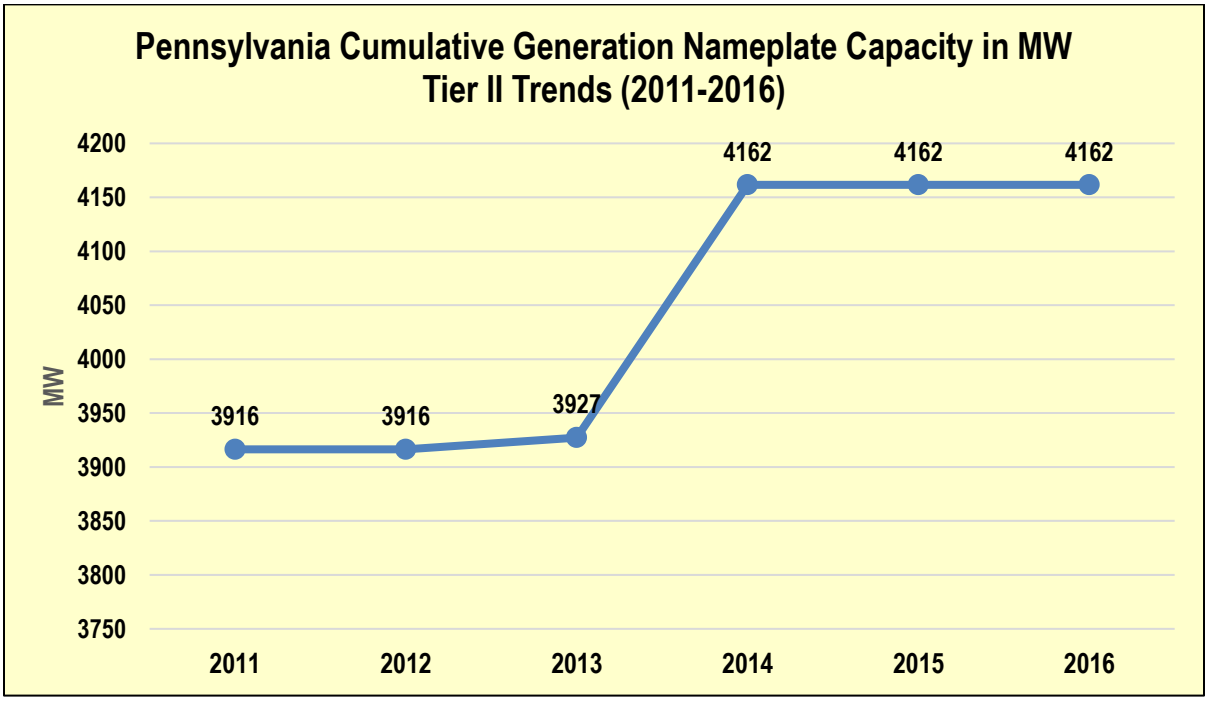


Chart 17: Cumulative Tier II Nameplate Capacity



Charts 18, 19 and 20, on the following pages, provide a comparison of average spot market prices 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.

Chart 18: Solar Average Spot Market VS. Weighted Average AEC Credit Prices

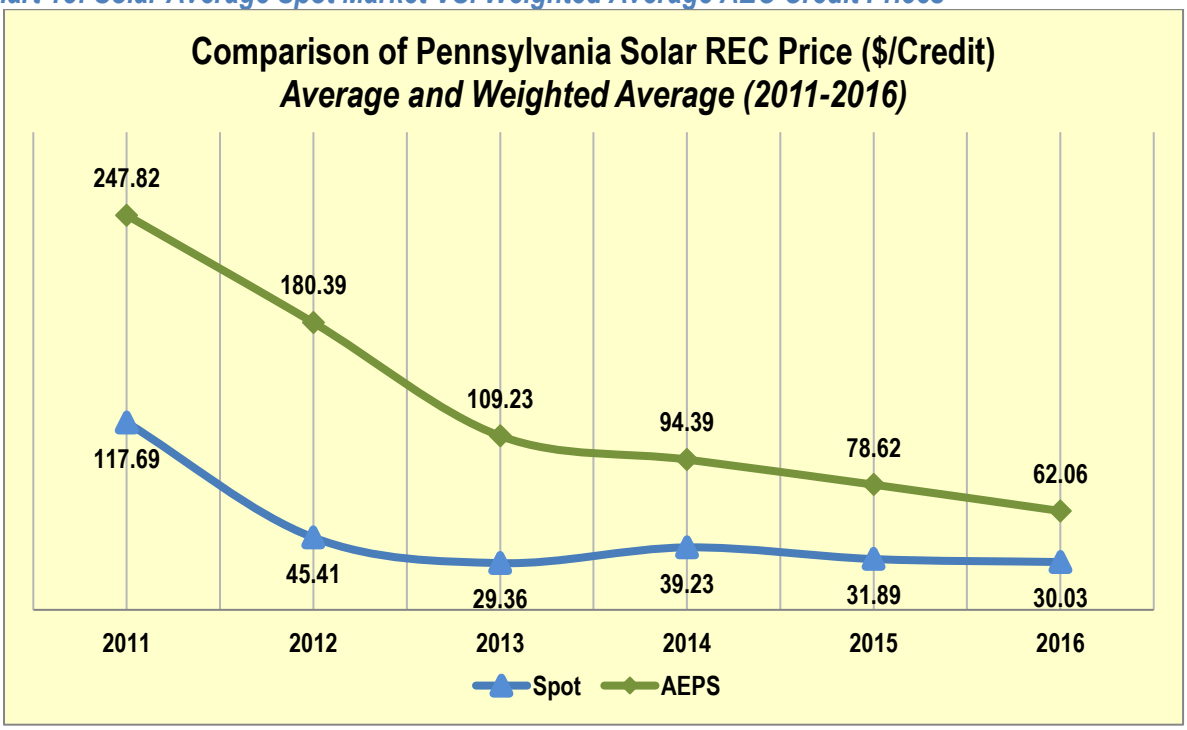


Chart 19: Tier I Average Spot Market vs. Weighted Average AEC Credit Prices

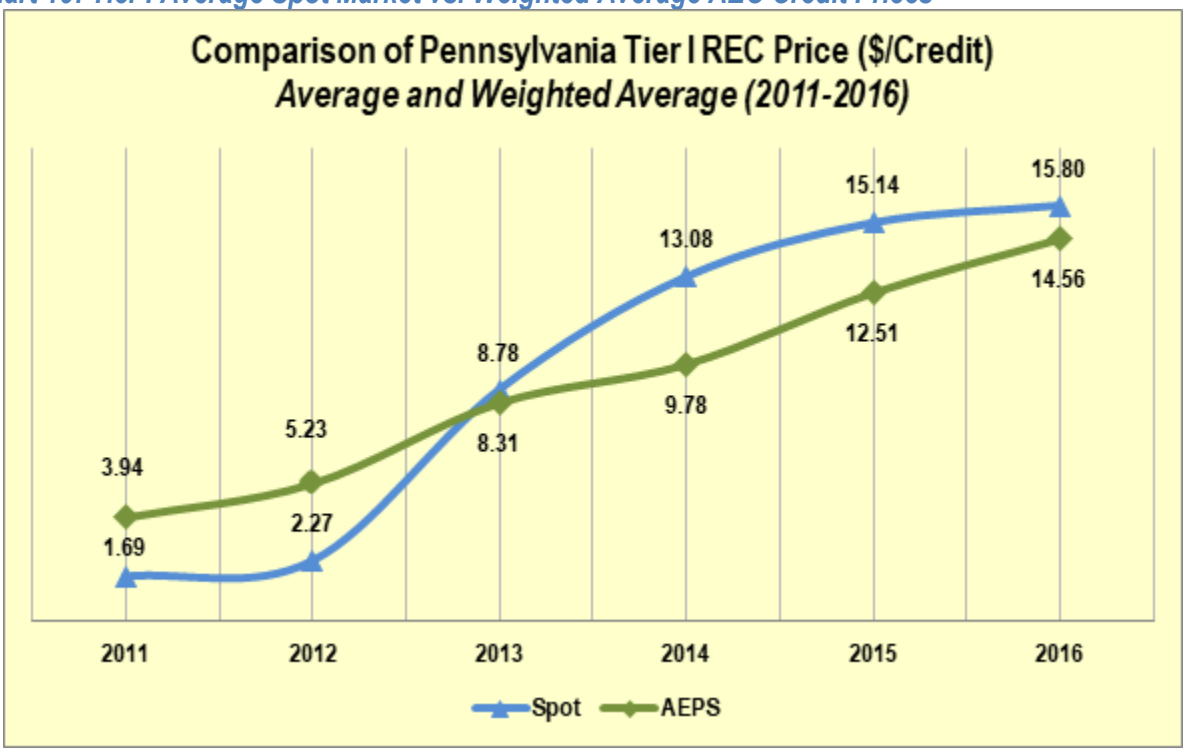
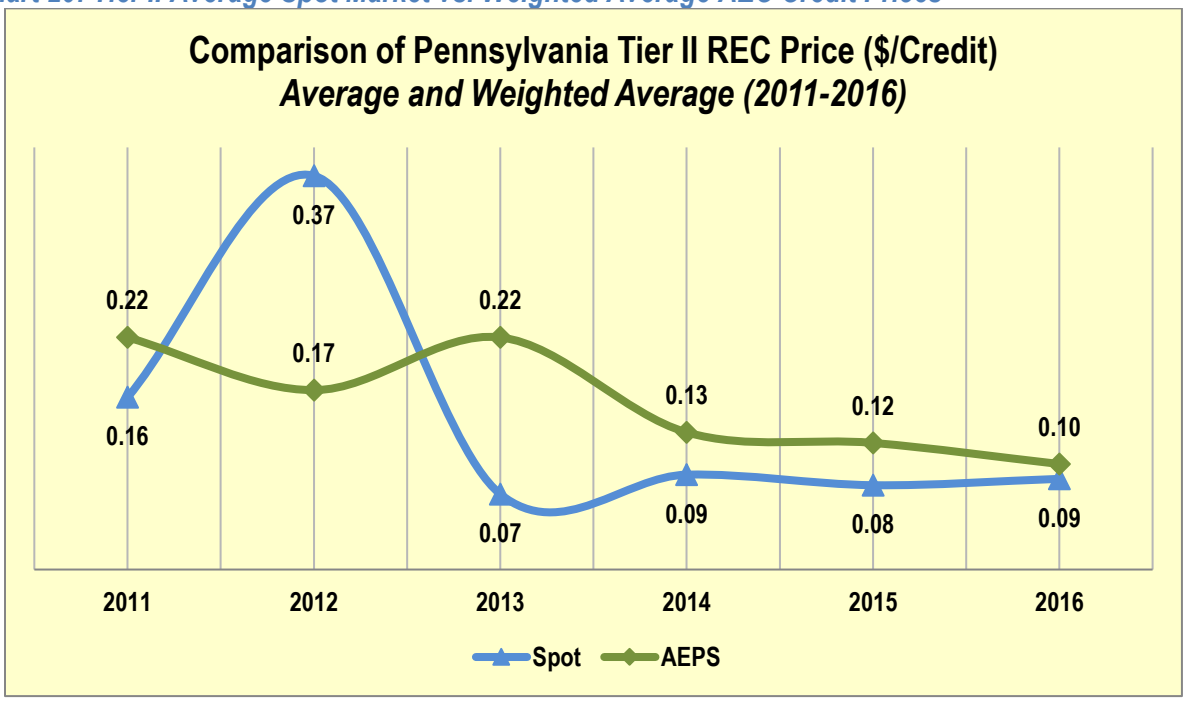
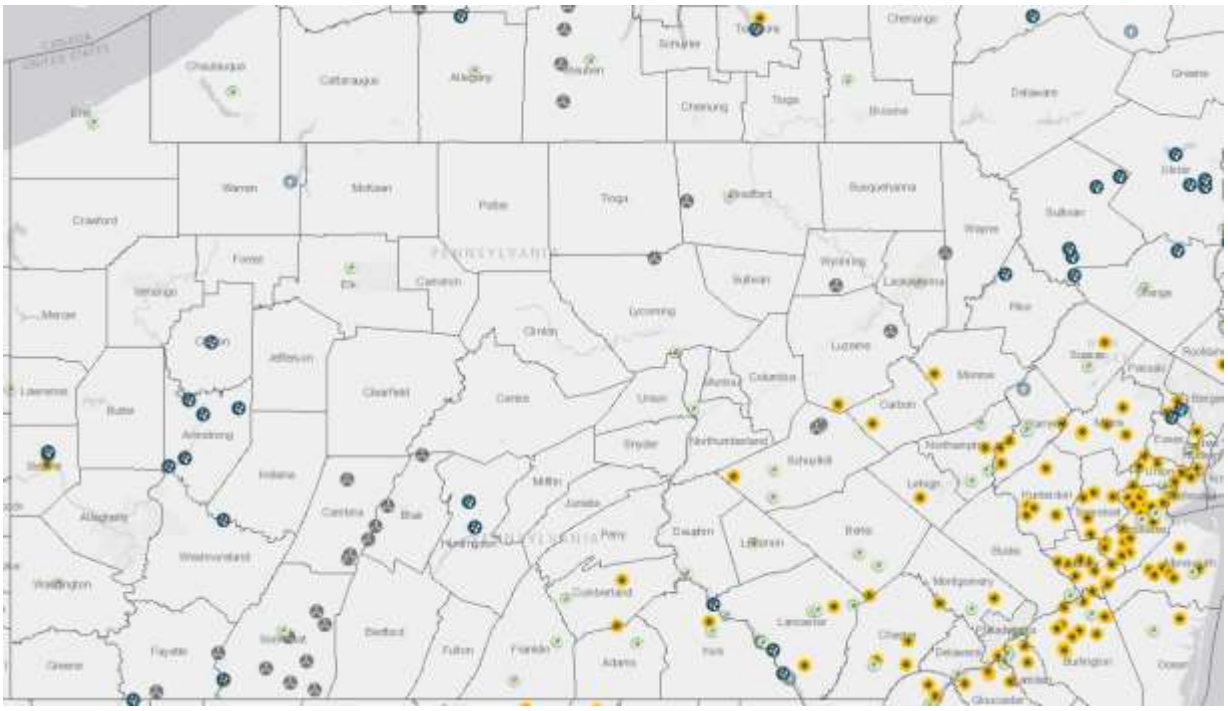


Chart 20: Tier II Average Spot Market vs. Weighted Average AEC Credit Prices



8. 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 (2015 year-end data).[31]



The Pennsylvania AEPS website[32] maintains a summary of qualified generation facilities and qualified energy efficiency and demand-side management (EE/DSM) resources. There were 12,630 qualified generation facilities certified as of May 31, 2016. Of those qualified generation facilities, 8,897 facilities (70.4 percent) are located in Pennsylvania and 3,733 facilities are located outside of Pennsylvania.

Statistics for AEPS-registered generators, as of May 31, 2016, include:

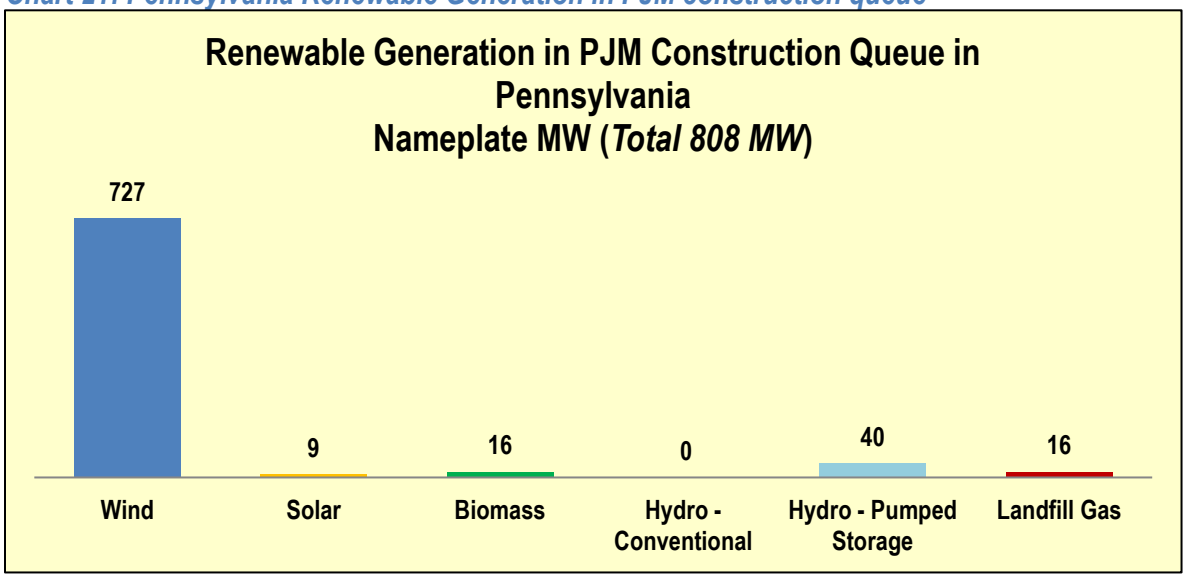
- 8,897 generators located in Pennsylvania with a total nameplate generating capacity of 7,652 MW
- 3,733 generators located outside of Pennsylvania with a total nameplate generating capacity of 12,036 MW
- 8,730 solar facilities in Pennsylvania with a total nameplate generating capacity of 243 MW
- 3,548 solar facilities outside of Pennsylvania with a total nameplate generating capacity of 624 MW

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

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 21 summarizes the proposed renewable generation projects in the queue for Pennsylvania through May 31, 2018.[33] Withdrawn projects and projects that are in service are not included.

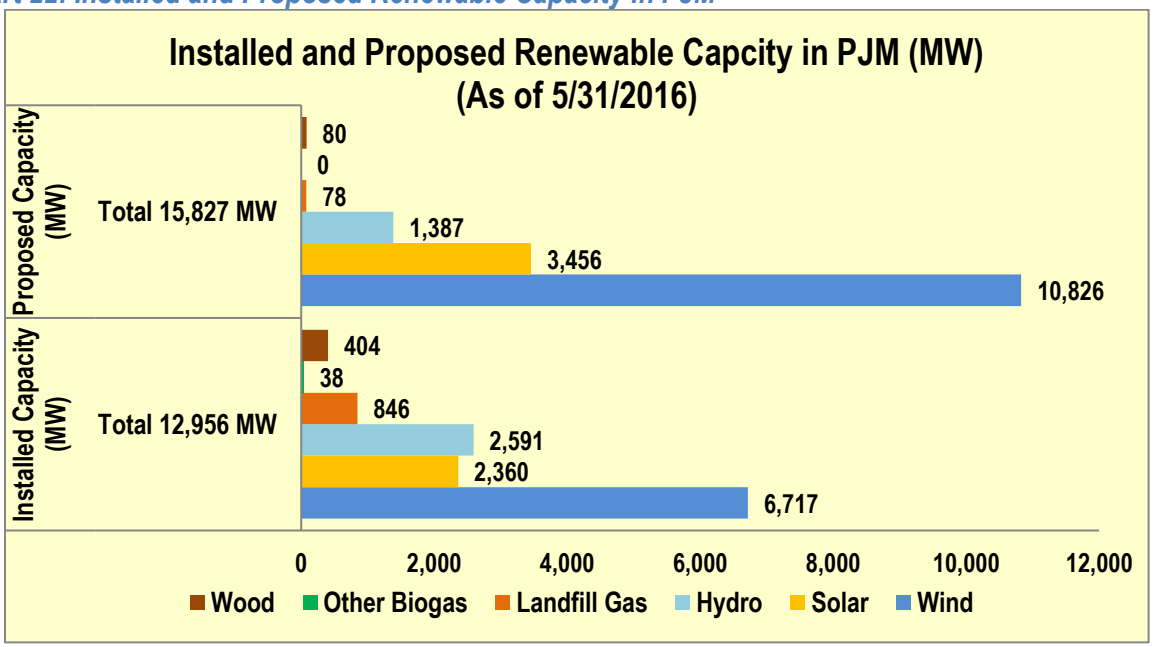
Chart 21: Pennsylvania Renewable Generation in PJM construction queue



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 22.[34]

[33] http://www.pjm.com/planning/generation-interconnection/generation-queue-active.aspx
[34] PJM-EIS Public Reports, Renewable Generators Registered in GATS and PJM queue. Includes "Active" and projects "Under Construction"

Chart 22: Installed and Proposed Renewable Capacity in PJM



PJM states with renewable portfolio standards include Pennsylvania, Michigan, Ohio, North Carolina, Illinois, Delaware, District of Columbia, Maryland, and New Jersey. Virginia and Indiana have Renewable Portfolio Standard (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[35].

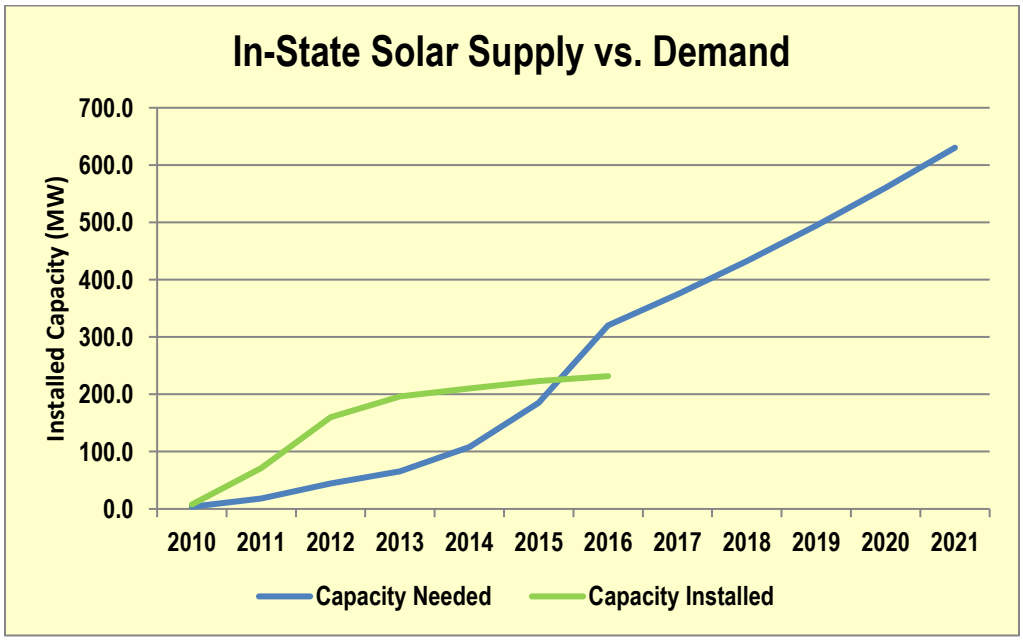
The RPS requirements of the PJM states and the District of Columbia vary considerably regarding generation resources eligible to meet the requirements. Differences are found in the types of renewable and/or alternative energy generation resources that qualify. Some states allow resources that are not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

[35] EIA Annual Energy Outlook 2016 – Published August 2016

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 23 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 our own installed capacity are realized in each of the next several years. Even if all the solar projects proposed for Pennsylvania in the PJM planning queue came to fruition, it would still only add an additional 9 MW of installed capacity. 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. Despite this, the graph illustrates that very likely, a significant and increasing percentage of out-of-state solar credits will be necessary to comply with the annual solar obligations of the AEPS.

Chart 23: Pennsylvania In-State Solar Supply vs. Demand



Note: Solar PV supply in Chart 23 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 for Pennsylvania is summarized in Table 7 in Appendix A. Please note that a capacity factor of 13 percent was used for this table.

9. Recent Activity Since End of Compliance Year

A. Quarterly Adjustment

Act 129 of 2008, P.L. 1592, (Act 129) was signed into law on Oct. 15, 2008, and took effect 30 days thereafter on Nov. 14, 2008. Section 5 of Act 129 adds Section 2814 to the Pennsylvania Public Utility Code expanding the types of alternative energy sources that qualify as Tier I alternative energy sources under the AEPS Act to include specific categories of low-impact hydropower and biomass energy. Specifically, Section 2814 added to Tier I, Pennsylvania municipality-owned and Pennsylvania electric cooperative-owned hydropower facilities that met certain requirements. Specifically, such facilities must have a FERC licensed capacity of 21 MW or less and have held a FERC hydropower license that was issued on or prior to January 1, 1984, and held on July 1, 2007. Section 2814 also added generation of electricity from Pennsylvania facilities that utilize byproducts of the pulping process and wood manufacturing process, including bark, wood chips, sawdust and lignins in spent pulping liquors to the Tier I biomass definition. Section 2814 further requires the Commission to increase, at least quarterly, the percentage share of Tier I resources to be sold by EDCs and EGSs to reflect any new Tier I resources added as a result of the amendment.[36]

On May 28, 2009, the Commission adopted a Final Order[37] at Docket Number M-2009-2093383 that established the procedures and guidelines to follow for low-impact hydropower facilities and generators utilizing byproducts of pulping and wood manufacturing processes to follow in order to qualify as a Tier I resource. The Final Order also established reporting requirements and related procedures that the Commission uses to adjust the AEPS Act Tier I requirements that EDCs and EGSs must meet to account for the newly qualified Tier I resources.

On July 8, 2016, the Commission notified all EGSs and EDCs by Secretarial Letter that it discovered an error in how the non-solar Tier I quarterly adjustments had previously been calculated.[38] The Secretarial Letter explained that the Commission corrected this error for the 2016 compliance year. The Secretarial Letter referenced

[36] See 66 Pa. C.S. § 2814

[37] *See Implementation of Act 129 of 2008 Phase 4 – Relating to the Alternative Energy Portfolio Standards Act*, Final Order at Docket No. M-2009-2093383, entered on May 28, 2009.

[38] AEPS Compliance Obligation, July 8, 2016, Secretarial Letter at Docket No. M-2009-20933831, which can be found at: http://www.puc.state.pa.us/Electric/docs/AEPS/Sec_Ltr-AEPS_Q_Adjmt_Error_Notice.docx.

an increase of approximately 7%, when in reality it was an increase of approximately 7% of the 5.25% unadjusted, non-solar requirement. The actual result was an absolute increase of about 0.37% to the unadjusted, non-solar Tier I requirement for a final adjusted Tier I obligation of 5.62%. In light of the miscalculation, the Commission requested comments on the impact of the quarterly adjustment obligation increase, on possible remedies to mitigate any impact, and on any other appropriate action to be taken by the Commission. The Commission by Final Order extended the true-up period from November 30, 2016 to May 1, 2017, for the non-solar Tier I adjustment obligations relevant to the 2016 AEPS Act compliance year.

B. Rulemaking

During the 2016 compliance year, the Commission was still engaged in efforts to update its regulations to clarify certain issues of law, administrative procedure and policy. A summary of the proposed changes follows:

- The addition of definitions for aggregator, default service provider, grid emergencies, micro-grids and moving water impoundments.
- Revisions to the interconnection rules to reflect the increase in limits on customer-generator capacity contained in the Act 35 of 2007 amendments.
- A process for obtaining Commission approval to net meter alternative energy systems with a nameplate capacity of 500 kilowatts or greater.
- Clarification of the virtual meter aggregation language.
- Clarification of net metering compensation for customer-generators receiving generation service from EDCs, default service providers and EGSs.
- Revisions to the definitions for low-impact hydropower and biomass to conform with the Act 129 of 2008 amendment.
- Addition of provisions for adjusting Tier I compliance obligations on a quarterly basis to comply with the Act 129 of 2008 amendments.
- Addition of provisions for reporting requirements for new low-impact hydropower and biomass facilities in Pennsylvania to comply with the Act 129 of 2008 amendments.
- Clarification of Commission procedures and standards regarding generator certification and the use of estimated readings for solar photovoltaic facilities.
- Clarification of the authority given to the Program Administrator to suspend or revoke the qualification of an alternative energy system and to withhold or retire past, current or future alternative energy credits for violations.
- Clarification of the process for verification of compliance with the AEPS Act.

- Standards for the qualification of large distributed generation systems as customer-generators.

On Sept. 2, 2015, Commission Chairman Gladys M. Brown provided testimony on net metering before the Pennsylvania House of Representatives' Consumer Affairs Committee. Chairman Brown testified on the history of net metering and prior actions of the Commission in support of net metering. The Chair further testified on the Commission's ongoing rulemaking process and the Commission's rationale for changing and clarifying the long-standing rules and policies regarding the AEPS.

At its Feb.11, 2016 Public Meeting, the Commission issued a Final Rulemaking Order regarding implementation of the AEPS at Docket No. L-2014-2404361. That Order adopted final-form regulations that revised Chapter 75 of the Commission's regulations. The Order was subsequently delivered to the Independent Regulatory Review Commission (IRRC)and the Legislative Oversight Committees on March 22, 2016.

On May 19, 2016, the IRRC held a public meeting during which it reviewed and subsequently disapproved the PUC's final-form regulations. In its Disapproval Order dated June 2, 2016, the IRRC found that the Commission did not have the statutory authority to impose the proposed limits on net metering. In response to the IRRC's findings, the Commission issued an Amended Final Rulemaking Order on June 9, 2016, that removed the non-statutory limits, in reference to the previously proposed 200% cap, on a customer-generator's ability to net meter excess generation. The Amended Final Rulemaking Order was delivered to the IRRC and the Legislative Oversight Committees on June 13, 2016.

At its public meeting on June 30, 2016, the IRRC reviewed the modified final-form regulations and again disapproved them. In its disapproval Order dated July 12, 2016, the IRRC found that the Commission's deletion of the non-statutory limits on net metering, coupled with the revised definition of "utility," created an unclear and ambiguous regulation. The IRRC further stated that they were not convinced of the need for all provisions of this rulemaking, noting that while the 200% limit was deleted from the rulemaking, other unspecified provisions appear to limit a customer-generator's ability to net meter.

The Pennsylvania House Consumer Affairs Committee and the Senate Consumer Protection and Professional Licensure Committee had thirty days from July 12, 2016, to act on the IRRC's Disapproval Order. Since neither Committee issued a

concurrent resolution to the IRRC order, the final-form regulation package was deemed approved by the Committees. Subsequently, on August 11, 2016, the Commission submitted to the Pennsylvania Attorney General's office the modified final-form regulations for review as to form and legality and as required by the Regulatory Review Act. In consultation with the Attorney General's office, the Commission modified the definition of "utility" for greater clarity and the Attorney General's office subsequently approved the rulemaking package. At its Public Meeting on October 27, 2016, the Commission voted to implement the modified regulations which, upon publishing in the *Pennsylvania Bulletin*, became effective on November 19, 2016.

10. 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: 2016 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				
138,167,579	Solar	0.25	351,889	$62.06	$21,476,534	0
	I	5.25	7,757,649	$14.56	$105,782,714	13
	II	8.2	11,333,354	$0.10	$1,034,810	0
	Total	13.7	19,442,888	N/A	$128,294,058	N/A

Table 3: 2016 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	166,161				
Solar		0.25%	415	415	In Compliance
Tier I (non-solar)		5.25%	8,723	9,341	In Compliance
Tier II		8.20%	13,625	13,625	In Compliance
Duquesne Light and EGSs	12,990,499				
Solar		0.25%	32,476	32,558	In Compliance
Tier I (non-solar)		5.25%	682,001	730,292	In Compliance After ACP
Tier II		8.20%	1,065,221	1,065,900	In Compliance
Met-Ed and EGSs	13,921,498				
Solar		0.25%	34,804	34,870	In Compliance
Tier I (non-solar)		5.25%	730,879	782,649	In Compliance
Tier II		8.20%	1,141,563	1,141,497*	In Compliance
PECO and EGSs	37,475,409				
Solar		0.25%	93,689	93,781	In Compliance
Tier I (non-solar)		5.25%	1,967,459	2,106,849	In Compliance After ACP
Tier II		8.20%	3,072,984	3,072,959*	In Compliance After ACP
Penelec and EGSs	13,554,118				
Solar		0.25%	33,885	34,045	In Compliance
Tier I (non-solar)		5.25%	711,591	761,987	In Compliance
Tier II		8.20%	1,111,438	1,111,444	In Compliance
Penn Power and EGSs	4,361,649				
Solar		0.25%	10,904	6,765	In Compliance
Tier I (non-solar)		5.25%	228,268	245,191	In Compliance
Tier II		8.20%	357,655	357,753	In Compliance
Pike County and EGSs	46,502				
Solar		0.25%	116	117	In Compliance
Tier I (non-solar)		5.25%	2,441	2,614	In Compliance
Tier II		8.20%	3,813	3,814	In Compliance

Distribution Service Territory	Total Energy Sold (MWhs)	Alternative Energy Requirement	Credits Required	Credits Retired	Compliance Status
PPL and EGSs	35,189,998				
Solar		0.25%	87,975	88,063	In Compliance
Tier I (non-solar)		5.25%	1,847,475	1,979,760	In Compliance After ACP
Tier II		8.20%	2,885,580	2,887,175	In Compliance After ACP
UGI Electric and EGSs	945,481				
Solar		0.25%	2,364	2,368	In Compliance
Tier I (non-solar)		5.25%	49,638	53,155	In Compliance
Tier II		8.20%	77,529	77,712	In Compliance
Wellsboro Electric	119,924				
Solar		0.25%	300	300	In Compliance
Tier I (non-solar)		5.25%	6,296	6,742	In Compliance
Tier II		8.20%	9,834	9,834	In Compliance
West Penn Power and EGSs	19,396,329				
Solar		0.25%	48,491	48,579	In Compliance
Tier I (non-solar)		5.25%	1,018,307	1,092,013	In Compliance
Tier II		8.20%	1,590,499	1,592,641	In Compliance

* Apparent credit deficiency due to credit being retired to a different distribution territory.

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Table 4: AEC State of Origin – Used for compliance in 2016

Tier	PA	NJ	MD	VA	WV	IL	OH	DE	NC	IN	KY	TN
Solar	215,489	386	107	7,817	1,947	13,069	22,227	10,322	80,497	14	2	12
Tier I	2,505,353	75,348	35,364	1,537,660	545,243	1,930,498	457,436	32,434	3	623,424	14,886	0
Tier II	7,902,268	368,792	10,555	2,675,187	310,397	0	61,333	0	4,821	1	0	0
Total	**10,623,110**	**444,526**	**46,026**	**4,220,664**	**857,587**	**1,943,567**	**540,996**	**42,756**	**85,321**	**623,439**	**14,888**	**12**

Table 5: Estimated Statewide AEPS Cost of Compliance in 2021 (2016 Dollars)

EDC	Solar Credits		Tier I Credits		Tier II Credits		Total Cost
	Credits Needed	Solar Credits @ $40	Credits Needed	Tier I Credits @ $20	Credits Needed	Tier II Credits @ $0.20	
Duquesne	67,141	$ 804,643	1,007,119	$ 10,649,686	1,342,825	$ 236,660	$ 11,690,989
Met-Ed	70,837	$ 848,930	1,062,550	$ 14,981,117	1,416,733	$ 249,685	$ 16,079,732
Penelec	70,792	$ 848,401	1,061,887	$ 14,971,776	1,415,850	$ 249,530	$ 16,069,706
Penn Power	24,069	$ 288,456	361,042	$ 5,090,400	481,389	$ 84,840	$ 5,463,696
PECO	194,027	$ 2,325,286	2,910,408	$ 41,034,457	3,880,544	$ 683,908	$ 44,043,651
PPL	185,630	$ 2,224,650	2,784,449	$ 39,258,537	3,712,599	$ 654,309	$ 42,137,496
UGI	5112	$ 61,269	76,686	$ 1,081,213	102,248	$ 18,020	$ 1,160,502
West Penn	114,875	$ 1,376,701	1,723,126	$ 24,294,720	2,297,502	$ 404,912	$ 26,076,333
Citizens'	942	$ 11,291	14,132	$ 199,246	18,842	$ 3,321	$ 213,858
Pike County	408	$ 4,886	6,116	$ 86,228	8,154	$ 1,437	$ 92,551
Wellsboro	635	$ 7,611	9,526	$ 134,309	12,701	$ 2,238	$ 144,159
Totals	**734,469**	**$ 8,802,123**	**11,017,041**	**$151,781,689**	**14,689,388**	**$2,588,860**	**$163,172,672**

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			
I	Cellulosic (woody) Biomass	48.5	1,039.2	1,087.7
I	Black Liquor	163.8	0.0	163.8
I	Coal Mine Methane (primary fuel source)	0.8	0.0	0.8
I	Coal Mine Methane (secondary fuel source)	0.0	88.0	88.8
I	Low-Impact Hydropower	175.8	2.2	178.0
I	Biologically Derived Methane Gas			
	Anaerobic Digester Gas (primary fuel source)	14.2	7.1	21.3
I	Anaerobic Digester Gas (secondary fuel source)	0.0	447.7	447.7
I	Landfill Gas (primary fuel source)	218.6	601.9	820.5
I	Landfill Gas (secondary fuel source)	1,338.0	57.0	1,395.0
I	Solar PV	241.8	613.8	855.7
I	Wind	1,304.6	4,825.0	6,129.6
I	**TOTAL of Tier I**	**3,506.13**	**7,681.89**	**11,188**
II	Biomass Energy			
	Cellulosic (woody) Biomass	0.0	0.0	0.0
II	Black Liquor	0.0	429.4*	429.4*
II	Distributed Generation	5.0	0.0	5.0
II	Hydropower			
	Conventional, Non-Low Impact	677.8	1,022.3	1,700.1
	Pumped Storage	1,540.0	2,553.0	4,093.0
II	Municipal Solid Waste	252.4	449.6	702.0
	Demand Side Management			
II	Blast Furnace Gas	52.5	67.0	119.5
II	Other Gases	30.0	0.0	30.0
II	Waste Heat	5.0	0.0	5.0
II	Industrial By-product	0.0	7.2	7.2
II	Waste Coal	1,582.9	244.6	1,827.5
II	**TOTAL of Tier II**	**4,145.6**	**4,343.7**	**8,489.3**
I & II	**TOTAL of Tiers I & II**	**7,651.7**	**12,025.59**	**19,677.32**

* 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	
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

11. Appendix B

A. Tier I Resources

i. Solar Photovoltaic (PV)

A solar PV System[39] 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 and an inverter that converts the direct current (DC) generated by the system to alternating current (AC).

ii. Solar Thermal

Solar thermal power plant[40] 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;

[39] Solar Photovoltaic Technology Basics at www.energy.gov
[40] Solar Thermal Power Plants at www.eia.gov

(iv) protects against erosion; and

(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.[41]

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.[42]

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

[41] Geothermal Energy Association – Geothermal Basics Q&A, 2012

[42] 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.

12. 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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