Pennsylvania Clean Energy Market Report

Prepared by the Coalition for Green Capital
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Prepared for The Nature Conservancy

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About the Coalition for Green Capital

The Coalition for Green Capital (CGC), a 501(c)(3) nonprofit, is the nation's leading, advocate, expert and consultant on the topic of Green Banks, dedicated finance entities that use public-purpose dollars to drive greater private investment in clean energy deployment. CGC works directly with state governments and other partners to identify ways for public capital to stimulate private investment in mature clean energy technologies and accelerate the growth of clean energy markets. CGC often works with government to help create the institution, assessing various legal options to institutional creation and financial options for green bank capitalization. CGC also works with states to implement innovative clean energy finance and market development mechanisms through existing public institutions.

About The Nature Conservancy

Founded in 1951, The Nature Conservancy is a nonprofit, science-based organization that has grown from a pioneering U.S. land trust to a global organization whose work to conserve lands and waters for nature and people reaches all 50 states and 72 countries around the world. The Conservancy and its nearly one million members have protected more than 119 million acres of land and 5,000 miles of river around the world. In support of its mission in Pennsylvania and across the world, the Conservancy advances market-based strategies to promote the sustainable and efficient use of energy and the deployment of appropriately-sited clean energy resources.

About this Report

The Nature Conservancy has partnered with the Coalition for Green Capital to explore the potential need for greater clean energy finance capacity in the state of Pennsylvania. The first part of this project is to perform a comprehensive report on the state's clean energy program and policy landscape and the market potential for various clean energy technologies, paying particular attention to the role of financing programs. This report includes information on institutions, programs, policies, laws and incentives that shape the clean energy market in Pennsylvania. This report also includes information on the clean energy market activity to date, as well as various estimates of clean energy market potential drawn from a variety of sources. This report will be followed by a report on specific recommendations for financing structures, institutions, products, and activities in Pennsylvania that could help fill market gaps and spur more clean energy deployment.

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Executive Summary

This report estimates that Pennsylvania has a $16 to $20 billion dollar clean energy investment market potential that is currently unrealized. Today, most of the energy produced, generated and consumed in Pennsylvania comes from fossil-fuel based sources. This makes Pennsylvania the third largest CO_2 emitter of any state in the country. The state is missing an immense opportunity to drive private investment into economically viable clean energy projects that would produce a return for investors and lower energy costs for citizens and businesses. This includes both renewable generation and energy efficiency projects. The findings of this paper will support a follow-on report on finance and market development solutions that can address market barriers, fill gaps and drive clean energy investment in the state. This will include a description of the finance products most suitable for Pennsylvania's clean energy markets; the potential forms or entities through which those products can be offered; and the sources of public and private capital that can be drawn upon to bring those products to market.[i]

Over the last decade Pennsylvania has enacted several clean energy policies meant to support market growth.[ii] However, the large number of public and quasi-public programs created to address this market are not collectively aligned, focused, or using the most innovative tools available to drive clean energy investment at scale. There have been pockets or instances of success, but they are either geographically limited, constrained by budgets, or undercut by inefficient policy or program design. Pennsylvania lacks a focused, fiscally sustainable, unitary, widely-marketed, product-driven approach to clean energy finance which results in market conditions that do not encourage private participation on the supply side or stimulate consumer interest on the demand side. There is a need to fill market gaps to more effectively animate private investment and stimulate demand for clean energy.

This report, the first in an on-going analysis of clean energy investment needs and solutions in the state, provides a comprehensive review of:

- The current state of Pennsylvania's energy markets;
- The policies Pennsylvania has enacted to support clean energy market growth;
- The public and quasi-public institutions that operate subsidy or finance programs to address these markets; and

[i] For the entirety of this report, *footnotes* are denoted in roman numerals and are used for providing additional information, and *endnotes* are denoted in European digits and are used for citations.

[ii] The term "clean energy" is used in this report to refer to any zero-carbon or low-carbon renewable energy generation technology, energy-saving or energy efficiency technology, and fuel-switching activities. The term "clean energy" is distinct form the term "alternative energy," which is frequently used in Pennsylvania and includes several fossil-fuel based technologies. Clean energy explicitly excludes all fossil fuels except for the purposes of fuel switching from fuel oil to natural gas heating.

- The size of the economically viable clean energy market potential

Based on this review, and a large number interviews with policymakers and market participants, the report concludes with an analysis of policy and programmatic limitations, as well as barriers to clean energy market growth.

The report finds that most renewable energy installed in the state to date comes from wind, with smaller amounts of bioenergy and solar. Renewables only comprise 4% of the electricity consumed in the state. However clean energy resources and investment opportunities, particularly for distributed resources, are abundant and underexploited. The state has enacted modest targets for "alternative energy" (which includes fossil fuels) and efficiency. However, due to policy design and implementation approaches, there is little if any private activity in these markets beyond the minimum needed to meet requirements.

Large utility-scale wind, bioenergy and even some solar projects have been financed by large banks. Distributed solar installers mostly serve the segments of the market that can afford to purchase the systems upfront with cash. The distributed solar market was previously largely driven by a state-run grant program, but the market shrunk considerably when the program ended. Relatively few of the solar projects are financed, especially in the residential space. More commercial-scale projects are financed, as there are more financing options for both commercial-scale solar and efficiency projects.

Analysis in this paper finds that there is a suitable, economically viable market for distributed solar in Pennsylvania. Installation costs have fallen dramatically over the last several years. Net-metering is offered by all the electric distribution companies (though electric generation suppliers offer it on a voluntary basis). There is certainty in federal tax credit policy. And with upfront finance at modest rates and long-terms, distributed solar can be net cash-flow positive for customers. Both private and public-purpose capital is needed to bring this finance to market.

The state's residential market for efficiency is largely dependent on utility rebate programs. Some homeowners finance efficiency projects through government-sponsored and private products, though deal volume is lower than it has been in the past, and much lower than it could be. In the commercial and industrial sector, private ESCOs compete to implement efficiency projects, but there is distrust of ESCO savings projections in the market.

Several factors reduce both the supply of project financing for residential and commercial clean energy projects and the demand for the few finance options that do exist. These include disaggregated and constrained program resources, little or no marketing efforts at the program level, sparse private financing options, few financial products that target a single market segment, information gaps, limited fund capacity, and disparate areas of expertise and program familiarity among market participants.

There are several revolving funds across the state that make capital available for clean energy projects in the form of grants and loans. However, some of the programs have limited capacity to disburse funds, many suffer from low utilization, and most give out most of their capital in the form of grants. As a result, the impact of public dollars is not maximized, private capital remains on the sidelines and market potential is not realized.

Pennsylvania Energy Market Profile

Pennsylvania is the 3rd largest energy producer in the country—it is the 2nd largest natural gas producer, the 5th largest coal producer, and the 3rd largest electricity producer.[1] Pennsylvania's power industry is dominated by coal, nuclear, and natural gas, with natural gas taking an increasing share of the electricity fuel mix. Renewables make up a small portion of the electricity fuel mix, though distributed renewable generation projects have risen in recent years. As a result of its output and its fuel mix, Pennsylvania has the 3rd highest carbon dioxide emissions in the nation, after Texas and California. Pennsylvania has restructured electricity and natural gas markets that allow for retail choice of energy suppliers. Statewide sectoral consumption of electricity across is 36.9% residential, 32.9% industrial, 29.6% commercial, and 0.6% transportation. Statewide sectoral consumption of natural gas is 32.3% power sector, 30.1% industrial sector, 21.2% residential, 13.3% commercial, and 3.1% transportation. For home heating fuel, 51% of homes use natural gas, 22% use electricity, 18% use fuel oil, and 9% use another fuel or none. Of the state's carbon dioxide emissions in 2013, 43% are from the electric power sector, 24% are from transportation, 20% are from the industrial sector, 8% are from the residential sector, and 4% are from the commercial sector.

Total Energy Mix

Pennsylvania consumes a diverse mix of energy types to satisfy its energy needs. Coal, natural gas, and nuclear power, hydro power and other renewables are consumed primarily to generate electricity for the grid. Pennsylvania is a net electricity exporter, so about 27% of the electricity generated within the state's borders is ultimately transported and consumed out of state. Fuel oil is used for heating buildings while gasoline is consumed primarily for the transportation sector, as are jet fuel and other forms of petroleum.[2]

Figure 1: Pennsylvania Energy Consumption Estimates[3]

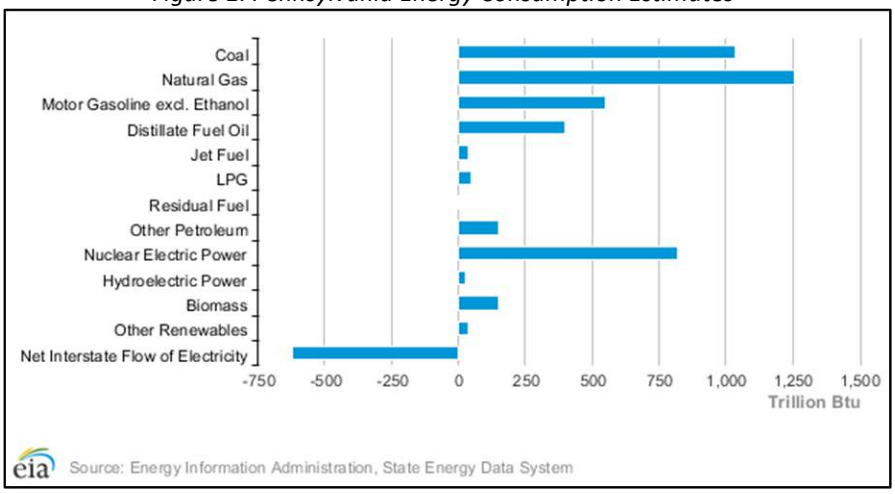
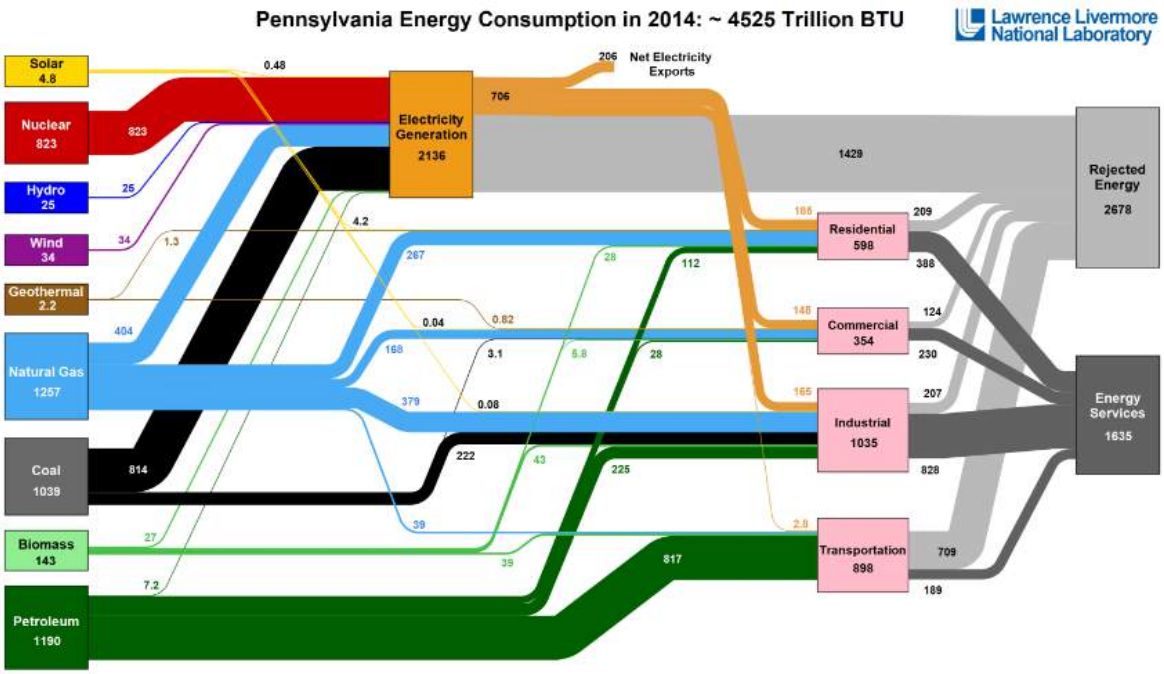
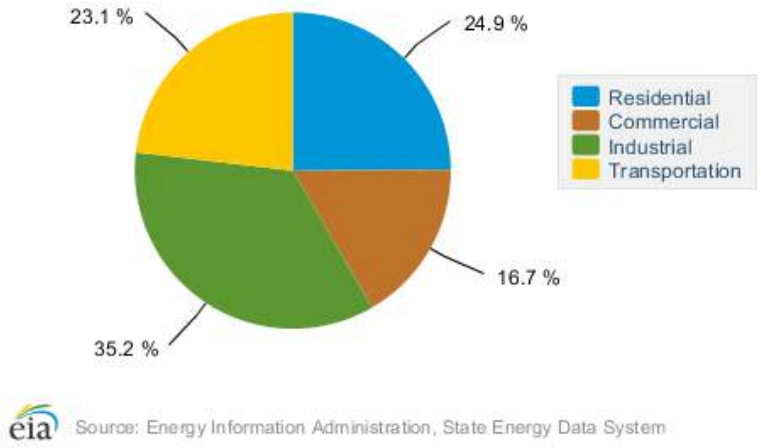


Figure 2: Pennsylvania Energy Use in 2014[4]



The residential and transportation sectors respectively consume 24.9% and 23.1% of the energy in Pennsylvania, the industrial sector consumes 35.2%, and the commercial sector consumes 16.7% of the energy in the state. Pennsylvania's buildings—the residential, commercial, and industrial sectors together—consume 76.8% of the energy across the state.[5]

Figure 3: Pennsylvania Energy Consumption by Sector[6]



Electricity

Utility Structure

Pennsylvania exists within the PJM Interconnection, the regional electricity grid serving the mid-Atlantic region and much of the Midwest.[7] Pennsylvania has a deregulated electricity market, and the electricity for Pennsylvania's wholesale power market is supplied almost entirely by independent power producers.[8]

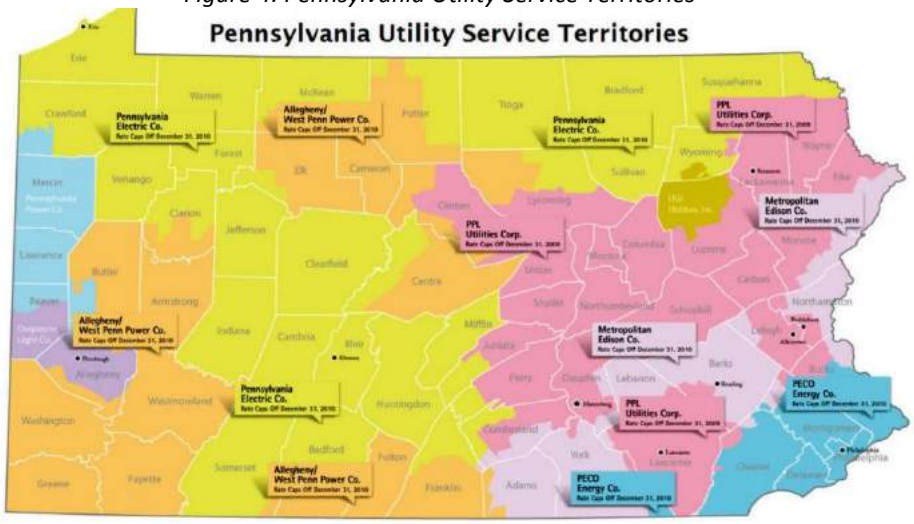
In 2014, Pennsylvania generated approximately 221,058 GWh of electricity and retail sales of electricity within the state were approximately 146,687 GWh. Exports and losses of electricity were approximately 70,094 GWh.

Table 1: Electricity Generation, Sales and Exports in Pennsylvania in 2014[9]

Net Generation	Retail Sales	Exports, Losses & Direct Use
221,058 GWh	146,687 GWh	74,948 GWh

There are 7 investor-owned utilities (IOUs) that serve Pennsylvania, and because they do not own generation, they are called "electricity distribution companies" (EDCs). The Philadelphia Electric Company, or "PECO," is a subsidiary of Exelon serving Philadelphia and the surrounding area. Duquesne Light Company (DQE) serves the Pittsburg area. Pennsylvania Power and Light (PPL) serves most of eastern Pennsylvania including Allentown, Harrisburg, Scranton, Bethlehem, and Lancaster. First Energy has 4 subsidiaries—Metropolitan Edison Company (Met-Ed), Pennsylvania Electric Company (Penelec), Penn Power, and West Penn Power—which collectively serve most of western Pennsylvania and a few areas in eastern Pennsylvania.[10]

Figure 4: Pennsylvania Utility Service Territories[11]



There are also a 4 smaller utilities throughout the state—Pike County Light & Power Company, UGI Utilities Inc., Wellsboro Electric Company, and Citizens Electric of Lewisburg. The Pennsylvania Public Utilities Commission (PUC) has authority over these 11 utilities, or EDCs.[12] There are 13 rural electric cooperatives in the state, mostly owned and operated by cities and townships, which are represented by the Pennsylvania Rural Electric Association (PREA).[13]

Table 2: Key Statistics on Retail Electricity Providers and Sales in Pennsylvania in 2014[14]

	Privately Owned Utilities (incl. EDCs)	Publicly-Owned Utilities	Cooperative	Direct Sales from Generators	Energy & Delivery Providers (incl. ESGs)	Total
Entities	15	35	13	5	83	
Retail Customers	3,554,206	83,922	219,570	5	2,146,096	6,003,799
Retail Sales (GWh)	42,066	1,422	2,994	10	100,192	146,687
Share of Sales	28.7%	1.0%	2.0%	0.0%	68.3%	100%
Retail Sales ($ million)	$5,159	$186	$354	$1	$9,376	$15,077
Share of Sales	34.2%	1.2%	2.4%	0.0%	62.2%	100%

Retail Choice

The Pennsylvania electricity market is deregulated and allows consumer choice for retail electricity.[15] While customers can buy their electricity directly from EDCs or co-ops through a "standard offer" rate package, there are also a large number of electric generation suppliers (EGSs) from which customers may purchase electricity in a variety of rate packages.[16] Electric generation suppliers are anything from a person, corporation, generator, broker, marketer, aggregator or any other entity licensed by the PUC that sells electricity to customers, using the transmission or distribution facilities of an electric distribution company.[17] As of 2015, 36% of all customers in Pennsylvania received their electricity from an EGS—34% of residential customers and 46% of non-residential customers got their electricity from an EGS.[18]

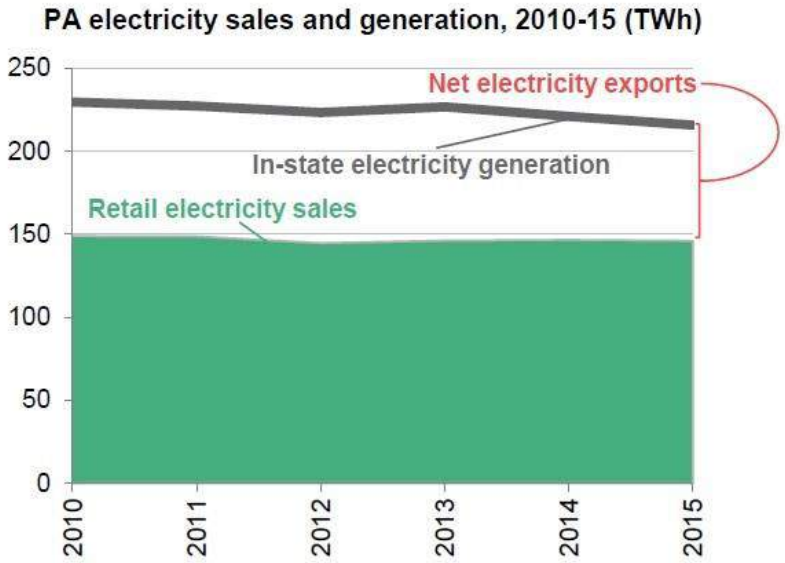
Figure 5: Share of EGS Accounts by EDC Territory in 2015[19]

	Number Residential Accounts			Number Non-Residential Accounts			Total Number Accounts		
EDC	**EGS**	**Total**	**%**	**EGS**	**Total**	**%**	**EGS**	**Total**	**%**
Citizens	12	5,765	0	79	1,170	7	91	6,935	1
Duquesne	167,967	524,560	32	26,383	61,589	43	194,350	586,149	33
UGI	392	55,197	1	933	8,506	11	1,325	63,703	2
Met-Ed	157,202	493,793	32	30,688	67,563	45	187,890	561,356	33
Penelec	143,917	497,959	29	36,661	86,039	43	180,578	583,998	31
Penn Power	32,706	143,073	23	8,788	20,740	42	41,494	163,813	25
PECO	482,105	1,444,465	33	82,790	165,251	50	564,895	1,609,716	35
Pike	1,932	3,681	52	463	994	47	2,395	4,675	51
PPL	567,001	1,241,062	46	99,111	181,668	55	666,112	1,422,730	47
Wellsboro	0	5,103	0	0	1,197	0	0	6,300	0
West Penn	169,523	619,612	27	36,294	102,709	35	205,817	722,321	28
Total	**1,722,757**	**5,034,270**	**34**	**322,190**	**697,426**	**46**	**2,044,947**	**5,731,696**	**36**

In-state generation and Exports

Pennsylvania generated the third most electricity of any state in the country in 2016, behind only Texas and Florida. Pennsylvania is a national center of natural gas production, as it sits on top of the Marcellus Shale, the largest reserve of natural gas in the country. The increased availability of natural gas has led to increased electricity production from natural gas. Pennsylvania also has the second-largest nuclear generation capacity in the country. The state has five nuclear stations that have generated more than a third of net electricity in recent years.[20] Electricity production is well above in-state consumption—Pennsylvania is a net exporter of electricity. Over the course of 2014, for example, the net exports to other states were approximately 60 TWh of electricity, or 27% of the total generation, to other states.[21]

Figure 6: Pennsylvania Electricity Generation, Retail Sales, and Net Exports 2010-15[22]



Electricity Fuel Mix

In 2014, Pennsylvania's electricity fuel mix was 35.7% coal, 35.6% nuclear, and 24.0% natural gas. Hydroelectric generation was 1.2% of the electricity fuel mix, while wind was 1.6% and solar was 0.03%.[23] Renewable power made up 4% of total state generation. In 2015, natural gas generation has increasingly replaced coal in the electricity generation portfolio—natural gas has risen to 28%, nuclear has risen slightly to 37%, while coal has dropped to supplying 30% of the electricity in the state.[24]

Figure 7: Pennsylvania Electricity Fuel Mix in June 2016[25]

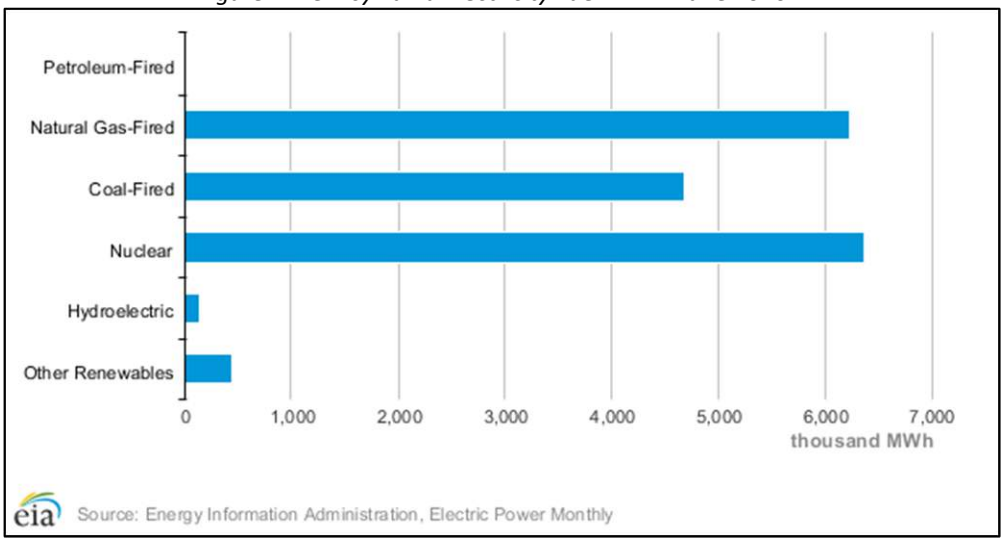
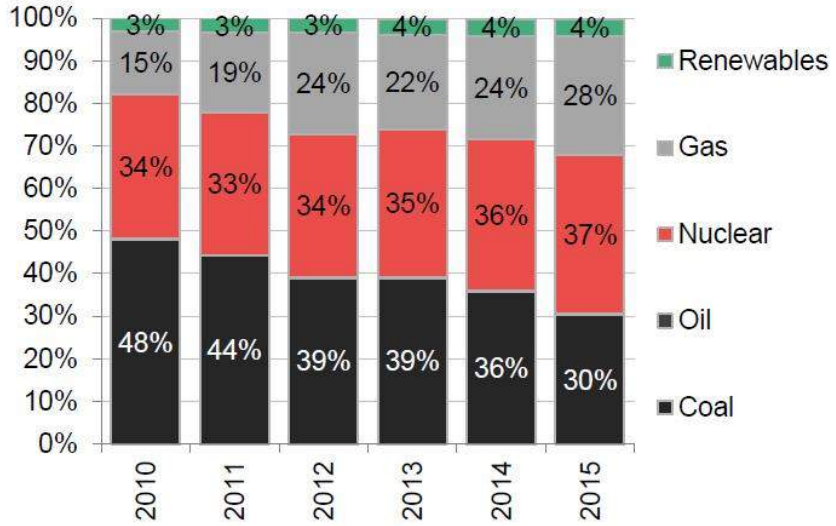
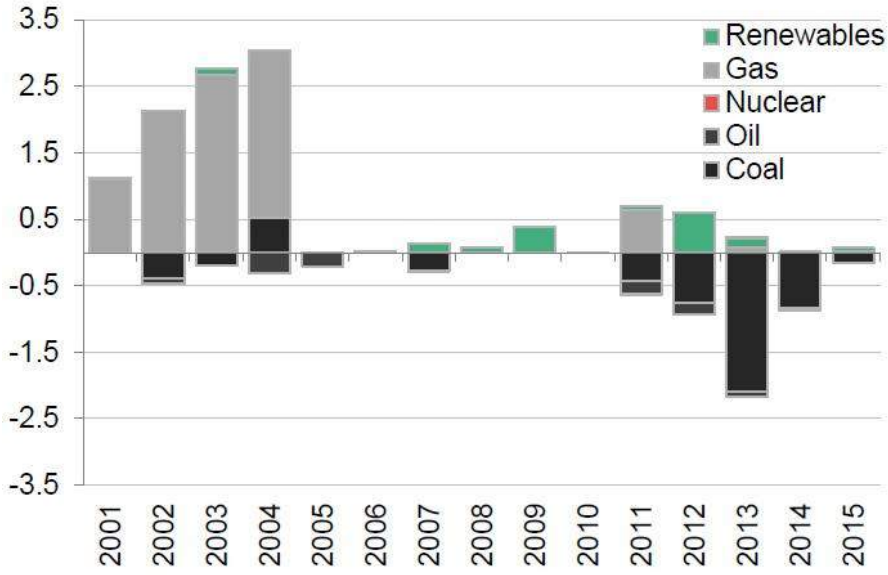


Figure 8: Pennsylvania Electricity Fuel Mix 2010-15[26]



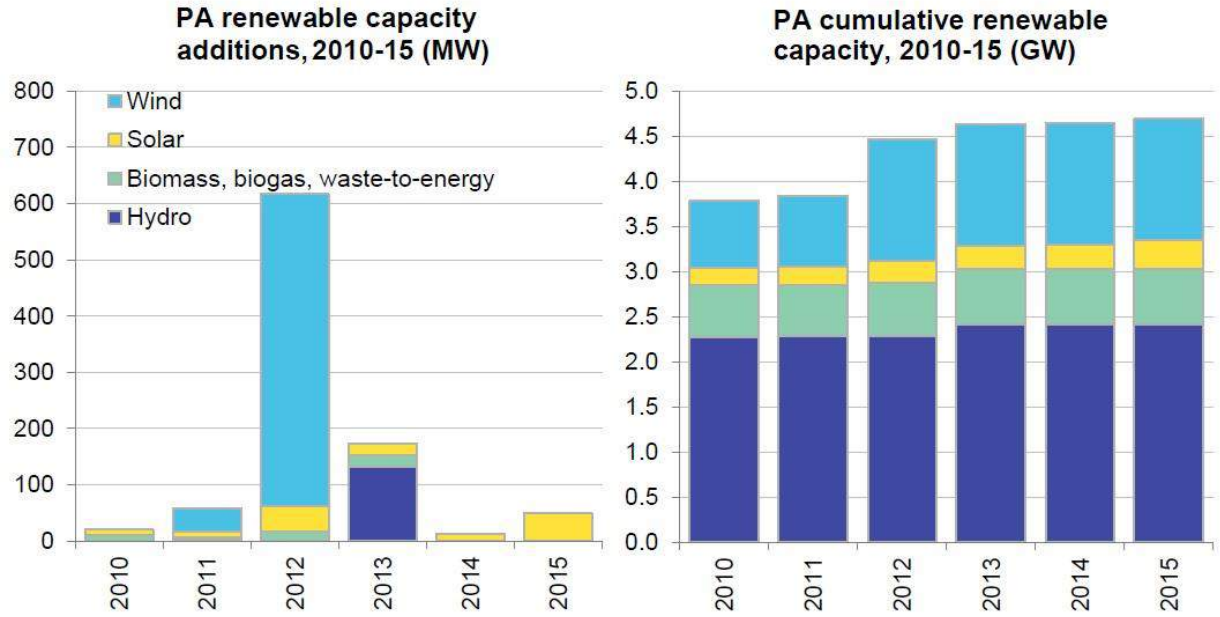
Pennsylvania's electricity fuel mix has changed over the past few years largely because of two factors: coal power plant retirements and cheap natural gas resulting from in-state gas production. Power generation from coal is decreasing while generation from natural gas increases, and renewable generation increases marginally. Since 2011, Pennsylvania has retired 4.3 GW of coal generation capacity.[27]

Figure 9: Utility Scale Capacity Additions and Retirements in Pennsylvania 2000-15[28]



In the period of 2010 through 2015, Pennsylvania brought 930 MW of renewable capacity online. Of this new renewable capacity, 827 MW was utility-scale and 103 MW was distributed. Onshore wind projects accounted for 595 MW of these additions and hydro projects accounted for 134 MW. At the end of 2015, total renewable capacity in the state was 4.7 GW which produced 4% of in-state generation.[29]

Figure 10: Renewable Energy Additions and Cumulative Capacity in Pennsylvania 2010-15[30]



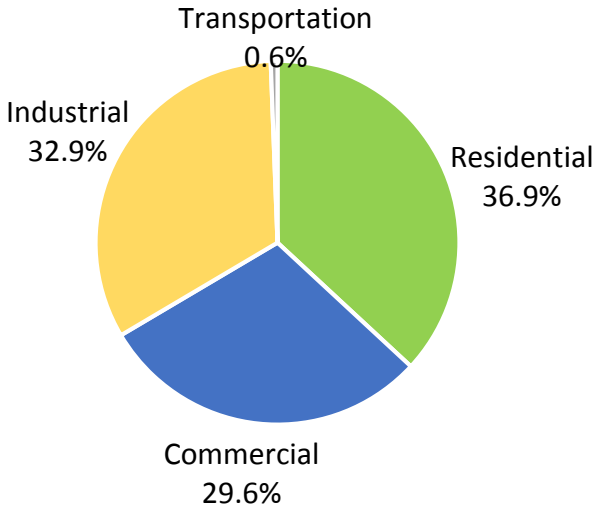
Distributed Generation

In 2014, 216 MW of distributed generation capacity was connected to the state's grid in net metering arrangements. Solar accounted for 181 MW of capacity, wind accounted for 1.5 MW of capacity, and the remaining 32 MW of net-metered capacity was from other technologies. Of the 181 MW of solar distributed generation, 61 MW is in the residential sector while 120 MW is deployed in the commercial and industrial sectors.[31] In 2016, 251 MW of distributed solar was connected to the state's grid—64 MW in the residential sector and 187 MW of commercial and industrial sectors. Distributed solar installations dominate the overall solar market in Pennsylvania—only 22 MW of solar is utility-scale.[32]

Consumption by Sector

Of the electricity consumed in-state in 2014, 36.9% was consumed by the residential sector, 32.9% was consumed by the industrial sector, 29.6% was consumed by the commercial sector, and 0.6% was consumed by the transportation sector.

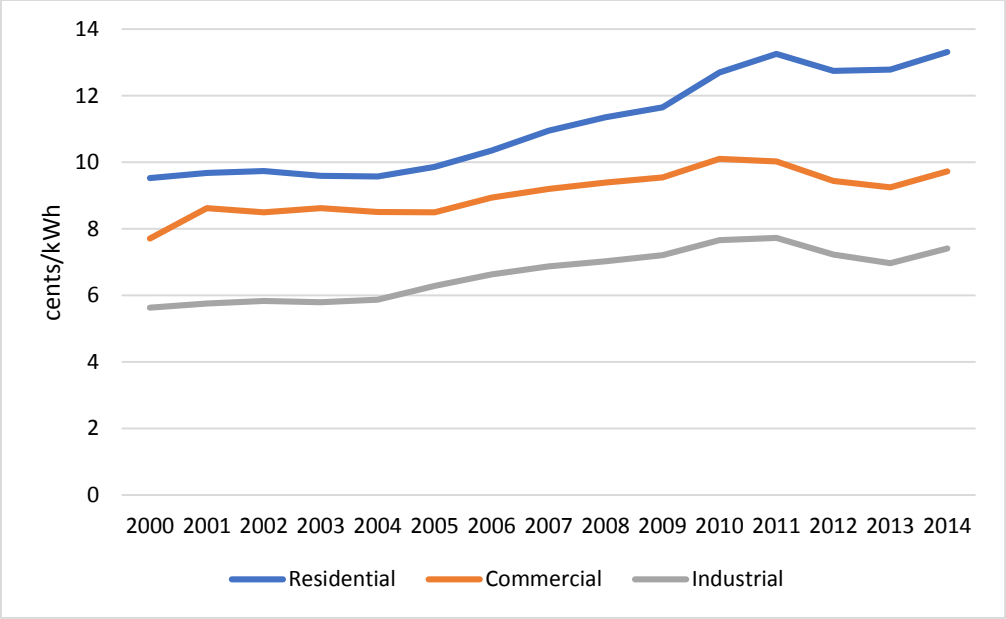
Figure 11: Pennsylvania Electricity Consumption by Sector 2014[33]



Electricity Prices

In the period of 2000 through 2014, industrial and commercial electricity prices rose by about 1 cent per kWh each, while the residential price of electricity rose by about 2 cents per kWh.

Figure 12: Pennsylvania Electricity Prices by Sector 2000-14[34]



In September of 2016, Pennsylvania's residential electricity prices were above the national average by more than a cent per kWh, while the state's commercial price was below the national average by more than a cent per kWh. The industrial price was almost even with national average.

Table 3: Pennsylvania Electricity Prices by Sector in 2016 (cents/kWh)[35]

	Residential	Commercial	Industrial
Pennsylvania	14.17	9.08	6.99
U.S. Avg.	12.87	10.70	7.15

Electricity Expenditure

Pennsylvania's total expenditure on retail electricity in 2014 was around $15 billion.[36] The total expenditure on energy was $55.7 billion or $4,351 per capita. Pennsylvania ranks 29th among the states in highest energy spend per capita.[37]

Table 4: 2014 Energy Expenditures by State[38]

State	Retail Electricity Sales (millions)	Total Energy Expense (millions)	Energy Spending per Capita	State Rank
MD	$6,975	$22,595	$3,840	39
NY	$23,950	$68,056	$3,446	49
OH	$14,661	$51,386	$4,431	26
PA	**$15,077**	**$55,666**	**$4,351**	**29**
VA	$9,780	$35,135	$4,292	28
WV	$2,502	$8,756	$4,736	20

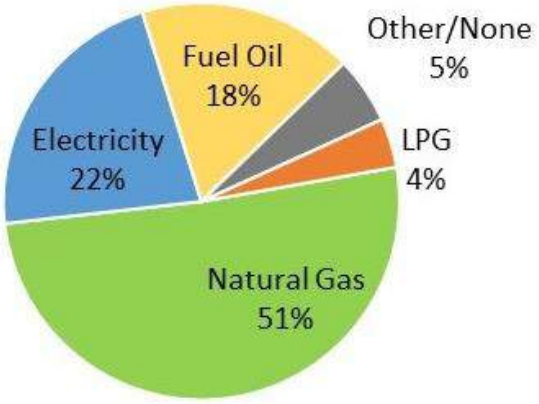
Pennsylvania's per capita energy spending is comparable to that of several of its neighbors (Ohio, Virginia, and West Virginia). Two of its neighbors (Maryland and New York) have noticeably lower per capita energy spending.

Thermal

Fuel Consumption in Residential Buildings

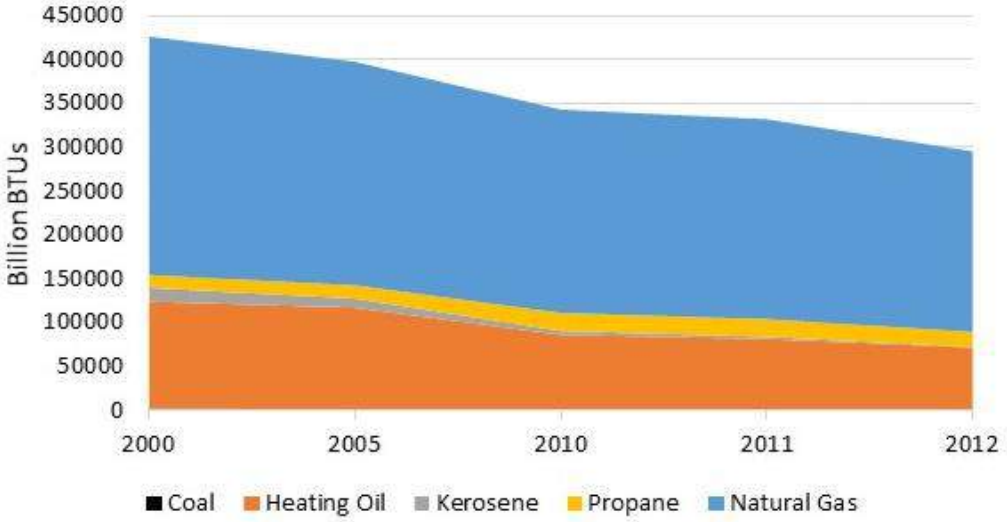
Fuel consumption in the residential sector is primarily for heating purposes. There are several home heating fuels widely used in the state. Of the heating fuel consumed, 51% is natural gas, 22% is electricity, 18% is fuel oil, 4% is LPG, and the remaining 6% is other fuel sources (such as wood).[39]

Figure 13: Pennsylvania Home Heating Fuel Consumption by Type in 2015[40]



Historically, Pennsylvania homes relied more heavily on more carbon-intense forms of heating fuel: heating oil, kerosene, and even some coal. The trend toward natural gas and electricity (not included in below table) for home heating fuel is visible as early as 2005.[41][iii]

Figure 14: Pennsylvania Residential Fuel Consumption 2000-12[42]

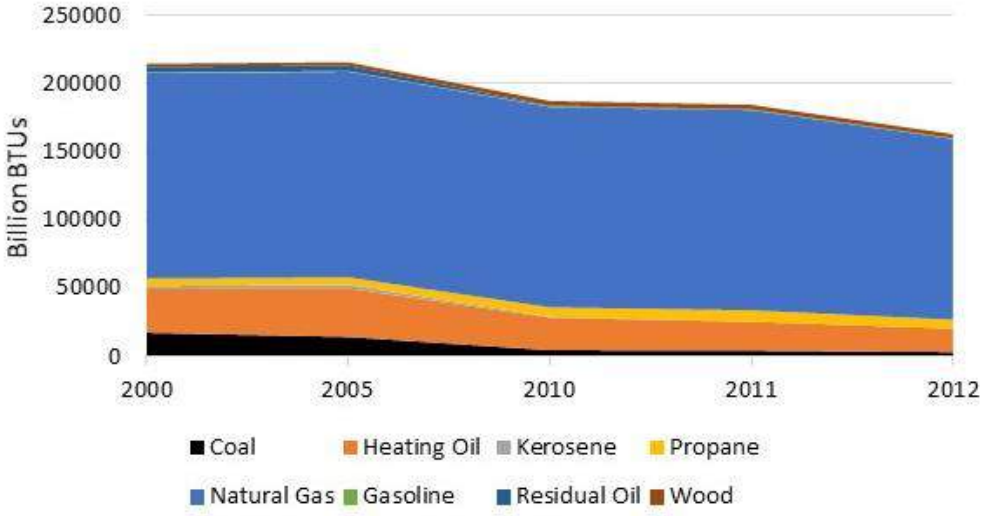


[iii] These were drawn from the "2015 Climate Change Action Plan Update" which was published by the DEP in 2016, and are the most recent data available on sectoral heating fuel consumption.

Fuel Consumption in Commercial Buildings

Consumption of nearly all fuels in the commercial sector has decreased on an absolute basis, with the exception of propane and wood. The share of natural gas has gradually increased over time. In 2000 it accounted for approximately 70% of consumption and in 2012 it reached approximately 80%.[43]

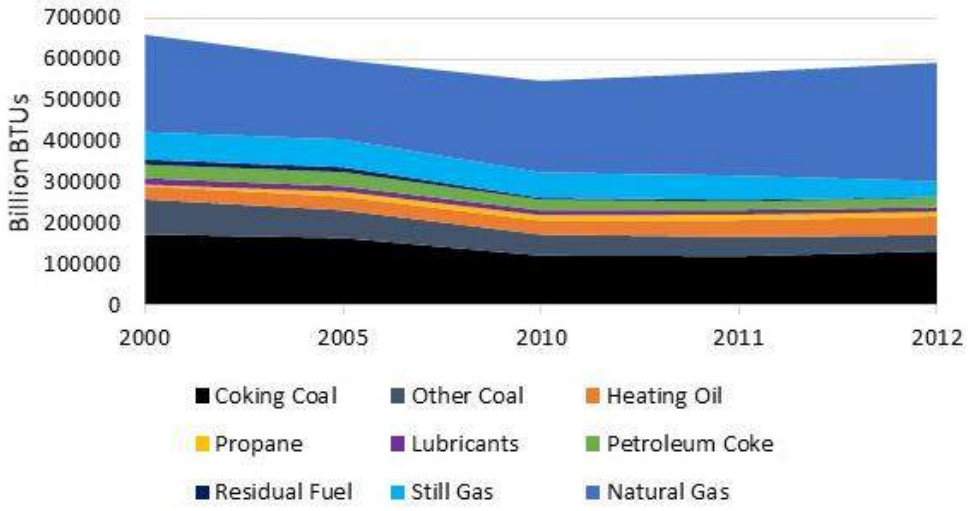
Figure 15: Pennsylvania Commercial Fuel Consumption 2000-12[44]



Fuel Consumption in the Industrial Sector

The industrial sector in Pennsylvania consume a wide variety of thermal fuels. Consumption of coal, lubricants, and residual fuel has decreased, while consumption of coking coal, propane, petroleum coke, still gas and natural gas has variously increased and decreased over the last decade or more. In the period between 2000 and 2012, the share of natural gas consumed rose from approximately 36% of industrial fuel use to 49%.[45]

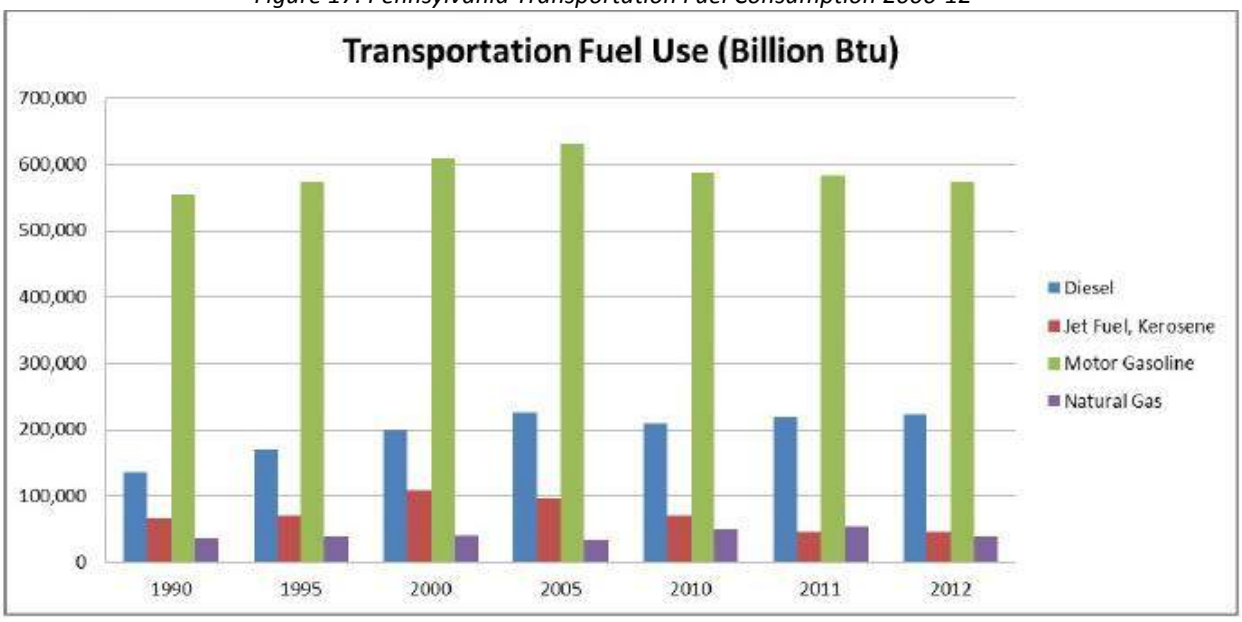
Figure 16: Pennsylvania Industrial Fuel Consumption 2000-12[46]



Fuel Consumption in Transportation

As in most geographies, petroleum makes of up the majority of fuel consumption in the transportation sector. Diesel is the second-most consumed fuel by a wide margin. "Alternative" fuels such as natural gas make up the remainder of fuel consumption in the transportation sector.[47]

Figure 17: Pennsylvania Transportation Fuel Consumption 2000-12[48]



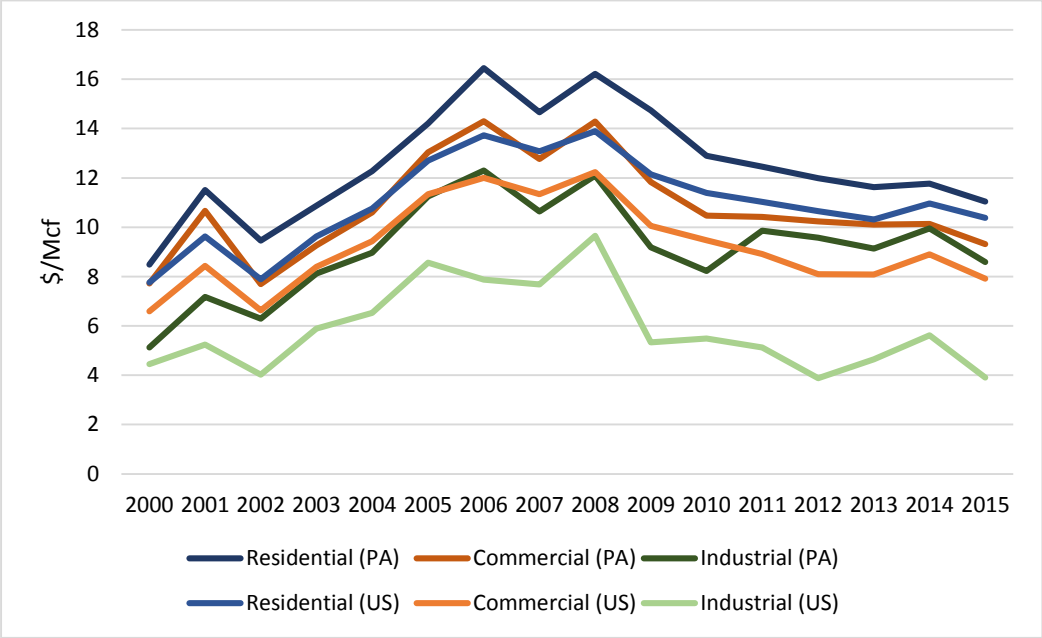
Natural Gas Utility Structure

The natural gas market in the state is deregulated, and works much in the same way that the electricity market works. There are nine natural gas distributors in the state that serve different territories.[iv] Consumers can choose to buy their gas directly from the distributor that serves their region or from among dozens of competing natural gas suppliers.[49] The state's PUC has regulatory authority over 35 natural gas utilities.[50]

Natural Gas Prices and Consumption

The price of residential natural gas in Pennsylvania peaked in 2006 at $16.45 per thousand cubic feet. Since then, the price dipped in 2007 then shot back up in 2008 to $16.22, and has declined to $11.04 in 2015. The price of natural gas since 2000 is plotted below by sector, in comparison to the U.S. average.[51]

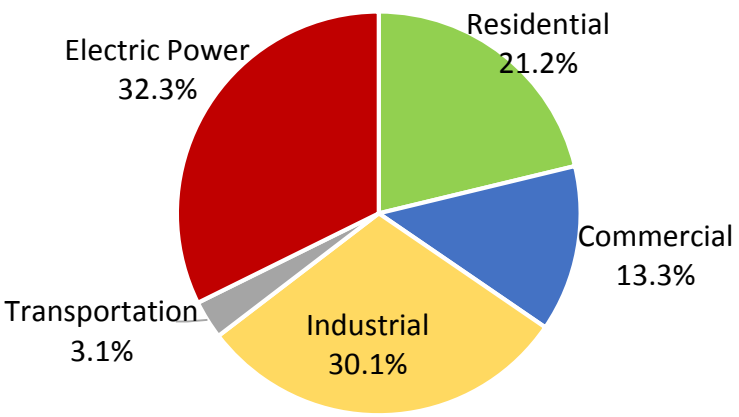
Figure 18: Natural Gas Prices in Pennsylvania by Sector[52]



Electricity generation is the largest use of natural gas in the state, comprising 32% of consumption, followed by industrial uses which comprise 30% of consumption.[53]

[iv] Natural gas distributors in the state include: Columbia Gas of PA, National Fuel Gas, PECO Gas, Peoples Natural Gas, Peoples TWP, Philadelphia Gas Works, UGI Central Penn Gas, UGI Penn Natural Gas, and UGI Utilities.

Figure 19: Natural Gas Consumption by Sector in Pennsylvania in 2014



Emissions

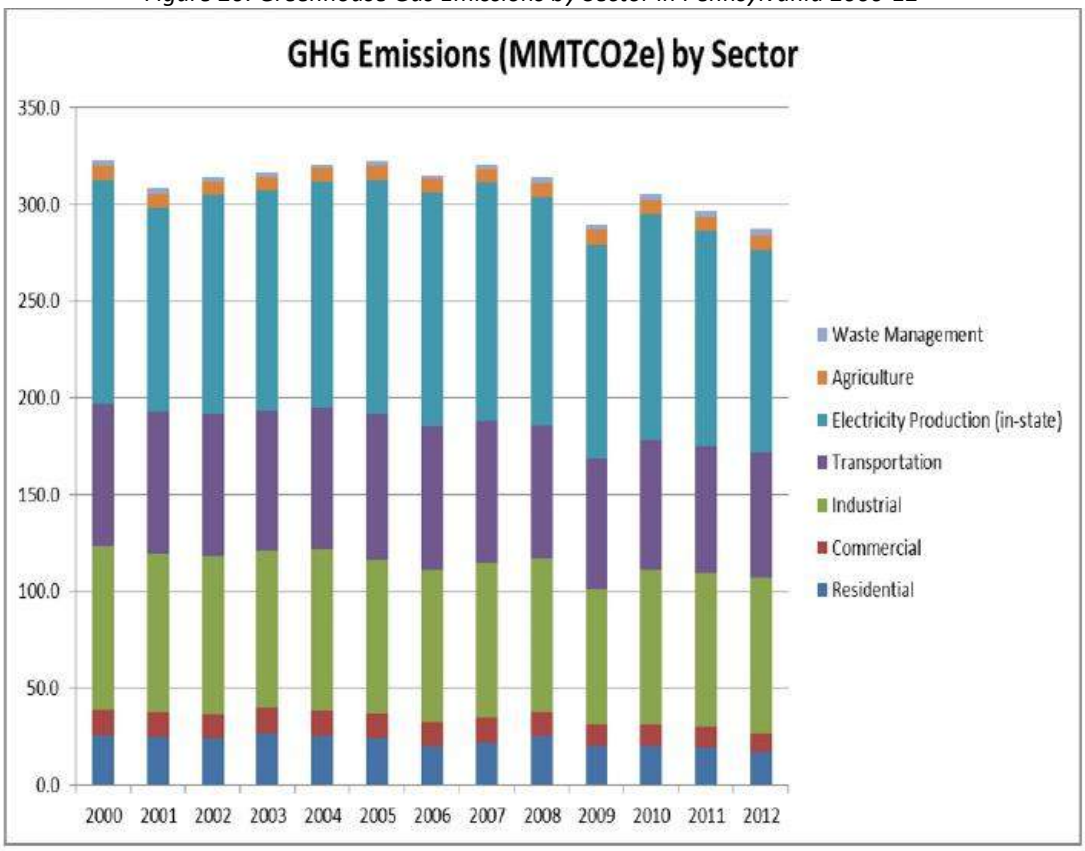
In 2013, Pennsylvania was responsible for 244 million metric tons of carbon dioxide emissions from energy-related sources. Of those emissions, 4.1% came from the commercial sector, 43.4% came from the generation of electricity, 8.1% came from the residential sector, 20.4% came from the industrial sector, and 24.0% came from the transportation sector.[54]

Table 5: Energy-Related Carbon Dioxide Emissions by Sector in 2013[55]

Pennsylvania Sector	Carbon Dioxide Emissions (million metric tons)	Share of Total
Residential	20	8%
Commercial	10	4%
Industrial	50	20%
Transportation	59	24%
Electric Power	106	43%

In the period of 2000 through 2012, the share of emissions from each sector of the Pennsylvania economy has remained relatively constant, with the power, industrial, and transportation sectors consistently producing the largest shares of emissions in the economy.[56]

Figure 20: Greenhouse Gas Emissions by Sector in Pennsylvania 2000-12[57]



Pennsylvania has the 3rd highest emissions of any state in the country after Texas and California. Of the states neighboring it, Ohio and New York are also in the top ten highest-emitting states.[58]

Table 6: Energy-Related Carbon Dioxide Emissions by State in 2013[59]

State	Carbon Dioxide Emissions (million metric tons)	State Rank
MD	62	34
NY	160	9
OH	229	5
PA	**244**	**3**
VA	103	18
WV	98	21

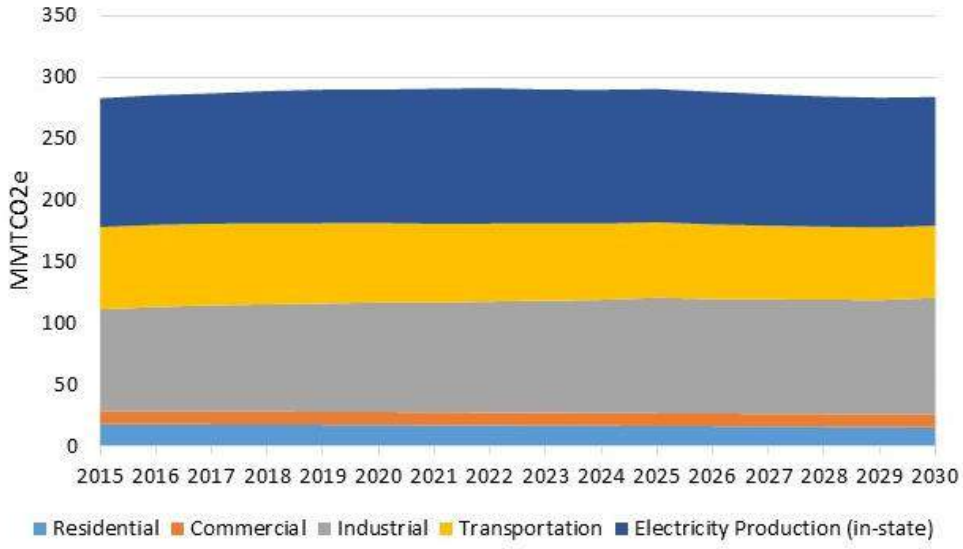
Pennsylvania's per capita emissions place it in the top half of states in the country. Pennsylvania ranks 21st in emissions per capita, following its neighbor Ohio which has the 20th highest emissions per capita.

Table 7: Energy-Related Carbon Dioxide Emissions per capita by State in 2013[60]

State	Carbon Dioxide Per Capita (metric tons)	State Rank
MD	10	44
NY	8	50
OH	20	20
PA	**19**	**21**
VA	13	35
WV	50	3

The "2015 Climate Action Plan Update," published by the DEP in 2016, uses the U.S. Environmental Protection Agency's Projection Tool to estimate the level emissions by sector in Pennsylvania going forward through 2030. The statewide greenhouse gas emissions in 2030 are projected to increase by about 9 million metric tons from 2013.

Table 8: Pennsylvania Emissions Projections through 2030 by Sector and Source[61]



Laws and Policies

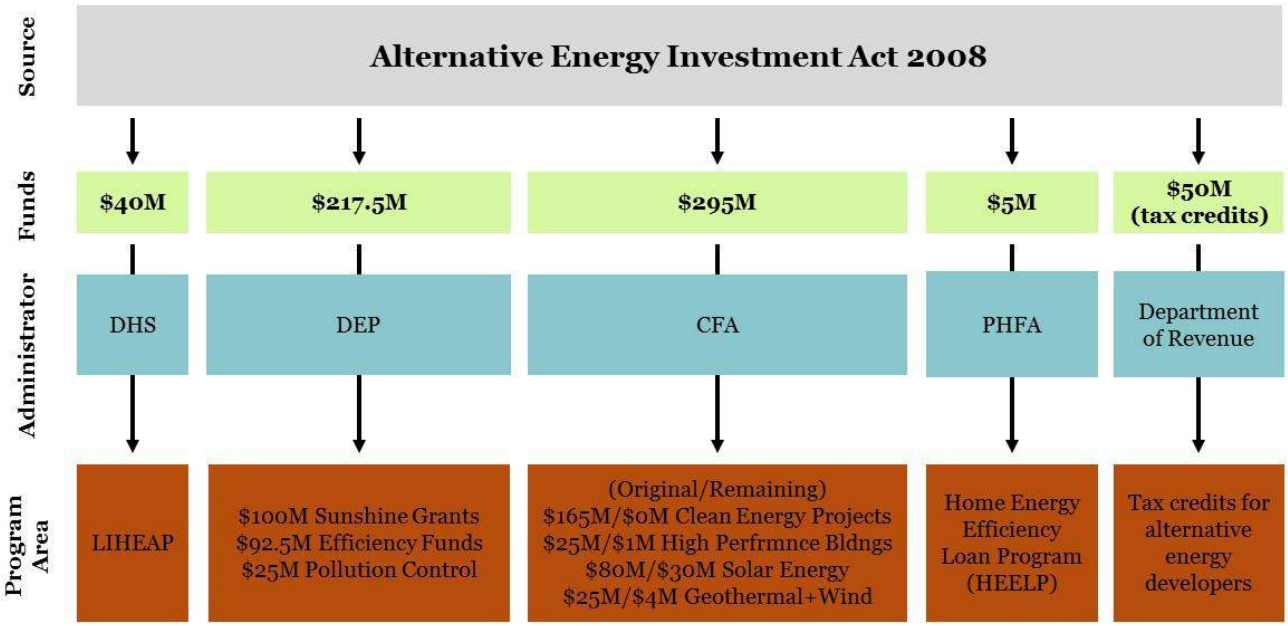
Several key laws and policies have a significant role in shaping the clean energy market landscape in Pennsylvania. They are discussed in the following sections.

Renewable Energy

Alternative Energy Investment Act

The Alternative Energy Investment Act was passed in 2008 in Pennsylvania and made $650 million available for alternative energy across several state programs. The below table and diagram illustrate the programs to which the money was disbursed.

Figure 21: Summary of Alternative Energy Investment Act of 2008 Components[62]



Alternative Energy Portfolio Standard

Pennsylvania has an Alternative Energy Portfolio Standard (AEPS) that requires each electric distribution company (EDC) and electric generation supplier (EGS) to supply 18% of the electricity it provides to consumers using alternative-energy resources by 2021. Of the required alternative energy, 8% must be from Tier 1 sources and 10% must be from Tier 2 sources.[63]

Table 9: Eligible Technologies for Pennsylvania's AEPS[64]

Tier	Eligible Technologies

Tier 1	Solar PVs, solar-thermal energy, wind, low-impact hydro, geothermal, biomass, in-state wood pulping and manufacturing byproducts, biologically-derived methane gas, coal-mine methane, fuel cells
Tier 2	waste coal, distributed generation <5 MW, demand-side management,[v] large-scale hydro, municipal solid waste, out-of-state wood pulping and manufacturing byproducts, and integrated gasification combined cycle coal technology

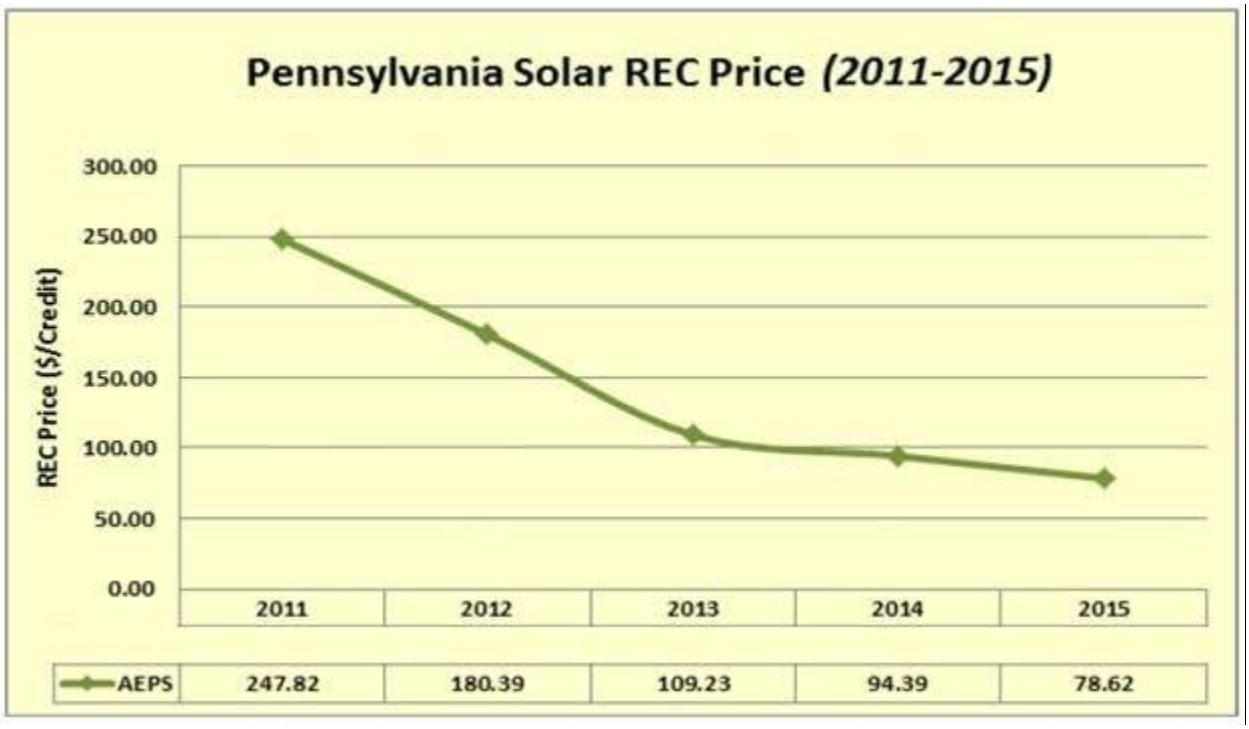
The AEPS also requires that 0.5% of the electricity supplied to consumers by distribution companies and electricity suppliers come from solar PV by 2021.[65] Eligible energy resources within the PJM RTO can be counted for AEPS compliance only in the parts of Pennsylvania that are served by the RTO.[66]

Under the AEPS, qualified technologies generate Alternative Energy Credits (AECs)—which are sometimes called Solar Renewable Energy Credits (SRECs) in the case of solar—for each megawatt hour of electricity they produce. AECs belong to the owner of the generator, can be transferred to another owner via contracts, are tracked by the PJM GATS system, and can be banked for two years after the year it was produced. Alternative Compliance Payments (ACPs) are required for shortfalls in the annual targets for Tier 1 and Tier 2 resources under the AEPS.[67] Under the law that created the AEPS, ACPs must be paid into a special fund of the Pennsylvania Sustainable Energy Board. Those funds are available to the regional Sustainable Energy Funds (discussed below) for the sole purpose of funding projects that will increase the amount of electric energy generated from alternative sources.[68]

In the 2015 compliance year for the AEPS, electric generation suppliers (EGSs) and electric distribution companies (EDCs) were required to supply 5% of electricity with Tier 1 resources (including 0.144% solar PV) and 6.2% of electricity with Tier 2 resources. In 2015, the weighted average credit prices for each category were $78.62 for one MWh of solar, $12.51 for a MWh of non-solar Tier 1 resource, $0.12 for a MWh of a Tier 2 resource. Weighted average credit prices are determined using data for credits that have a known cost.[vi]

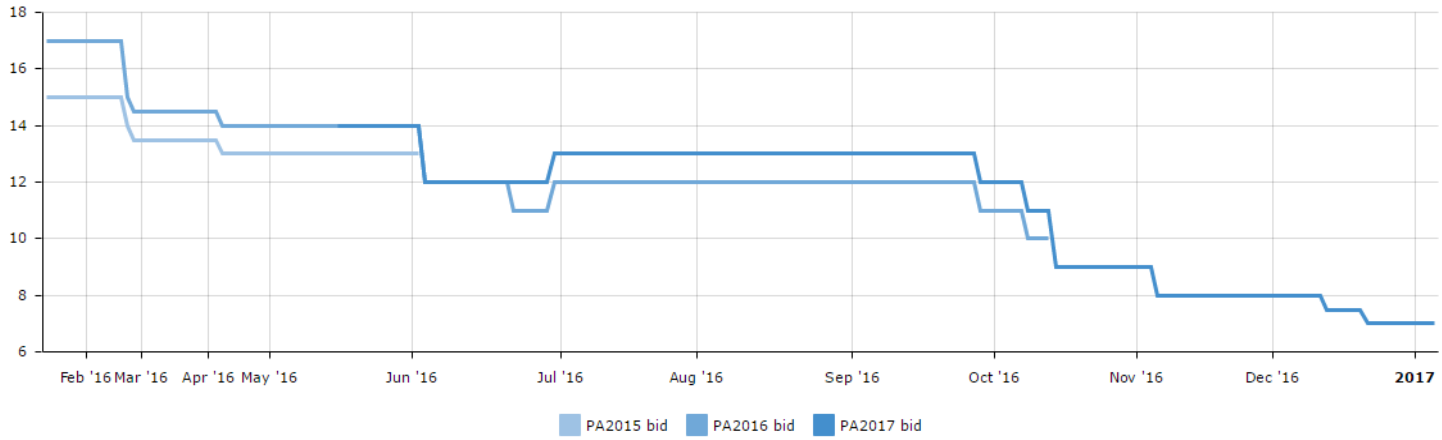
[v] This includes solar thermal technologies that do not produce electricity, such as domestic solar water heaters.
[vi] Data on some credit prices are not available, as some credits are self-generated and retired to meet obligations or are purchased bundled with the electricity.

Figure 22: Historical SREC Prices in Pennsylvania 2011-15[69]



In 2016, SREC prices in Pennsylvania bottomed out, reaching $7.[70] With SREC prices this low, the value of the SREC cannot be monetized, and SRECs have little or no impact on the impact of solar project economics.

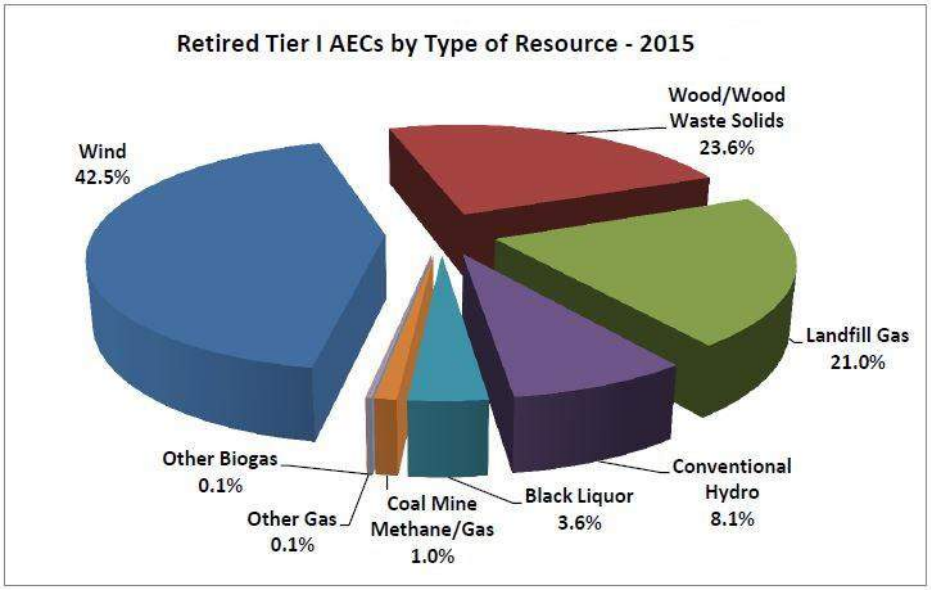
Figure 23: Pennsylvania SREC Bid Prices in 2016-17[71]



According to statute, the solar ACP is 200% 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, and the ACP for Tier 1 and Tier 2 resources is $45.[72] In 2015, all EDCs complied with the AEPS requirements by retiring the requisite number of AECs. Three EGSs did not retire sufficient AECs and had to pay ACPs. A total of 142 ACPs were made by EGSs—2 for solar, 61 for non-solar Tier 1, and 79 for Tier 2.[73]

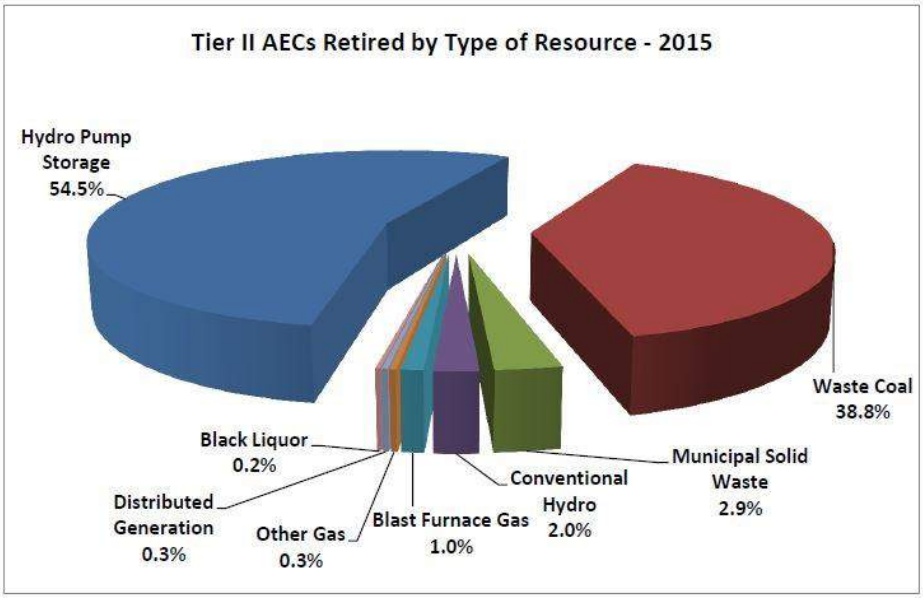
Tier 1 AECs retired in 2015 were mostly created by wind (42.5%), wood products and waste (23.6%), landfill gas (21.0%), and hydro (8.1%). Solar PV was used to meet 0.007% of the Tier 1 compliance obligation in 2015. Tier 2 AECs retired in 2015 were mostly created by hydro pump storage (54.5%) and waste coal (38.8%). The following charts display the types of resources used to meet the AEPS in 2015.[74vii]

Figure 24: Tier 2 AECs by Resource Type[75]



[vii] Resources comprising less than 0.1% are not shown in these charts.

Figure 25: Tier 2 AECs by Resource Type[76]



Of the solar AECs (or SRECs) retired in 2016, 62.1% were sourced in-state, while the remainder came from 11 other states throughout the PJM interconnection. North Carolina supplied 22.3% of solar AECs in 2016. Tier 1 AECs retired in 2015 were mostly sourced from Pennsylvania (35.8%), Virginia (25.2%), and Illinois (21.5%). Tier 2 AECs retired in 2015 were mostly sourced from Pennsylvania (62.3%) and Virginia (31.0%). The following charts display the state of origin of resources used to meet the AEPS in 2015.[77][viii]

[viii] Resources comprising less than 0.1% are not shown in these charts.

Figure 26: Solar AECs by Origin in 2016[78]

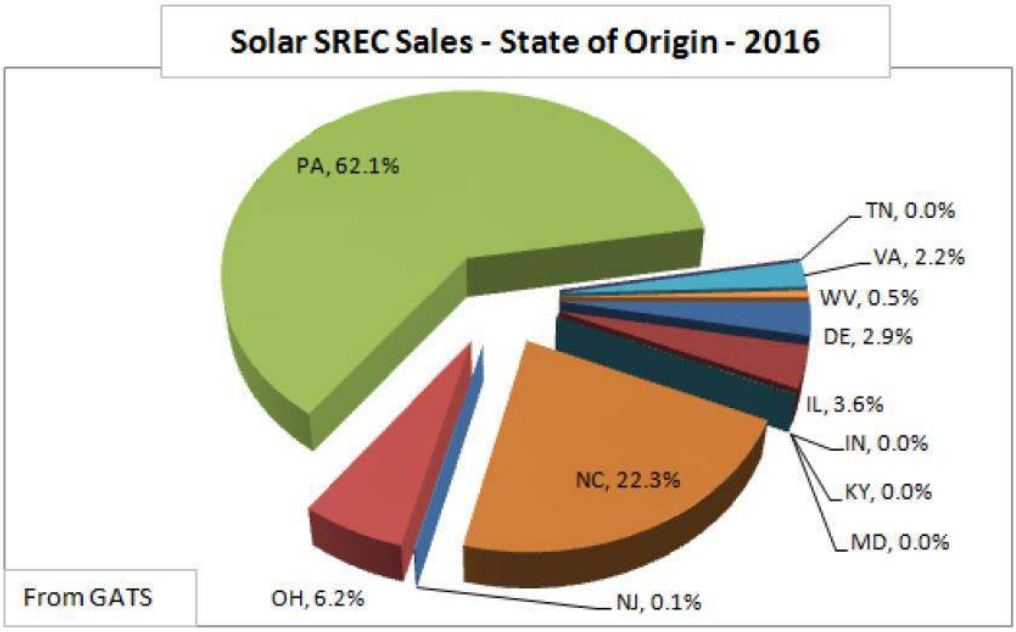


Figure 27: Tier 1 AECs by Origin in 2015[79]

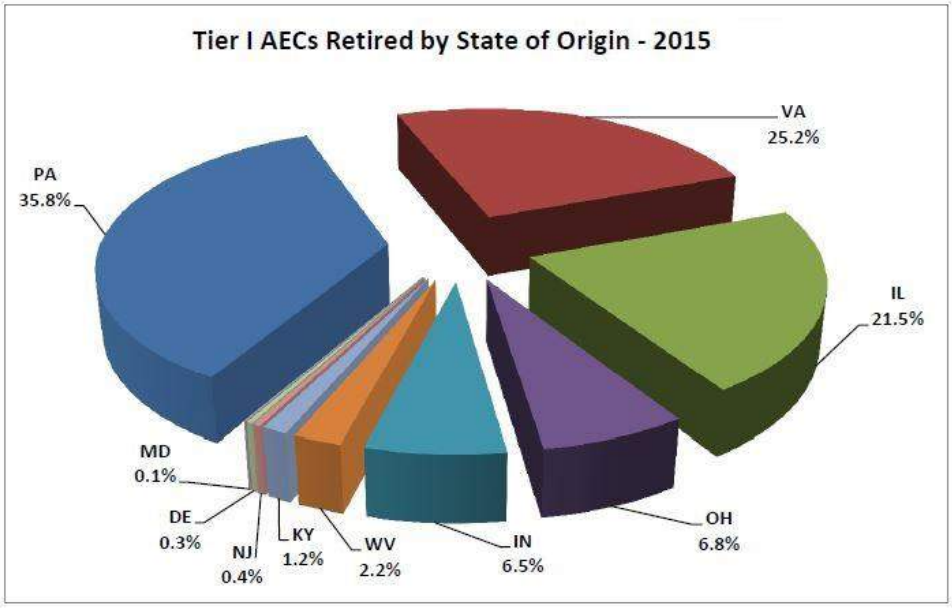
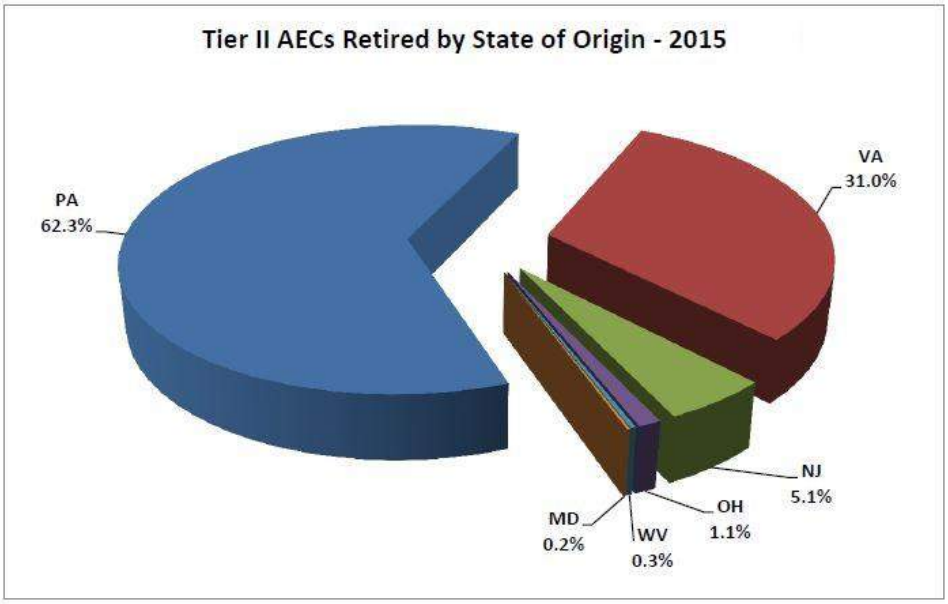


Figure 28: Tier 2 AECs by Origin in 2015[80]



The above information is mostly from the 2015 AEPS report. Market conditions have changed since 2015—many more large out-of-state solar projects have registered into the AEPS compliance system and SRECs are oversupplied in Pennsylvania. The oversupply of SRECs has contributed to the dramatic drop in SREC price.

Figure 29: Solar in Pennsylvania by Capacity and Systems Installed in 2016[81]

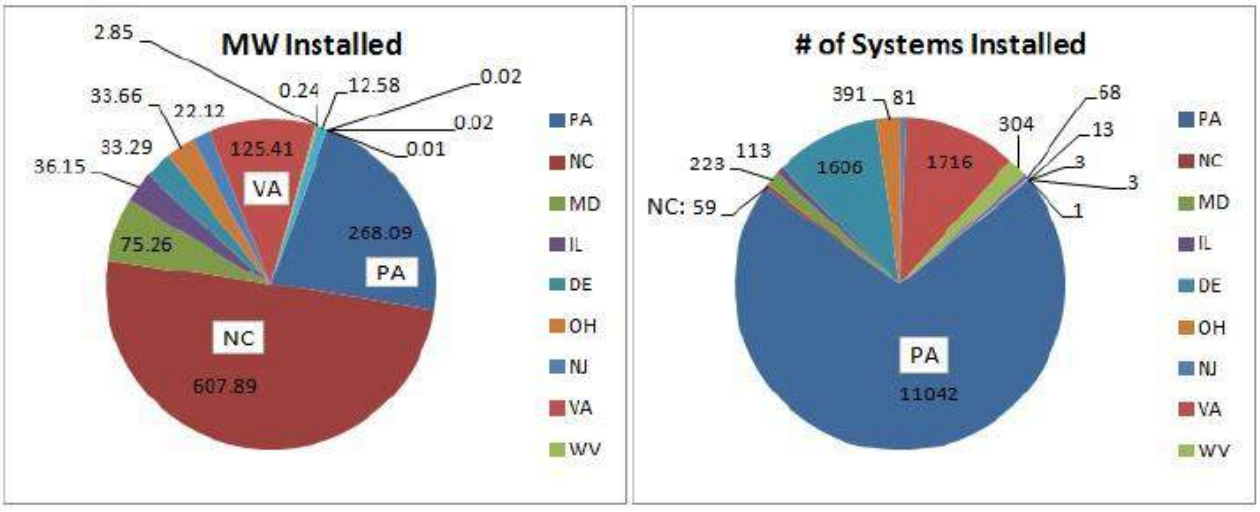
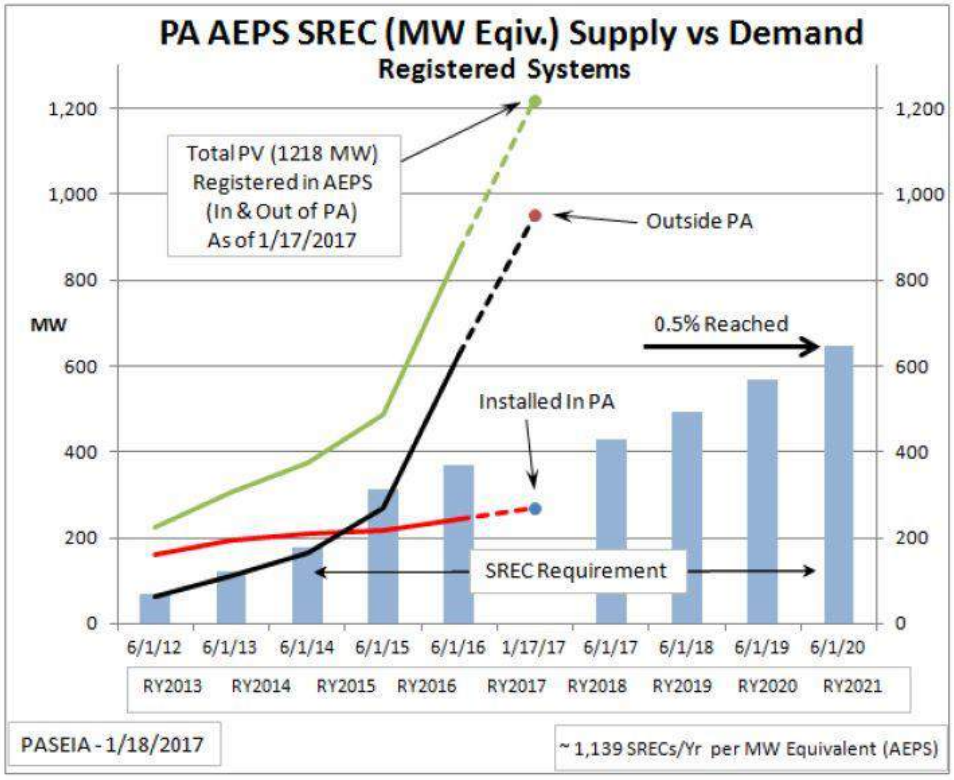


Figure 30: SRECs Available for AEPS Compliance[82]



Though Pennsylvania's AEPS targets appear to be more ambitious than some of its neighbors' standards, its expansive definition of "alternative energy" and acceptance of out-of-state resources ultimately undermine incentives for in-state clean energy development. The wide variety of eligible technologies under the AEPS allow the state to satisfy their targets with non-renewable resources, which results in a diminished incentive for EDCs to procure cleaner renewable energy. Using out-of-state resources for AEPS compliance creates a situation in which there is an "oversupply" of energy resources that can satisfy the AEPS. This dramatically reduces the incentive for in-state development of alternative energy generation. Relatively low ACP levels also contribute to diminished incentives to comply with the AEPS.

Net-Metering

Net metering is a regulatory structure that allows owners of distributed generation systems to sell any unused electricity back into the grid, with the utility paying a set rate per kWh and crediting consumer-generators on their energy bills. Net metering has been in effect on a statewide basis since 2006. Electric distribution companies (EDCs) must offer net metering to residential customers with systems less than 50 kW in capacity; nonresidential customers with systems less than 3 MW in capacity; and customers with systems between 3 and 5 MW that make their systems available to the grid during emergencies. Electric generation suppliers (EGSs) in Pennsylvania are permitted but not required to offer net metering.[83]

Currently Pennsylvania's net metering rules allow virtual meter aggregation, do not allow community solar,[ix] and do not include a cap on system generation relative to annual on-site consumption.[84]

Under Pennsylvania's net metering rules, customers' net excess generation is credited to their future bill at the retail kWh rate. If a customer has leftover net excess generation at the end of an AEPS compliance year, the utility compensate the customer for their remaining excess generation at the utility's "price-to-compare," which includes the generation and transmission (but not distribution) components of the utility's retail rate.[85] The price to compare is approximately two-thirds of the full retail price.[86]

Efficiency

Act 129

On Oct. 15, 2008, Governor Rendell signed HB 2200 into law as Act 129 of 2008. Act 129 expands the PUC's oversight responsibilities and imposes new requirements on electric distribution companies (EDCs), with the overall goal of reducing energy consumption and demand.[87]

Part of Act 129 required the PUC to establish energy efficiency and conservation standards for all investor owned utilities with at least 100,000 customers.[x] The Act 129 had initial energy conservation and demand reduction targets for utilities through 2013, after which it required the PUC to evaluate the cost effectiveness of the utility programs every five years and set additional efficiency goals for programs when benefits exceeds program costs. As a result, the energy efficiency standards have been divided into three phases:

- Phase I: Applies from June 1, 2010 to May 31, 2013. By May 31, 2013, achieve electricity savings equivalent to 3% of projected June 2009 - May 2010 electricity consumption.
- Phase II: Applies from June 1, 2013 to May 31, 2016. By May 31, 2016, achieve electricity savings equivalent to between 1.6% and 2.9% of June 2009 - May 2010 sales (varies by utility).
- Phase III: Applies from June 1, 2016 through May 31, 2021. By May 31, 2021, achieve electricity savings ranging from 2.6% to 5% (varies by utility).

For the current Phase III standards, the energy consumption reduction targets vary between the utilities, but are collectively expected to achieve a statewide average of a 5,710,487 MWh reduction in energy use by 2020 based on 2010 standards.[88]

Table 10: Energy Efficiency Goals by Utility[89]

EDC	EE Potential Savings (MWh)	% of 2010 Forecast	Average Annual	% Reduction relative to 2007 peak demand

[ix] "Community solar" is a scenario in which multiple end users share the benefits of a single solar system.

[x] At the time, the following Electric Distribution Companies had at least 100,000 customers: PECO Energy, PPL Electric Utilities, Penn Power, Pennsylvania Electric (Penelec), Metropolitan Edison (Met-Ed), Alleghany Energy, and Duquesne Light.

			Potential Savings (MW)	
Duquesne	440,916	3.10%	42	1.70%
Met-Ed	599,352	4.00%	49	1.80%
PECO	1,962,659	5.00%	161	2.00%
Penelec	566,168	3.90%	0	0.00%
Penn Power	157,371	3.30%	17	1.70%
PPL	1,443,035	3.80%	92	1.40%
West Penn Power	540,986	2.60%	64	1.80%

Phase III's demand reduction targets for each utility use methodology assuming 10% of an EDC's energy efficiency budget goes to peak demand reduction and 90% of the budget is for electricity sales reduction. EDCs are responsible for the administration of the programs, and submit annual plans to achieve at least 15% of the target amount in each program year. For EDCs with efficiency programs with greater benefits than costs, the PUC is required to set additional demand reduction goals for those EDCs.[xi] EDCs recover all reasonable costs associated with their efficiency program offerings through a reconcilable adjustment clause.

Under Phase III, EDCs are required to obtain 5.5% of their reduction target from energy efficiency programs targeting low-income ratepayers, and 3.5% of their reduction targets must come from energy efficiency achieved in federal, state, and local government, and the nonprofit sector. Failure to hit these targets could result in financial penalties.

The total cost of an EDC's reduction plan may not exceed 2% of the utility's total annual revenue on an annual basis. Failure to achieve the required reductions in electricity consumption and peak demand is punishable by fines from $1 million to $20 million, and are not recoverable from ratepayers.[90]

[xi] Pennsylvania utilizes the Total Resource Cost test (TRC) as its primary test for measuring the cost-effectiveness of energy efficiency programs.

Public & Quasi-Public Institutions

This following sections are organized such that each institution in Pennsylvania that has a role in the clean energy market is described. Each program housed within that institution that facilitates clean energy market activity is described in a subsection.

There are a variety of institutions in Pennsylvania that engage in clean energy activity in Pennsylvania, and each of them has a unique set of programs designed to facilitate clean energy deployment—either explicitly or in the form of community or economic development, or pollution prevention. Many of the institutions and programs discussed in this section do not receive annual funding—roughly a dozen were capitalized by legislation or by ratepayer dollars and now operate as revolving loan funds. Many programs do not have rigid boundaries in terms of eligible technologies and financing terms. For example, a program in Pennsylvania offers funding for clean energy service companies, manufacturing companies and individual projects in the form of grants, loans, leases, and equity investments. Unlike other states, which often separate project financing programs, grant programs, and programs for investment in companies, several Pennsylvania programs engage in all three types of activity. Pennsylvania also distinguishes itself in terms of the sheer number of programs that support clean energy in some shape or form. As a result, many market sectors are, at least by design, highly supported by state programs.

However, many of the programs have limited capacity to meet additional demand from the market because their funds are depleted and have not been given new resources. And on the other extreme, the existing capacity of some programs has gone unused. Several of the more high-profile clean energy programs only serve specific regions of the state, providing funds only within specific utility territories. This creates challenges to building broad demand for clean energy. Though there is a high number and variety of clean energy programs in place, the collective set of institutions and programs have not been designed or funded to stimulate steady statewide clean energy investment and market growth.

Public Utilities Commission (PUC)

The Pennsylvania Public Utilities Commission, or PUC, is the state agency tasked with regulating several utilities and industries across the state—electric, gas, transportation, communication and water. The PUC is funded by the assessments placed on the regulated utilities' in-state revenue.[91] The PUC has authority over 11 electric utilities and 35 gas utilities. The PUC licenses electric suppliers and gas suppliers but does not otherwise oversee or regulate the suppliers.[92] The PUC provides oversight of the competitive energy markets and their development.[93] The PUC also administers and monitors the state's Alternative Energy Portfolio Standard (AEPS) and the Act 129 Energy Efficiency and Conservation (EE&C) Program.[94]

Department of Community and Economic Development (DCED)

The Department of Community and Economic Development (DCED) is a state agency tasked with growing local businesses and facilitating economic growth in Pennsylvania communities. The DCED has various

programs that fall broadly into two areas—business assistance and community and local government assistance.

Through dozens of different funding programs, the DCED makes dollars available to businesses, nonprofits, and local governments in the form of grants, loans, loan guarantees, tax credits, and bonds. Examples of programs that DCED administers include a flood mitigation program, historic preservation tax credit, industrial sites reuse program, high performance building program, job creation tax credits, minority business development program, and renewable energy program, just to name a few of many.[95]

Weatherization Assistance Program

Pennsylvania's Weatherization Assistance Program serves low-income individuals (at or below 200% of the federal poverty level), with priority given to higher risk residents such as the elderly, disabled individuals, families with children and high energy users. The WAP provides energy audits assess conditions in homes and to identify the most cost-effective energy saving measures to be installed. Weatherization services include: improvements to insulation and ventilation to reduce energy loss, heating system modification or replacement to increase the efficiency or safety, other minor repairs, and client education. The average expenditure per household is $6,500 depending on the home audit results. Different weatherization agencies serve different counties across the state.[96]

Pennsylvania Economic Development Financing Authority (PEDFA)

The Pennsylvania Economic Development Financing Authority (PEDFA) offers tax-exempt and taxable bond financing for clean, advanced energy projects.[97] It was established by the Economic Development Financing Law in 1987 to provide low-interest financing through the issuance of tax-exempt and taxable debt and sits within the DCED. PEDFA finances stand-alone projects and pooled projects. PEDFA's tax-exempt and taxable financings have distinct eligibility criteria and interest rates—tax-exempt projects get lower interest rates but must meet stringent eligibility criteria established by federal tax law and be reviewed by PEDFA's bond counsel. Minimum loan size for all PEDFA projects is $400,000.[98]

Tax-exempt bond financing through PEDFA can include rates below market rates, as well as terms up to 30 years (maxing out at 120% of the depreciable life of the asset financed). Up to 100% of qualified costs may be funded, but lenders or credit banks usually require a significant equity contribution. Funds can be used for construction and take-out financing for land, buildings and equipment. Eligible tax-exempt projects include manufacturing facilities, nonprofit facilities, affordable housing multifamily facilities,[xii] solid waste disposal facilities, sewage facilities, facilities for the local furnishing of electricity or gas, facilities for the furnishing of water, qualified hazardous waste disposal facilities, local district heating or cooling facilities, airports, docks, wharves, and mass commuting facilities, high-speed intercity rail

[xii] Eligible properties must have 20% or more of their units occupied by individuals with incomes 50% or less of the area median gross income, or 40% or more of their units occupied by individuals with incomes 60% or less of the area median gross income. These facilities may include assisted living and continuing care retirement facilities.

facilities, environmental enhancements of hydro-electric generating facilities, qualified residential rental projects, qualified public educational facilities, qualified green building and sustainable design projects, qualified highway or freight transfer facilities.[99]

Taxable bond financing through PEDFA carries few restrictions—borrowers have much more flexibility in terms of how they use funds and how much they borrow. PEDFA's taxable financing also has the advantage of allowing borrowers to use accelerated methods of calculating tax depreciation. All businesses qualified to do business in Pennsylvania are eligible for PEDFA's taxable bond financing.[100]

To date, PEDFA has never financed a clean energy project or even received an application from a clean energy project. PEDFA seeks large scale projects, requires that a project have a PPA in hand to be considered financeable, prefers tax exempt projects, and requires borrowers with credit ratings. Wind and solar do not qualify for tax exemption, many project owners seeking capital for clean energy projects do not have credit ratings or PPAs in hand, and many clean energy projects generally do not meet the minimum scale to justify the expense of the bond counsel.[xiii] Though some large clean energy projects may be able to overcome these hurdles to successfully apply for PEDFA bond financing, the PEDFA structure is not conducive to financing most clean energy projects.[101]

Commonwealth Financing Authority (CFA)

In 2004 the Commonwealth Financing Authority (CFA) was created as an independent agency of the DCED to administer Pennsylvania's economic stimulus packages. The CFA administers 21 programs.[102] The CFA consists of seven board members, four of which are legislative appointees and three of which are the secretaries of DCED, the Office of the Budget and Department of Banking. For the CFA to approve funding for a project, five board members must vote for it, and four of the five votes must come from legislative appointees.[103] The CFA is responsible for funding programs and investments related to the state's economic growth. To do so, the CFA issues limited obligation revenue bonds. The CFA has no power to pledge the credit or taxing power of the Pennsylvania government, and obligations of the CFA are not obligations of the Pennsylvania government.[104]

In 2016, the CFA issued $767 million in revenue bonds, which received an 'A+' rating from Fitch Ratings. These bonds are limited obligations of the CFA secured by service fees paid to the CFA by various state agencies and state appropriations for debt service. The CFA has $1.6 billion in outstanding revenue bonds.[105] Between $78 and $96 million was allocated to the CFA in the 2016-17 budget for debt repayment for bonds that financed projects approved by the CFA Board.[106]

In 2012 (the most recent year for which an annual report is available), the CFA had approved more than $2 billion in funding for 1,829 projects. While much of this investment was in water, infrastructure, and

[xiii] Accounting for the expense of bond counsel, developers of clean energy projects $8 million in value or less are likely to find cheaper capital at private lending institutions.

real estate rehabilitation, a sizeable amount of investing took place through several clean energy funding programs administered by the CFA. Through 2012, the CFA approved 187 applications for more than $153 million for clean energy projects.[107]

The four primary programs devoted to clean energy administered by the CFA were the product of the Alternative Energy Investment Act of 2008. One of the programs (the Alternative and Clean Energy Program) depleted its funds and another (the High Performance Buildings Program) had its funds reallocated. The two remaining funds are devoted to commercial-scale solar (the Solar Energy Program) and wind and geothermal (the Renewable Energy Program), and have approximately $30 million and $4 million in remaining capacity, respectively. Though the CFA may have the authority to recapitalize these funds or start new clean energy focused programs, it is unlikely to do so.

Of the 21 programs CFA administers, the following sections only discuss those explicitly focused to renewable energy and energy efficiency. Additional CFA programs that could conceivably finance clean energy projects are discussed in the Appendix.

Alternative and Clean Energy Program (ACE)

The Alternative and Clean Energy Program (ACE) is administered jointly by the Department of Community and Economic Development (DCED) and the Department of Environmental Protection (DEP), under the direction of the Commonwealth Financing Authority (CFA). The program originally received $165 million as part of the Alternative Energy Investment Act of 2008, and it has since depleted those funds and is "temporarily closed."[108]

ACE provided grant and loan funds for the utilization, development and construction of alternative and clean energy projects in the state. Businesses, economic development organizations, or a political subdivision (municipalities, counties and school districts) were eligible for ACE funding. Eligible projects included any of the technologies defined under the Alternative Energy Portfolio Standard, as well as any energy efficiency projects, construction and renovation of high performance buildings, and a few others. There was a matching investment requirement of at least $1 in any new public or private source for every $1 of program funds awarded.[109]

Maximum loan size for any alternative energy production or clean energy project was $5 million or 50% of the total project cost, whichever was less. Maximum grants size for such projects could not exceed $2 million or 30% of the total project cost, whichever was less.

Loans for manufacturers of alternative or clean energy generation equipment or components could not exceed $40,000 for every new job projected to be created within three years after approval of the loan. Grants for such manufacturers could not exceed $10,000 for every job projected to be created by the business within three years after approval of the grant.[110]

ACE loans had a max amortization period of the lesser of 25 years and the useful life of the asset, and a maximum repayment period of 10 years. Loans for energy efficiency projects and geothermal systems had a 10 year amortization. Interest rates on ACE loans were fixed at the 10-year Treasury plus 250 basis points and updated on a quarterly basis. All loans had to be secured by a lien on the asset financed, and potentially additional assets, revenues and securities at the discretion of the CFA.[111]

Over the lifetime of the ACE program, $25 million worth of loans were made to 26 projects and $140 million worth of grants were given to 153 projects.[112] Much of the matching funds provided for these commitments (including the loans) was provided by public grant programs and as simple cash payments from the applicant companies.[113]

While mobilizing $165 million to clean energy projects is an impressive and laudable achievement, there are a few ways that the approach of the ACE program unnecessarily constrains the market development potential of those dollars. Disbursing 85% of the available funds as grants limits the impact of those funds to the projects that receive them. Twenty six projects benefited from loans, and those loans are now slowly generating revenue for the CFA, but not enough to keep the fund active and operational. Had ACE developed a large portfolio of loans, they would have a larger revenue stream and would have had the option of selling the assets to another financial institution to recapitalize the fund. Doing so would have multiplied the impact of the original $165 million and established a dependable source of clean energy project capital for the market.

In defining the matching funds requirement as any public or private investment, the ACE program limits the role private investors could have played in investing alongside the CFA. The ACE program effectively just financed half (or less) of the total project costs, and the applicant company or another grant provider would step in to pay for the remaining project costs. Leveraging this kind of “private” spending does not move the clean energy market forward the way that having a private co-lender involved in the deal would. Using the public capital in the ACE program to de-risk clean energy projects and draw in private investors would help the capital markets and banking sector build familiarity and expertise with clean energy asset classes and potentially help stimulate independent private financing activity of clean energy projects in the future.

Solar Energy Program (SEP)

The Solar Energy Program (SEP) previously offered grants and loans to promote the generation and use of solar energy and the manufacture or assembly of solar equipment. Eligible borrowers include businesses, economic development organizations, municipalities, counties, and school districts. The SEP is administered jointly by the DCED and DEP under the direction of the CFA. The program originally received $80 million as part of the Alternative Energy Investment Act of 2008, and has been drawn down

to approximately $30 million in available funds. At the end of 2016, the program issued new program guidelines and now no longer disburses money in the form of grants.

For solar generation and distribution projects, maximum loan size is the lesser of $5 million or $3 per watt. For manufacturers of solar energy generation equipment, the SEP loans cannot exceed $40,000 for every new job created within three years after approval of the loan. The SEP requires a matching investment of at least $1 for every $3 of program funds awarded. There is a $100 non-refundable application fee and a 1% commitment fee on all approved loans.[114]

SEP loans have a maximum repayment period of 22 years for equipment and 15 years for real estate. The interest rates for the loans are fixed at the 10-year Treasury note plus 250 basis points and are updated on a quarterly basis. All loans need to be secured by a lien on the asset financed, and potentially additional assets, revenues and securities at the discretion of the CFA.[115]

To date, the SEP program has made 2 loans for a combined value of $1.8 million and 67 grants for a combined value of $47 million. This activity occurred before the program was restructured to only offer loans.[116]

Deploying nearly $50 million to clean energy projects is an important and impressive milestone. Yet the SEP program could have a much larger impact. The SEP has the same unnecessary impact-limiting features of the ACE program (discussed above) and others. Disbursing 96% of the dollars as grants, while great for recipients, reduces the impact of the dollars on market development, eliminates the opportunity for the fund to be fiscally sustainable through asset-sales, and do not help prove the economic viability of the asset class.

Though the new program structure has addressed these issues by only allowing loans, there are some remaining features that may limit the impact of the fund. The matching fund requirement will allow project applicants to finance 75% of the project costs (at most) with SEP's capital, and provides no incentive to leverage private debt capital. As has happened in the previous iteration of the SEP program and the ACE program, applicants may result in simply paying for, or seeking a grant for the remaining 25% (or more) of project costs, instead of finding private financing. Jointly financing 100% of the project cost with private co-lenders would help investors enter the market and get comfortable with clean energy deals, and help contribute evidence of revenue-generation and low-default rates in the clean energy projects that might help inspire private investors to enter the market. Increasing the matching funds requirement, and incentivizing applicants to seek private financing—or better yet partnering with private lender to provide private financing—would bring more capital into the market, use the limited public capital in the SEP program more efficiently, generate more economic activity for Pennsylvania businesses, and help the clean energy market begin to stand on its own economic strength.

Another potential impact-limiting feature of the SEP program is the dissonant eligible project classes. Solar electricity generation and storage projects, solar equipment manufacturing facilities, and solar technology research and development facilities each have wildly different risk-return profiles, time horizons, and capital requirements. With only one staff to review applications and conduct due diligence on potential investments, this broad array of eligible projects effectively requires the staff to have and maintain three distinct areas of expertise, which may slow down the SEP program operationally and thereby reduce loan volume. It also may lead to a portfolio that is less conducive to an asset sale that would allow the fund to recapitalize.

That all said, the new SEP program guidelines do deserve praise for 22 year terms (for equipment). Long terms are important for solar generation projects to achieve cash flow positivity for end-users. That is, the longer the term, the lower the monthly payments, and the more likely it is that monthly revenue from the solar project will be greater than the monthly debt service payments. Long terms thus greatly improve the appeal of financing to customers and contractors, and may reduce the risk of default, which would increase the appeal of solar projects to private debt investors providing upfront project capital or purchasing productive solar loan assets.

It should also be noted that no matter how well-structured the SEP may be, the existence of a quality financing program alone does not generate demand for that financing. Various outreach and market-development activities—such as contractor training seminars or targeted marketing campaigns—may be necessary to stimulate demand for the SEP's capital.

Renewable Energy Program (REP) – Geothermal and Wind Projects

The Renewable Energy Program (REP) provides grants and loans to promote the use of geothermal technologies and wind energy projects. Eligible participants in the REP include: businesses; economic development organizations; individuals (for geothermal projects only); and municipalities, counties and school districts. The REP is administered jointly by the DCED and DEP under the direction of the CFA. The program originally received $25 million as part of the Alternative Energy Investment Act of 2008, and has been drawn down to approximately $4 million.[117]

REP offers loans for component manufacturers of renewable energy generation equipment of up to $40,000 for every new job created and grants for such manufacturers of up to $5,000 for every new job created. Maximum loan size for geothermal systems or wind energy generation or distribution projects is the lesser of $5 million or 50% of the total project cost. Maximum grant size for such projects is the lesser of $1 million or 30% of the total project cost. REP also offers grants for planning and feasibility studies up to 50% of the total cost of the planning project or $175,000, whichever is less. The REP requires a matching investment of at least $1 for every $1 of program funds awarded. There is a $100 non-refundable application fee and a 1% commitment fee on all approved loans.[118]

REP loans have a maximum repayment period of 10 years for equipment and 15 years for real estate. The interest rates for the loans are fixed at the 10-year Treasury note plus 250 basis points and are updated on a quarterly basis. All loans need to be secured by a lien on the asset financed, and potentially additional assets, revenues and securities at the discretion of the CFA.[119]

To date, the REP program has made 26 loans for a combined value of $1.7 million and 5 grants for a combined value of $17 million. The majority of the loans were made for the purchase and installation of geothermal systems, and all the grants were made to wind electricity generation projects.[120]

The REP program has a few of the same impact-limiting features discussed for the ACE and SEP programs. To date, 91% of the funding disbursed by the REP program has been in the form of grants, which do not help develop the clean energy market for the same reasons discussed above. Also, combining residential geothermal HVAC projects, distributed wind generation, utility-scale wind generation, and potential wind energy technology manufacturing enterprises in the same lending program and in the same loan portfolio may create inefficiencies and difficulties recapitalizing.

As an asset class, utility-scale wind projects are generally well understood by market participants, have achieved high levels of penetration relative to other clean energy technologies, and do not systematically suffer from difficulty accessing capital. Distributed wind projects may have trouble accessing capital due to their scale and the limited returns they would provide to investors, but, as discussed below, resources for distributed wind in Pennsylvania are not abundant. Devoting 91% if the REP's funding activities to grants for 5 wind projects certainly helped the recipient projects, but it may not have helped develop the market for wind, and the opportunity cost of that $17 million was high.

High Performance Building Program (HPB)

The High Performance Building Program (HPB) provides grants and loans to cover the additional costs of designing, constructing or renovating high performance buildings for small businesses or individual residential projects. The HPB program is administered jointly by the DCED and the DEP under the direction of CFA. The program originally received $25 million as part of the Alternative Energy Investment Act of 2008, but due various operational setbacks, $24 million was reallocated to different programs, leaving $1 million for the HPB program.

Maximum loan size in the HPB program is $2 million for small businesses and $100,000 for individual residence projects. Maximum grants size for high performance building projects is the lesser of $500,000 or 10% of the total eligible building construction/renovation costs. The HPB program requires a matching investment of at least $1 for every $1 of program funds awarded. There is a $100 non-refundable application fee and a 1% commitment fee on all approved loans.[121]

HPB loans have a maximum amortization period of 25 years and a maximum repayment period of 10 years. The interest rates for the loan are fixed at the 10-year Treasury note plus 250 basis points and are updated on a quarterly basis. All loans need to be secured by a lien on the asset financed, and potentially additional assets, revenues and securities at the discretion of the CFA.[122] To date, the HPB program has made no loans and $421,099 in grants across 4 projects.[123]

Apart from having its funds reallocated, there are a few impact-limiting features of the HPB program which are similar to some of those previously discussed for CFA programs. The matching requirement essentially requires building owners (including residential homeowners) to pay for some of the upfront costs of the projects. The inability to finance 100% of the project, either with HPB capital or alternative sources of capital increases the perceived complexity and difficulty using the program and thus reduces the attractiveness to end-users and contractors. The maximum term of 10 years makes multi-measure efficiency projects less likely to be cash flow positive for end users—terms should be long enough that it is possible for monthly savings to be greater than monthly debt service payments. Combining a grant and loan program limits the ability of the fund to prove the economics of projects, stimulate more private activity, and develop a portfolio that could generate significant revenue or be sold to recapitalize the fund.

Department of Transportation (PennDOT)

The Pennsylvania Department of Transportation, or PennDOT, is responsible for the programs and policies affecting highways, urban and rural public transportation, airports, railroads, ports and waterways. PennDOT's primary focus is the state and local highway system. PennDOT also administers the state's vehicle registrations and driver's licenses and oversees safety and emission inspection programs.[124]

PA Infrastructure Bank

The Pennsylvania Infrastructure Bank (PIB) is a PennDOT revolving loan fund that offers low-interest loans to fund transportation projects in whole or in part. The PIB endeavors to leverage state and federal funds, accelerate priority transportation projects, spur economic development and assist local governments with their transportation needs.

The PIB has a good set of finance tools that it uses to fund highways, railways, bridges, and other transit projects. Since it was established, the PIB has facilitated more than $500 million in transportation projects across the state. None of this activity has been devoted to electric vehicles or charging stations. The PIB is made up of four distinct accounts: aviation, highway/bridge, rail freight, and transit. Loans to eligible projects are made from one of these four accounts.[125] Electric vehicle charging infrastructure would likely be financed out of the transit account of the PIB, which has been used to finance capital purchases, buildings, and intermodal facilities in the past.[126]

Department of Environmental Protection (DEP)

The Pennsylvania Department of Environmental Protection (DEP) is the state agency tasked with protecting the air, land, and water of the state from pollution. It serves as the state's energy office and provides staffing for the Pennsylvania Energy Development Authority (PEDA).[127]

Sunshine Grant Program

The Sunshine Program was established as a result of the Alternative Energy Investment Act of 2008. It was a solar grant program targeting homeowners and small business owners that employed 100 or fewer people. It ran from 2009 to 2013, when the funds were depleted. The program offered rebates of up to 35% of the cost of the project design and installation on a cost per installed-watt basis.[128]

The $100 million that was devoted to the program by the legislation was supplemented by funds from other sources: around $9 million from the American Resource Recovery Act (ARRA) funding; $3 million in Clean Air funds; $1 million from a settlement agreement between the PUC and Duquesne Light Company; and $116,000 in DOE State Energy Program (SEP) funds. Of the $113 million available for rebates, around $104 million went to solar PV systems. The program deployed all $104 million by 2013, which offset the upfront costs of around $500 million in solar projects.[129]

Figure 31: Number of PV Systems Installed with Sunshine Program Rebate[130]

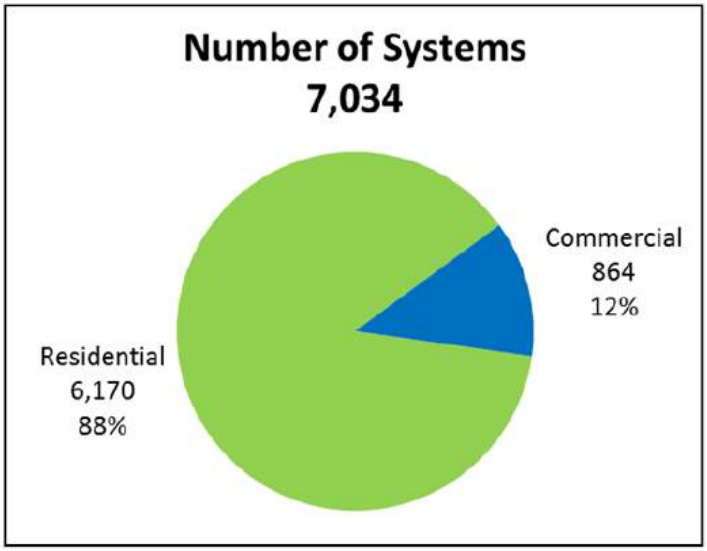


Figure 32: Rebates Paid for PV Systems through Sunshine Program[131]

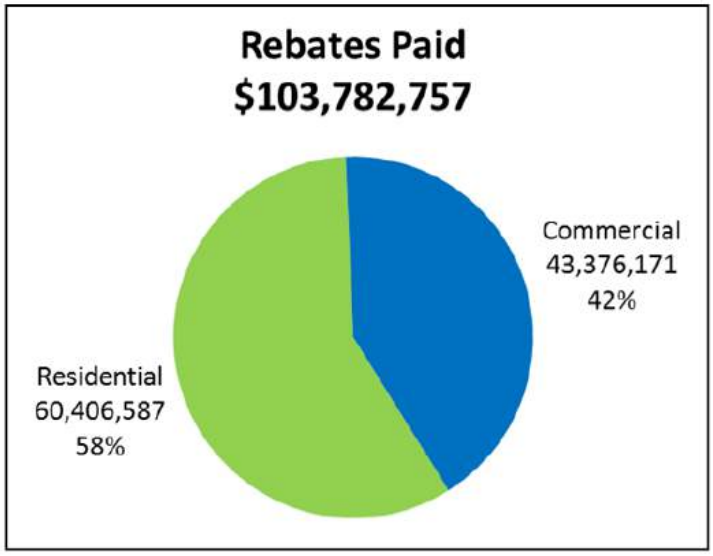
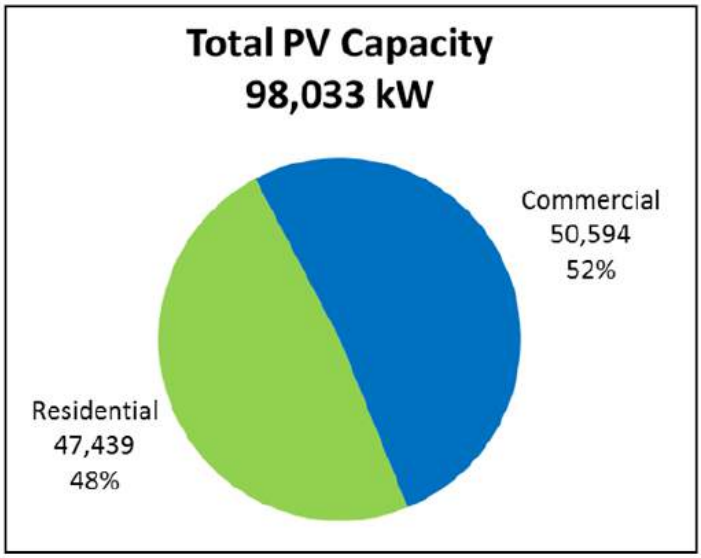


Figure 33: Capacity of PV Systems Installed under Sunshine Program[132]



Of the PV systems installed with the rebate, the average residential system was 7.7 kW and the average commercial system was 58.6 kW. The average residential rebate was $9,790. The average commercial rebate was $50,204. Averaged across the program, the Sunshine Program gave rebates of $1.06/W for all new PV systems. In the residential sector, the average rebate was $1.27/W. In the commercial sector, the average rebate was $0.86/W.[133]

When the program ran out of funds in 2013, there was a dramatic reduction in residential and small business solar market activity. The Sunshine Grant program was propping up a large chunk of the market. Without the grant, contractors lost a powerful marketing tool, upfront costs of solar systems increased, customer demand waned, and installations fell as a result. Many of the Pennsylvania-based solar contractors that had enjoyed prosperity in during the tenure of the grant program either relocated out of state or went out of business. Of the solar contractors that remain, there is a desire for dependable long-term financing for solar systems. The solar installation industry in Pennsylvania is currently small and growing, but in the absence of good financing products for residential solar systems, they primarily serve the segment of the market that can afford to pay for solar systems upfront.

The Sunshine Grant Program illustrates the positive and negative impacts of grants on the markets. The program undeniably increased the number of solar distributed projects across the state, helped develop the in-state solar installation industry, and allowed the distributed solar market in Pennsylvania to pick up some momentum. However, the end of the grant program underscored the reliance of the market on grants and the obstacle presented by the upfront cost of solar. If affordable, long-term financing was available, contractors could serve a greater portion of the market, more Pennsylvania residents could enjoy the benefits of solar, and the market for distributed solar projects in Pennsylvania could continue to develop and stand on its own on the strength of the underlying project economics.

Small Business Pollution Prevention Assistance Account Loan Program

The Pollution Prevention Assistance Account (PPAA) is jointly administered by the DEP and DCED and provides loans for businesses with a maximum of 100 full-time employees to finance energy efficiency and pollution prevention projects. Loans can cover 75% of project costs up to $100,000 with terms up to 10 years. Eligible projects include pollution prevention or energy efficient equipment or processes that reduce or reuse raw materials on-site, reduce waste-production, or significantly reduce energy consumption and are directly related to the business activity. Renewable energy systems are eligible for funding if they meet the project eligibility criteria. A further criteria of the program is that the project must have a payback period that is less than or equal to the loan term, and the expected benefits must extend past the term of the loan.[134]

Green Energy Loan Fund (GELF)

The Green Energy Loan Fund (GELF) is a revolving loan fund which aims to provide low-cost financing for building energy efficiency retrofits and the installation of high performance energy systems in all building types, except residential. GELF is administered by the Reinvestment Fund. In 2010, PA DEP contributed $12 million of federal American Recovery and Reinvestment Act funds as the initial funding for GELF. GELF is now funded through the U.S. Department of Energy (DOE) through the State Energy Program.[135] As of 2015, the GELF had about $900,000 in cash and marketable securities.[136]

GELF offers construction loans, term loans and lease financing to businesses, nonprofit organizations and local governments to support building energy efficiency retrofits, high-performance energy equipment or systems, and high performance energy measures and systems in gut rehab projects or in new construction. GELF aims to finance building energy projects that reduce energy consumption by 25% or more. GELF loans range in size from approximately $100,000 to $2,500,000. Because the capital for GELF loans came from federal sources, loan recipients are subject to various requirements, including the Davis Bacon Act and the National Environmental Policy Act, among others.[137]

The term of the loans are chosen to match the life of the improvements financed, up to a maximum of 15 years. The interest rate is set on a case-by-case basis, and generally falls within the 4-5% range. Loan recipients must have an independent energy expert (such as a registered architect, professional engineer, or individual with a current certification by the Building Performance Institute, the Association of Energy Engineers, the U.S. Green Building Council or comparable certification) confirm that their projects will reduce energy consumption by an estimated 25%.[138]

Since the GELF was first capitalized with ARRA dollars around 2009, 11 loans for approximately $15 million have been made.[139] This translates to an approximate annual rate of lending 1.5 loans a year and about $2.1 million in loans per year.

Though the GELF has deployed a significant sum of money since its inception, and has attractive lending terms, it is faced with two drawbacks—the increased transaction costs created by the additional federal regulation of the capital, and the near-depletion of its funds.

Alternative Fuels Incentive Grant Program (AFIG)

The Alternative Fuel Incentive Grant (AFIG) program seeks to promote and build markets for advanced, renewable and alternative energy transportation technologies. The grants are intended to reduce consumption of imported oil through the use of domestic alternative fuels that will improve the state's air quality and help the state's economy. The AFIG fund receives an annual allocation from the state's General Fund in an amount equal to 0.25 mills of the utilities' gross receipts tax. In 2016, approximately $7 million in grants were available for school districts, municipal authorities, political subdivisions, nonprofit entities, corporations, limited liability companies or partnerships incorporated or registered in Pennsylvania. The grant money can be for retrofitting vehicles to use alternative fuels; purchasing bi-fuel, dual-fuel, hybrid or alternative-fuel vehicles; installing refueling equipment; and research, training, development and demonstration of alternative fuel technology. The fuels promoted by the program include electricity, hydrogen, hythane (a combination of compressed natural gas and hydrogen), compressed natural gas (CNG), liquefied natural gas (LNG), ethanol, methanol, liquefied petroleum or propane gas, and fuels derived from coal, biomass, and soybeans. Since 1995, the DEP has awarded a total of approximately $70 million to a wide range of alternative fuel transportation projects and alternative fuel vehicle purchases. AFIG funds are awarded to public and private organizations via a competitive grant

process. AFIG funds are also made available to individual residents through a rebate program for the purchase of alternative fuel vehicles.[140]

Historically, AFIG grants have been awarded to public and private sector organizations in PA for a broad array of alternative fuel transportation projects, including fleet vehicle purchases, biofuels purchase and blending, innovative technology development and commercialization, nitrogen tire inflation equipment, and alternative fueling infrastructure (in particular, EV charging stations and CNG/LNG fueling stations). Currently, AFIG offers grants of up to $500,000 that can be used by organizations to cover a portion of the incremental cost to purchase or convert vehicles to run on alternative fuels, to install refueling equipment, for the purchase of advanced biofuels, and for research and development of near-commercial alternative fuel technologies. Since 2013, AFIG provided $7 million to 66 awardees to support the purchase or conversion of light to heavy duty vehicles that run on natural gas, propane, and electricity.[141]

Alternative Fuel Vehicle Rebate Program

The Alternative Fuel Vehicle Rebate Program, which is part of the AFIG program, provides rebates to Pennsylvania residents for the purchase of new, non-leased, plug-in hybrid, plug-in electric, natural gas, propane, and hydrogen fuel cell vehicles. Typically there is about $1 million available for rebates each year. The following rebates were available in the most recent program year: $2,000 rebate for Plug-in hybrid electric vehicles (PHEVs) or battery-electric vehicles (BEVs) with battery system capacity equal to or greater than 10 kWh (only 500 rebates available); $1,000 rebate for a PHEVs or BEVs with battery system capacity less than 10 kWh, CNG vehicles, propane vehicles, hydrogen, or fuel cell vehicles; and a $500 rebate for electric motorcycles or scooters. Applications for the rebates can be submitted up to six months after purchase. DEP approved 616 rebates for alternative fuel vehicles purchased and then registered in Pennsylvania from July 1, 2015 through June 30, 2016. DEP disbursed $947,000 in rebate reimbursements during this time period.[142]

Small Business Advantage Grant Program

The Small Business Advantage Grant Program provides grants for up to 50% of project costs to for-profit businesses for improvements in energy efficiency and pollution prevention through replacing and upgrading equipment. Eligible businesses have at least one and at most 100 full-time employees. Franchises are not eligible for funding. The DEP administers the grants, and each grant can provide up to $9,500 for proposed projects. Businesses that receive grants must submit a report to the DEP twelve months after project completion, detailing the environmental benefits and the savings from the project.

Projects must demonstrate annual savings of at least 25% in energy consumption or pollution output and at least $500 in annual savings because of the proposed project. Eligible projects include: energy efficient lighting, high efficiency, furnaces, boilers and air conditioners, geothermal heat pumps, energy efficient, refrigeration, process equipment upgrades, waste recycling systems, or solvent recovery systems.

Projects that receive energy efficiency incentives from a utility receive grants based on the total project cost after utility incentives are applied. The following project types are not eligible for grants: residential units, outdoor wood burners, wood-fired boilers, photovoltaics, solar hot water heaters, room air-conditioners, vending machines, and some types of building envelope measures. The measures identified above as eligible equipment are based on examples provided in program documents and lists of awards made for prior solicitations.[143]

This program helps small businesses pay for efficiency upgrades, which certainly has a positive economic impact on the businesses, yet it has limited impact on the market beyond the immediate benefit to the recipient. Furthermore, the 25% savings requirement is a high for some efficiency measures and may be difficult to demonstrate, which may lead to reduced uptake in this program.

High Performance Green Schools Planning Grants

The Governor's Green Government Council of Pennsylvania offers a grant for new schools to be built according to LEED Silver, Gold, or Platinum standards. These incentives are designed to cover some of the soft costs of designing a green building that are not typically included within the conventional design fee structure. Historically, grant awards have been around $25,000. Eligible use of grant dollars includes simulation and modeling costs, daylighting studies and energy modeling, additional consultancy fees, and costs of documentation required for LEED for Schools certification.[144]

Finding Pennsylvania's Solar Future

The DEP was recently awarded a Department of Energy SunShot grant to fund a statewide collaborative planning project to map out various solar development and investment strategies that would allow Pennsylvania to get 10% of its electricity from solar by 2030.[145]

The Pennsylvania Energy Development Authority (PEDA)

The Pennsylvania Energy Development Authority (PEDA) is an independent public financing authority that was created in 1982 and was revitalized in 2004. PEDA exists as an independent entity within the DEP, has its own 19-member Board, and its mission is to finance "clean, advanced energy projects" in Pennsylvania. PEDA can award grants, loans and loan guarantees, issue revenue bonds or notes and enter into contracts to help finance projects. Eligible project types include: solar energy, wind, low-impact hydropower, geothermal, biomass, landfill gas, fuel cells, integrated gasification combined cycle, waste coal, coal-mine methane, and demand management measures.[146]

The following entities are eligible to apply for PEDA funding: corporations and other legal business entities; nonprofit corporations; Pennsylvania schools, colleges and universities; and any Pennsylvania municipality and any public body.

The following types of projects are eligible for PEDA funding. “Advanced Energy Projects” which deploy: solar energy, wind, low-impact hydropower, geothermal, biomass, biologically derived methane gas including landfill gas, fuel cells, coalmine methane, waste coal, coal liquefaction, coal polygeneration, integrated gasification combined cycle, and demand management measures including recycled energy and energy recovery, energy efficiency and load management; and “Clean Alternative Fuels, Alternative Energy Manufacturing and Alternative Energy Research” such as new facilities or projects that produce alternative fuels for transportation, provide alternative fuels refueling infrastructure, or support manufacture of component parts of the alternative energy sector. Certain research projects and environmental compliance projects are eligible, as well as projects that purchase or convert vehicles to run on alternative fuels, including compressed natural gas (CNG), liquefied natural gas (LNG), liquefied petroleum gas (LPG) and others.[147]

In June 2015, PEDA had approximately $5.1 million in unreserved capital across the several funds from which it makes grants and loans. The PEDA Board is seeking funding opportunities.[148]

In the 2014-15 fiscal year, 184 applications were submitted to PEDA for $81 million in funding clean and alternative energy projects. PEDA approved $12.5 million in grants to 28 clean and alternative energy projects across the state. Clean energy generation, storage, and savings projects received 22 of these grants, while 4 manufacturing projects and 1 research project received the remaining grants.[149]

While PEDA has broad powers to choose how to disburse its limited capital, in 2015 it only awarded grants. Grants, though great for recipients, do not move the market forward the same way a loan can. Loans can help prove the economics of projects, potentially provide cash flow positive investments for end-users and sales tools for contractors, and help build investor confidence around new asset classes. Loans come with the added benefit of recycling public capital—if PEDA gave out more loans than grants, dollars would come back in the form of principal and interest payments, or as a lump of cash in the event of an asset sale. Using public dollars to leverage private investment, perhaps by co-lending with a private debt investor, allows a public financing institution to use its limited capital more efficiently, to recycle its capital and move toward fiscal self-sufficiency, build investor experience and expertise in clean energy asset classes and to help develop the market.

Having broad project eligibility also means applications will arrive for a wide variety of project types, technologies, scales, and business models. The heterogeneity of applications requires that each project be evaluated on an individual basis. Alternatively, PEDA could have dedicated financial products with public underwriting criteria. Applicants would have some sense of what project characteristics were needed to receive funding, and underwriters could evaluate batches of similar applications. Applications would be stronger, both PEDA and applicants would save time, and PEDA could potentially serve a greater volume of applicants.

Pennsylvania Infrastructure Investment Authority (PENNVEST)

The Pennsylvania Infrastructure Investment Authority (PENNVEST) funds sewer, storm water and drinking water projects in Pennsylvania to improve the state's environment and provide opportunities for economic growth. Projects funded by PENNVEST make the drinking water, rivers, and streams clean. Funding is also used to help businesses locate and expand operations in Pennsylvania to create jobs.[150] PENNVEST is responsible for administering the federal dollars Pennsylvania receives as part of the EPA's Clean Water State Revolving Fund (CWSRF).[151]

As the state's water finance authority, PENNVEST is not primarily focused on financing of energy projects. Yet energy efficiency, in reducing consumption of various water-polluting energy resources, promotes water cleanliness. For that reason, PENNVEST is able to devote $3.5 million a year for 7 years to the KeystoneHELP program out of the funds it has from the federal Clean Water State Revolving Fund (CWSRF). The KeystoneHELP program provides financing for residential energy efficiency projects, and is discussed separately in another section.[152]

Providing funds for KeystoneHELP is one of few PENNVEST activities in the area of clean energy. Other states have followed Pennsylvania's example in deploying sometimes-underutilized CWSRF funds toward energy efficiency endeavors.

Pennsylvania Housing Finance Agency (PHFA)

The Pennsylvania Housing Finance Agency (PHFA) is a state-affiliated agency that facilitates the affordable homeownership and the availability of rental apartment options for low- and moderate-income families, seniors, and people with special housing needs. PHFA has various mortgage programs and home loan offerings, and makes investments in multifamily housing developments.[153]

The PHFA also uses a scoring system for ranking the new construction and rehabilitation developments in low-income housing for allocating tax credits to developers. Developers that implement more energy efficiency measures and other sustainability measures are ranked more highly for tax credit allocation, which creates an incentive to develop more energy efficient buildings.[154]

PHFA has five categories of loan offerings—home purchase, purchase assistance, refinance, home improvements & repairs, and foreclosure assistance—and a few products and programs in each category. Under the home improvements and repairs category, there is one program specifically devoted to energy efficiency: the Homeowners Energy Efficiency Loan Program (HEELP).[155]

Homeowners Energy Efficiency Loan Program (HEELP)

The Homeowners Energy Efficiency Loan Program (HEELP)[xiv] offers loans for energy efficiency repairs at a fixed-rate of 1% for ten years with no prepayment penalties. Eligibility for this program is limited to Pennsylvania residents with incomes at 80% of area median income or lower, though in some cases this restriction can be relaxed. Loan sizes must be between $1,000 and $10,000. Eligible projects include: Air sealing, insulation and ductwork, energy efficient windows and doors, energy efficient heating or cooling system repairs or replacements, and roof replacements.[156]

PHFA has five home repair and home improvement loan programs, including HEELP. Other programs allow homeowners to improve the safety of their houses, increase energy efficiency, improve septic systems, and improve accessibility for a family member who has a disability. In 2015, $2.2 million loans were made to 150 projects across all 5 of PHFA's home repair and improvement programs, including HEELP. No public information is available on the number of these loans made specifically through HEELP.

Pennsylvania Treasury Department

The Pennsylvania Treasury is an independent department of state government. It is led by the state treasurer, who is elected every four years. Treasurers are limited to two terms. The Treasurer manages the state's financial assets. All state revenues, including tax revenue, are held in the Treasury. The Treasury uses that money to make payments on behalf of state government, including payroll for state employees and charges incurred by government agencies. The Treasury also makes short- and long-term investments to earn a return on taxpayer dollars. It also holds and invests funds for other Pennsylvania agencies, such as the state pension boards.[157]

The Pennsylvania Treasury Department and its partners, the Foundation for Renewable Energy and Environment (FREE) and the West Penn Power Sustainable Energy Fund, have established the Pennsylvania Sustainable Energy Finance Program, or PennSEF. The Pennsylvania Treasury also established the KeystoneHELP program along with its partners Renew Financial (formerly AFC First), the Pennsylvania DEP, the Energy Programs Consortium, and PENNVEST. Both programs are described below.

The Pennsylvania Sustainable Energy Finance Program (PennSEF)

The Pennsylvania Treasury partnered with the Foundation for Renewable Energy and the Environment (FREE), a nonprofit devoted to clean energy project development and research, to create the Pennsylvania Sustainable Energy Finance Program (PennSEF). PennSEF provides technical assistance and low-cost capital for energy improvement projects by municipalities, universities, schools and hospitals (the "MUSH" sector). MUSH sector participants in the PennSEF program receive free energy audits from certified energy service companies (ESCOs). Only improvement projects with projected savings sufficient to pay for themselves are eligible. Once a pipeline of participants and projects totaling approximately $20

[xiv] This is program should be confused with KeystoneHELP, a different lending program that also targets residential energy efficiency.

million has been defined, bonds will be issued to finance the improvement work. By aggregating the projects in a single financing, PennSEF lowers the cost of capital.[158]

Only qualified ESCOs are allowed to participate in the PennSEF program, and all participating ESCOs have agreed to use the model RFP and model guaranteed savings agreement and contract developed by FREE. Participating ESCOs have also agreed to the following process: an ESCO is selected by a MUSH facility; the ESCO provides a free preliminary audit; the MUSH facility decides whether to pursue the project; if it does, the MUSH facility enters into a savings agreement with the ESCO; the ESCO performs an investment grade energy audit; the ESCO then agrees to deliver savings of at least 90% of what was projected in the preliminary audit and to deliver savings sufficient to pay for the entire project; if so, the ESCO is authorized for construction; if participating MUSH facility opts to not to go forward with construction at this point, it pays a fee.

To date, no bonds have been issued for the PennSEF program, though some project pipeline is currently being developed.

The PennSEF program's requirement for uniform documents across projects and ESCOs will facilitate the bonding process and lead to cheaper capital. This practice also helps standardize the market and develop common practices and norms. The standard process requirement reduces risks, saves time, and provides confidence for both parties in the transaction.

The challenge with this structure arises from the difficulty of aligning $20 million in MUSH efficiency project pipeline for a bond issuance. This is a significant barrier that reduces the ability of market participants to undertake clean energy projects on their own schedules and may create delays and uncertainty regarding the outcomes of projects. Various marketing, outreach and market development activities could play an important role in building the pipeline necessary for the success of this program. The existence of a good financing program or product alone may not be sufficient to generate demand for financing. The PennSEF program is structured well, but is hampered by the need for scale to access capital in the bond market. Though outreach and market development activities may add to the operational costs of the PennSEF program, they could be vital in generating the pipeline needed to issue a bond. Otherwise, though perhaps more expensive, other more readily available sources of capital may be worth using for the sake of expediency.

KeystoneHELP

KeystoneHELP is a statewide program originally launched in 2006, as a public-private partnership that provided financing for approximately 14,000 homeowners to borrow up to $15,000 to pay for a variety of home energy improvements such as HVAC equipment, water heaters, air conditioning, roofing, insulation, windows, doors, siding, geothermal power systems, and others. Homeowners could borrow up to $15,000 at very competitive rates. KeystoneHELP was launched as a pilot program for the West Penn Power

Sustainable Energy Fund by energy efficiency lender AFC First Financial Corporation, now a part of Renew Financial. The Pennsylvania Treasury helped expand the program statewide. KeystoneHELP ran out of funds in 2014 and it discontinued its lending. The program became a model for the national Warehouse for Energy Efficiency Loans (WHEEL) financing program.

Pennsylvania has re-launched KeystoneHELP as a partnership among the Pennsylvania Treasury, Renew Financial (a national clean energy finance company), the Energy Programs Consortium (a national nonprofit), the Pennsylvania DEP, and PENNVEST (the state's water infrastructure development authority).

The re-launched KeystoneHELP program uses funds provided through the EPA's Clean Water State Revolving Fund (CWSRF) to buy-down the interest rate for the KeystoneHELP product managed by Renew Financial.[xv] Renew Financial originates and issues KeystoneHELP loans, which are eventually purchased by WHEEL, a national financing facility run by NASEO. WHEEL then aggregates loans and issues a bond for sale into the secondary loan market. This system promotes liquidity and allows Renew Financial to recapitalize the KeystoneHELP program.

The new KeystoneHELP program offers loans for energy efficiency home upgrades through Renew Financial. Low, fixed-rates of about 5% and terms of 5, 7, or 10 years create low monthly payments for borrowers. Homeowners can borrow up to $20,000 in unsecured financing to pay for 100% of the project costs, and there is no penalty for prepayment. There are numerous eligible energy-saving improvements and up to 25% of the financed amount can be used for non-qualifying products. The upgrades must be implemented by KeystoneHELP Registered Contractors. KeystoneHELP has a simple approval and application process and includes consumer protection measures.[159]

KeystoneHELP previously used ARRA funds to offer lower rates for deeper efficiency upgrades as an incentive for a whole-home, rather than single-measure, approach to efficiency. It no longer has ARRA money to offer this incentive. KeystoneHELP has begun competing with loans for efficiency offered by banks and subsidized by equipment manufacturers and the contractors themselves. These loans offer 0% interest and 5 year terms, and are reducing volume in the KeytsoneHELP program.

Two other programs that used ARRA funds were previously run as a part of the KeytoneHELP that are no longer available today. The Geothermal program was a subset of the unsecured Keystone HELP program funded by the ARRA money through the DEP and Treasury. The Geothermal program offered unsecured financing for geothermal heat pumps at 5% for 3, 5, or 10 year terms with loans ranging from $1,000 to $15,000 with support with built-in support for tax credits. AFC First (which has since been acquired by Renew Financial) partnered with the PHFA Renovate and Repair program to offer a secured KeystoneHELP loan with rates subsidized by ARRA funds (through the DEP and Treasury) for major energy improvements,

[xv] Loans financing residential energy efficiency improvements protect water quality by reducing airborne emissions.

solar, and whole-home efficiency. Rates ranged from 2.875% to 5.375% (based on home equity and loan term) and 10, 15 or 20 year terms were available for loans ranging from $5,000 to $35,000, and were secured by a lien on the property.[160]

Currently, the KeytsoneHELP program is making approximately $1 million in residential efficiency loans per month. Market participants believe this is a fraction of the potential market penetration this program could have.[161]

The KeystoneHELP program is designed to be uniform to facilitate the sale of assets into the secondary market through WHEEL. Renew Financial's network of contractors has experience with the KeystoneHELP loan product and are able to effectively use the availability of financing as a marketing tool and to bring the benefits of efficiency to more market segments. Yet the 10 year term may limit uptake among some end users, as some efficiency measures have effective useful lives of 15 years, and the longer the term is on efficiency financing, the more likely the financed project is to be cash flow positive for the end user.

Sustainable Energy Funds

As a result of Pennsylvania restructuring its electricity market, four clean energy funding programs were created and capitalized through individual settlements with five of the state's major distribution utilities. Each "Sustainable Energy Fund" was created by the associated utility to promote and develop clean-energy technologies, energy conservation and efficiency, and sustainable-energy businesses for the benefit of ratepayers in a given service territory. Each utility has established an oversight board and designated a fund administrator.[162]

Table 11: Sustainable Energy Funds in PA[163]

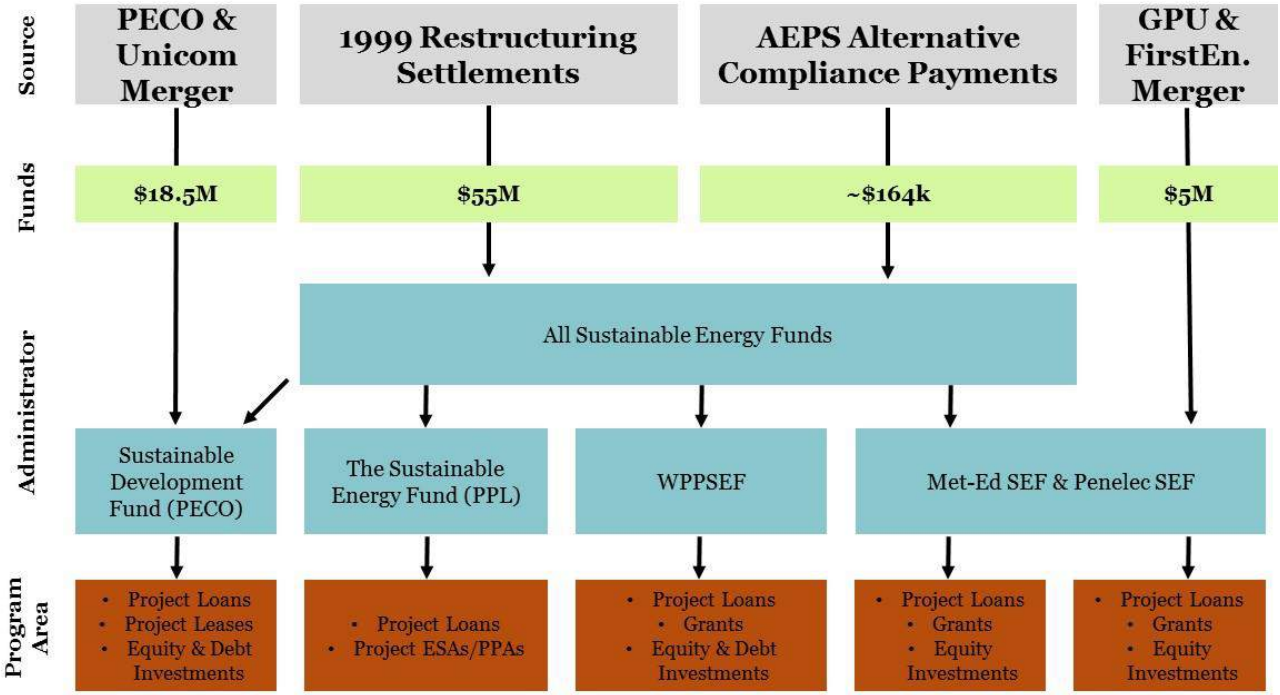
Sustainable Energy Fund	Associated Utility	Administered by
Metropolitan Edison Region SEF[xvi]	Metropolitan Edison	Berks County Community Foundation
Penelec Region SEF	Penelec	Community Foundation for the Alleghenies
Sustainable Development Fund	PECO Energy	The Reinvestment Fund
West Penn Power SEF	West Penn Power	Energy Institute of Penn State University; Energetics, Inc.
The Sustainable Energy Fund of Central Eastern Pennsylvania	PP&L	The Sustainable Energy Fund nonprofit

The Pennsylvania Sustainable Energy Board (PASEB) facilitates communications among the four SEFs and state agencies. PASEB has representatives from the PUC; the DEP; the DCED; the Pennsylvania Office of

[xvi] Metropolitan Edison Region SEF and the Penelec Region SEF are "companion funds," were both established by FirstEnergy, and are often counted together as a single fund.

Consumer Advocate; the Pennsylvania Environmental Council; and each regional board. PASEB developed PUC-approved uniform guidelines that govern the business practices of the SEFs.[164]

Figure 34: Summary of Sustainable Energy Fund Capitalization



As discussed in greater detail below, the SEFs generally provide both grants and loans, and generally give out more grants than they do loans. Below is a table showing the number and dollar value of loans from SEFs in 2015.

Table 12: Sustainable Energy Fund Loans in 2015[165]

Sustainable Energy Fund	Loans in 2015	Value of Loans in 2015
Met Ed & Penelec SEFs	4	$1.1 million
Sustainable Development Fund	4	$2.8 million
West Penn Power SEF	1	$1 million
The Sustainable Energy Fund	18	$4 million

The SEFs have many common features that may limit the positive impact they have on clean energy market development: dividing their capital across grants, loans, and equity investments; issuing many grants; disbursing high levels of funds as grants relative to loans; low loan volume; short terms for loans; broad project eligibility; lack of defined products, determining lending terms on case-by-case basis; need

for projects financed to benefit ratepayers in a given service territory; and little or no marketing of programs. Each of these features and their impact or lack thereof on the market will be discussed in the following sections.

It should be said that there are many useful roles grants can play. Grants play an important role for clean energy technologies that aren't cost effective on their own—a grant can directly alter the project economics to make it cost effective for the end user. Though many clean energy technologies, particularly efficiency technologies, the project economics do not need to be improved, but grants can provide an important incentive to end users and facilitate marketing, or demand generation. Grants might also allow entities that could not otherwise afford to finance clean energy projects, such as a nonprofit entity, to pay a reduced cost and enjoy the benefits of clean energy. Grants are thus important tools for building initial market uptake and project viability. Yet these are distinct goals from market development—to draw private investors into clean energy projects, and to allow the market to gain autonomy and inherent momentum, project economics must be proven as robust without the help of grants. For mature, economically viable clean energy technologies, financing, rather than grants, does much more to facilitate the development of an autonomous market with private participants and sources of capital.

Sustainable Development Fund Financing Program (PECO Territory)

The Sustainable Development Fund (SDF) is administered by the Reinvestment Fund, a CDFI that endeavors to facilitate growth and opportunities in low- and moderate-income individuals and communities.[166] The SDF has received $31.8 million in its lifetime from the PECO restructuring settlement and the PECO merger settlement, as well as $4 million in program income. Over its lifetime, the SDF has disbursed about $36 million: $12 million in loans, $4 million in investments, and $21 million in grants. In 2015, 4 energy loans were made out of the SDF totaling around $2.8 million. In 2015, 7 projects representing $7.7 million were approved but awaiting loan closings.[167] As of 2015, the SDF had about $8 million available in cash and marketable securities.[168]

The SDF provides commercial loans, subordinated debt, royalty financing, and equity financing to companies that generate renewable electricity, manufacturers and distributors of clean energy technology, and companies and organizations that are end-users of clean energy. The SDF also provides lease-financing for energy improvements for large nonprofit institutions and commercial real estate owners. The SDF also provides business loans to start-ups and expansions of companies producing clean energy, end-user companies that want to purchase clean energy technologies, and manufacturers, wholesalers, distributors, retailers and service companies who want to finance equipment upgrades energy improvements to their facilities. The specific terms of the financial support are flexible and are determined on a case-by-case basis.[169] Most of the loans have terms that fall into the range of 3.5% to 4% interest rates and 7 to 10 year terms.[170]

As a result of the PECO and Unicom utility merger, $4 million was given to the SDF to fund PA's first solar PV program, called the Sustainable Development Fund Solar PV Grant Program. This program served Philadelphia and the four counties surrounding it, and resulted in approximately 250 solar installations and totaling about 830 kW between 2002 and 2010. The systems were mostly residential, though there were several commercial systems.[171]

One challenge for the SDF, and all the SEFs, is the requirement that SEFs finance projects that benefit ratepayers of a given utility as a result of the restructuring settlement. Project economics and market conditions are not dependent on utility territories, and most contractors do no restrict the areas in which they do business to a single utility territory. Geographical constraints on financing create complexity and barriers for market participants. Recently however, the SDF has loosened this requirement and has become increasingly willing to lend to projects outside the PECO territory.[172] This will help reduce market complexity.

Another market impact-limiting feature of the SDF is the level of grants provided to projects—58% of the funds disbursed by the SDF to date have been in the form of grants. (It should be noted that much of the money disbursed as grants comes from a merger settlement and is unusable for loans.) As has been discussed above, grants can play some useful roles, but they tend to help individual recipients and do not help the clean energy market as a whole reach maturity. Grants are better suited to technologies that have not yet achieved economic viability. Similarly, investments in companies, which make up 11% of SDF's funding commitments to date, only have an immediate impact on the company itself, which may or may not have a future impact on the clean energy market as a whole. Equity investments also have an entirely different risk-return profile from project loans. Project loans generate steady returns and can be sold on secondary markets, whereas equity investments may not generate any returns. Equity investments have a high opportunity cost—they sit on a balance sheet and tie up capital that could be put toward more productive projects. Loans allow a lender to recycle capital—they produce revenue and can be sold to recapitalize a fund. A portfolio that combines project loans and equity investments limits opportunities for recapitalization.

To the SDF's credit, the administrator of the SDF, Reinvestment Fund, has placed a higher priority on financing than on grants, and are unlikely to make additional equity investments. The SDF's historical division of its focus across grants, equity investments, and project loans is not indicative of its future activities.[173] The SDF's financing-centric orientation will increase the SDF's positive impact on clean energy market development.

Additionally, Reinvestment Fund is engaging in two activities that increase the SDF's utility to the market—Reinvestment has a single application process for all of the funds it manages (which include GELF, discussed above), and it is exploring the creation of a standard offer product.[174] Having a single application process reduces market complexity and allows contractors and end users to more easily take advantage

of available capital in the SDF and other funds, thereby increasing volume and reducing project timelines. A standard offer financing, with public terms and underwriting criteria, would provide much more stability and certainty in the market. Contractors would know whether certain projects would be likely to receive financing in advance of applying for financing, which would reduce transaction costs and improve program uptake.

That said, loan volumes are low, perhaps reflecting low levels of demand for clean energy projects in the market. The SDF closed four loans in 2015. This may speak to the need for increased marketing and outreach efforts to generate increased demand for clean energy project capital.

Met Ed & Penelec SEF Loan Program (FirstEnergy Territory)

In 2000, FirstEnergy established the both the Metropolitan Edison Company Sustainable Energy Fund and the Penelec Sustainable Energy Fund. These two funds are "companion funds," share a single board of directors, and are usually jointly considered and evaluated.

The Met Ed SEF was established within Berks County Community Foundation with an initial capitalization of $5.7 million. The Met Ed SEF later received an additional contribution of $2.5 million as a result of the merger between GPU Energy and FirstEnergy. The purpose of the SEF is to provide funds for the development and use of renewable energy and clean-energy technologies, energy efficiency, and clean energy businesses. The Met Ed SEF makes loans, equity investments, and grants. While the fund is a component fund of Berks County Community Foundation, it serves the entire Met Ed service territory. A companion fund was established to serve the company's Penelec service territory.[175]

The Community Foundation for the Alleghenies administers the Penelec SEF, which has assets of approximately $9.1 million.[176] The Penelec SEF provides loans, equity investments, and grants for eligible individuals, organizations, governmental entities, or corporations that are located in FirstEnergy's Penelec service territory. The Penelec SEF provides funds for the development and use of renewable energy and clean-energy technologies, energy efficiency, and clean energy businesses. Examples of investments include renewable energy projects, projects related to the development of a clean energy technology (e.g. solar panel manufacturing), businesses that use renewable energy in the operation of a business, and businesses that increase their energy efficiency. The terms of the loans are determined on a case-by-case basis, and the tenors tend to be on the shorter side.[177]

Since their inception through 2015, the Met Ed and Penelec SEFs have disbursed approximately $28 million: 147 grants representing about $3 million; 43 loans representing about $23 million; and 3 equity investments representing about $1.6 million. In 2015, the SEFs approved $1.3 million in financing: $204,000 across 15 grants and $1.1 million in 4 loans across 3 projects.[178][xvii] Over the last few years, the

[xvii] One of the 3 projects received loans from the Met Ed SEF and Penelec SEF, pushing the number of loans up to 4.

large majority of applications that have received funding are energy efficiency projects, primarily for equipment-upgrade projects and LED lights. Other projects include solar and landfill methane.[179]

The Met Ed and Penelec SEFs are structurally limited by their focus on utility territories. As discussed above, making capital available on the basis of geography may make sense from the basis of allocating ratepayer dollars, but from the perspective of market participants such as contractors, private lenders, and project developers, it creates a learning curve and adds complexity to the market that may slow down projects or reduce the overall volume.

The Met Ed and Penelec SEFs have disbursed 82% of their funds in the form of loans to date. This allows these SEFs to benefit from a larger source of revenue and more opportunities for recapitalization through future asset sales, which would in turn allow for more clean energy funding opportunities in the future. Yet the majority of the applications for funding that are approved go to grants. Devoting so much time to grants reduces the organizational bandwidth for loans, and reduces the volume of loans. Higher loan volumes are good because they indicate the availability and affordability of capital and the economic viability of clean energy projects to the market. From an economic perspective, grants are excellent tools for promoting technologies that have not yet achieved commercial viability, and perhaps as an incentive to stoke demand, while loans are better tools for commercially viable projects that generate attractive savings or returns. Investments in companies, which make up 5% of these SEFs' commitments to date, do not contribute to the SEFs' prospects for fiscal sustainability the way project loans do, and have a much slower and less measurable positive impact on the development of the clean energy market.

Determining loan terms on a case-by-case basis for a broad array of project structures and technologies is time-consuming, creates uncertainty for applicants, and does not provide good signals to the market about availability and cost of capital. Alternatively, developing a focused financial product with public terms and underwriting criteria would be faster for the SEF and the applicants, provide good signals and information to the market, and would likely increase loan volume. It is also easier to market the availability of a focused product with set terms than a general availability of capital for a wide variety of projects with terms that are to-be-determined.

West Penn Power SEF (West Penn Power Territory)

The West Penn Power Sustainable Energy Fund (WPPSEF) is a nonprofit that finances clean energy projects for commercial, industrial, institutional and residential customers in the West Penn Power market region.

The WPPSEF generally accepts proposals for grant through RFPs, and accepts proposals for loans year round. Proposals are evaluated based on whether the projects are aligned with WPPSEF's goals and benefit West Penn Power ratepayers. WPPSEF provides commercial loans, equity investments, grants, subordinated debt and royalty financing. WPPSEF provides term loans to finance energy efficiency upgrades or construction, and working capital financing as part of a larger request. Commercial loans are

available to manufacturers, distributors, retailers and service companies involved clean energy technologies, energy efficiency products and services to end-user companies and community-based organizations. For some projects, WPPSEF may charge a below market rate of interest on a loan, secure the loans with available collateral provided the credit risk is acceptable.[180]

A broad array of technologies are eligible for financing, including: solar, wind, low-impact hydro, sustainable biomass such as closed-loop biomass and biomass gasification, innovative natural gas technologies, energy efficiency, landfill gas, and fuel cells. The WPPSEF aims to build a diverse portfolio of clean energy investments that provide some level of return, in addition to its grant-making. The terms of investments are determined on a case-by-case basis.[181]

WPPSEF has made more than 30 loans since its inception, ranging from $25k to $2 million. Rates typically range from 3% to 5% and terms typically run from 3 to 5 years, and can go as long as 10 years. WPPSEF has made more than 100 grants since its inception, primarily to nonprofits, ranging from $500 to $150,000. In 2015, WPPSEF made 1 loan of approximately $1 million, and made 20 grants representing about $600,000.[182] In 2016, WPPSEF received 3 applications for loans. Typically, WPPSEF funds about 80% of projects with grants and 20% with loans, while approximately 80% of the capital disbursed goes to loans ant 20% to grants. Most of the current assets in the portfolio fall into the category of energy efficiency, as WPPSEF generally encourages an "efficiency first" approach to clean energy projects. WPPSEF is not currently undertaking any marketing efforts.

WPPSEF has many of the same features discussed in previous sections that may limit its positive impact on the clean energy market as a whole: low loan volume, high level of grants relative to loans, determining terms of loans on a case-by-case basis, and relatively short terms on their loans. Shorter terms mean fewer and larger debt service payments, which decreases the likelihood that projects are cash flow positive for end users. Clean energy projects financed in this way are not treated as return-generating investments, as would be ideal for developing the clean energy market, but rather they are treated as big costs that must be broken up over several years and may or may not pay for themselves in the future. This type of financing is less attractive to consumers and contractors, and is unlikely to speed up the development of the clean energy market in Pennsylvania. Longer terms have the benefit of allowing a larger pool of clean energy projects, or deeper efficiency projects, to be cash flow positive or economically attractive to end users.

Sustainable Energy Fund of Central Eastern Pennsylvania (PP&L Territory)

The Sustainable Energy Fund (SEF)[xviii] was established in 1999 by PP&L Electric Utilities Corporation. The fund has received approximately $25 million through a rate surcharge on PP&L ratepayers that expired in 2006. The SEF promotes and invests in energy efficiency and renewable energy projects, and energy

[xviii] This fund is simply called the Sustainable Energy Fund, or SEF, which can be confusing because the same term is used to refer to this entire category of fund in the state.

education initiatives.[183] As of 2015, the SEF had approximately $14 million in cash, bonds, and equity securities.[184] The SEF is run by a nonprofit that was purpose-built to administer the SEF.[185]

The SEF provides loans to promote clean energy technologies and for projects with measurable energy savings. A wide range of energy efficiency and renewable energy technologies and projects are eligible for financing. Commercial, industrial, municipal, agricultural, and nonprofit entities can apply for financing. The SEF's loans generally include no prepayment penalty, subordinate lien positions, 100% financing, and interest-only period payments. Loans are typically $5,000 to $1 million, and have rates and terms that are determined on a case-by-case basis. Rates are as low as 4% and terms can be as long as 7 years.[186]

For nonprofits, the SEF offers financing through its Energy Savings Agreements (ESA) program—the SEF finances energy efficiency upgrades at a nonprofit facility, and is paid back through bill savings. The terms of ESAs range between 7 and 16 years, generally for longer. The SEF also has Solar Power Purchase Agreements (PPAs) for nonprofit organizations, which include technical assistance for the purchase and installation of solar systems, and can be as long as 20 to 25 years.[187] The SEF employs a variety of means for marketing its offerings: chamber of commerce events, exhibit booths, direct mail, newspaper advertisements, and online marketing. Different channels are used to target specific customer segments.[188]

From its inception in 1999 through 2015, the SEF has disbursed approximately $40 million for sustainable energy projects. In 2015, the SEF committed about $4 million in loans across 18 renewable and efficiency projects. As of 2015, the SEF had about $20.7 million in assets, including: $6.5 million in loans receivable and about $13.8 million in investments.[189]

The SEF is unique among its peers in how it is run and in offering ESAs and PPAs with long terms. In being run by a well-staffed purpose-built nonprofit, the SEF is able to focus its activities on driving volume and develop additional financing structures such as ESAs and PPAs. These financing structures broaden access to capital and expand the segments of the market that can benefit from clean enjoy projects. The SEF is also somewhat unique in relying on marketing efforts to the extent it does. Though marketing efforts increase SEF's overhead, they are vital for generating demand and increasing loan volume.

Like the SDF, the SEF is not as regionally bound as it was previously, and occasionally lends to projects outside the PP&L territory.[190] This is good for the market insofar as it reduces market complexity and increases access to financing.

The SEF determines terms on a case-by-case basis for a broad array of technologies and project types, offers short terms on its conventional loan, and does not offer technology-specific or market segment-specific programs or products. These features of the fund can limit its positive impact on the development of the clean energy market for many of the same reasons discussed in the previous sections.

Other Loan and Financing Programs

There are several additional programs worth some discussion that are not housed in the aforementioned institutions.

Fannie Mae HomeStyle Products

Fannie Mae, or the Federal National Mortgage Association, is a government sponsored enterprise designed to facilitate more liquidity in the housing market. Fannie Mae has two products designed to support borrowers seeking to renovate, repair, or improve the energy efficiency of their homes: the HomeStyle Energy loan and the HomeStyle Renovation loan. These products can take the place of a subordinate mortgage, home equity line of credit, or other potentially more costly financing methods.

The HomeStyle Energy loan, which is available for all Fannie Mae lenders, allows borrowers to finance energy-efficient upgrades when purchasing or refinancing a home. HomeStyle Energy financing may be more affordable than a subordinate lien, home equity line of credit, Property Assessed Clean Energy (PACE) loan, or unsecured loan.

The HomeStyle Renovation loan, which requires special approval from lenders, allows borrowers to include financing for home improvements in a purchase or refinance of an existing home. Borrowers can make renovations, repairs, or improvements totaling up to 50% of the as-completed appraised value of the property with a first mortgage.[191]

Property Assessed Clean Energy (PACE)

In the 2013-14 session of the Pennsylvania legislature, a bill was introduced that would have authorized municipalities and counties to create Property Assessed Clean Energy (PACE) programs. The PACE-enabling bill—H.B. 1339—was referred to the Environmental Resources and Energy Committee and there has been no action on it since.[192] In the 2015-16 legislative session, another PACE-enabling bill—S.B. 1069—was introduced and referred to the Community, Economic & Recreational Development Committee.[193] Most recently, PACE legislation was reintroduced in the 2017-18 legislative session as S.B. 234.[194]

On-Bill Financing & Cost Recovery

As a part of the PUC's Act 129 implementation, a working group was formed to explore the on-bill financing in Pennsylvania in 2012-13. The working group authored a report which evaluated potential on-bill financing models and enumerated possible next steps. Currently, no Pennsylvania utility has an on-bill financing or repayment mechanism.[195]

Clean Energy Market Potential

This chapter outlines the current levels of clean energy activity, and estimates the economically viable clean energy potential in Pennsylvania on an energy and dollar investment basis. This study seeks to highlight the potential size of the clean energy market by focusing on commercially proven technologies in feasible market segments. Technical potential (also known as total addressable market or TAM) is occasionally referenced, but the focus is on the economic potential (also known as the Serviceable Addressable Market or SAM). In other words, this study focuses on potential projects that use existing technologies and are deployed in feasible market segments that can deliver more in savings and revenue than they cost under current market conditions, and are thus NPV positive and economically viable. Different technical analyses often produce varying results, depending on methodologies used and the assumptions made. The estimates in this section are based on some of these existing technical analyses.

The objective of this market sizing assessment is to provide a reasonable estimate of the economically viable clean energy potential, based on available technical market research. This estimate can help policymakers and market participants understand the range and scale of investment opportunities in Pennsylvania's clean energy markets. The market sizing exercise is not meant to precisely calculate or identify one single "correct" figure for clean energy potential, or to indicate a recommended fuel mix. It should not be read as a technical analysis on par with those produced by energy engineering firms or the PUC.

This assessment relies on various technical analyses performed by researchers at leading institutions. This includes the National Renewable Energy Laboratory (NREL), the Oak Ridge National Laboratory (ORNL), the Department of Energy (DOE), the Environmental Protection Agency (EPA), the U.S. Energy Information Administration (EIA), Bloomberg New Energy Finance (BNEF), American Council on Renewable Energy (ACORE), American Biogas Council, the American Wind Energy Association (AWEA), the Solar Energy Industries Association (SEIA), the Pennsylvania Statewide Evaluation Team, the Pennsylvania Public Utilities Commission (PUC), the Pennsylvania Department of Environmental Protection (DEP), the Pennsylvania Environmental Council (PECPA), the Third-Party Delivered Energy Efficiency Coalition, and the American Council for an Energy Efficient Economy (ACEEE).

The following table outlines the market potential estimates for select clean energy technologies in Pennsylvania, using the sources listed above.

Table 13: Clean Energy Investment Potential by Technology[xix]

Technologies	Savings, Capacity & Project Potentials	Investment Potential ($M)
Efficiency (Electric)	6,748 - 61,000 GWh	$889 - $2,233
Efficiency (Thermal)	218,800 BBTU	$577
Solar (Distributed)	970 MW	$2,910
Solar (Utility-Scale)	6,261 MW	$9,078
Wind (80m)	69 – 1,100 MW	$117 - $1,876
Bioenergy Electric Generation	80 - 348 projects	$16 - $1,000
Micro Hydro	200 MW	$528
Fuel Switching	429,930 households	$2,107
TOTAL	**-**	**$16,222 - $20,309**

The following sections discuss the market activity for each of these technologies, followed by the market potential for the technologies.

Energy Efficiency

Current Market Activity

Over the first six years of the Act 129 efficiency programs, Pennsylvania's utilities have spent more than a billion dollars to achieve more than 7 million MWh of electricity savings across all sectors. The utility incentives have offset an average of about 25% of measure costs. Total utility spending has leveraged about $1.3 billion in private (i.e. participant) spending. The utility programs have a public-private leverage ratio of about 1:1.3, or put another way, for each $1 spent on utility programs and incentives, program participants have spent an additional $1.30.

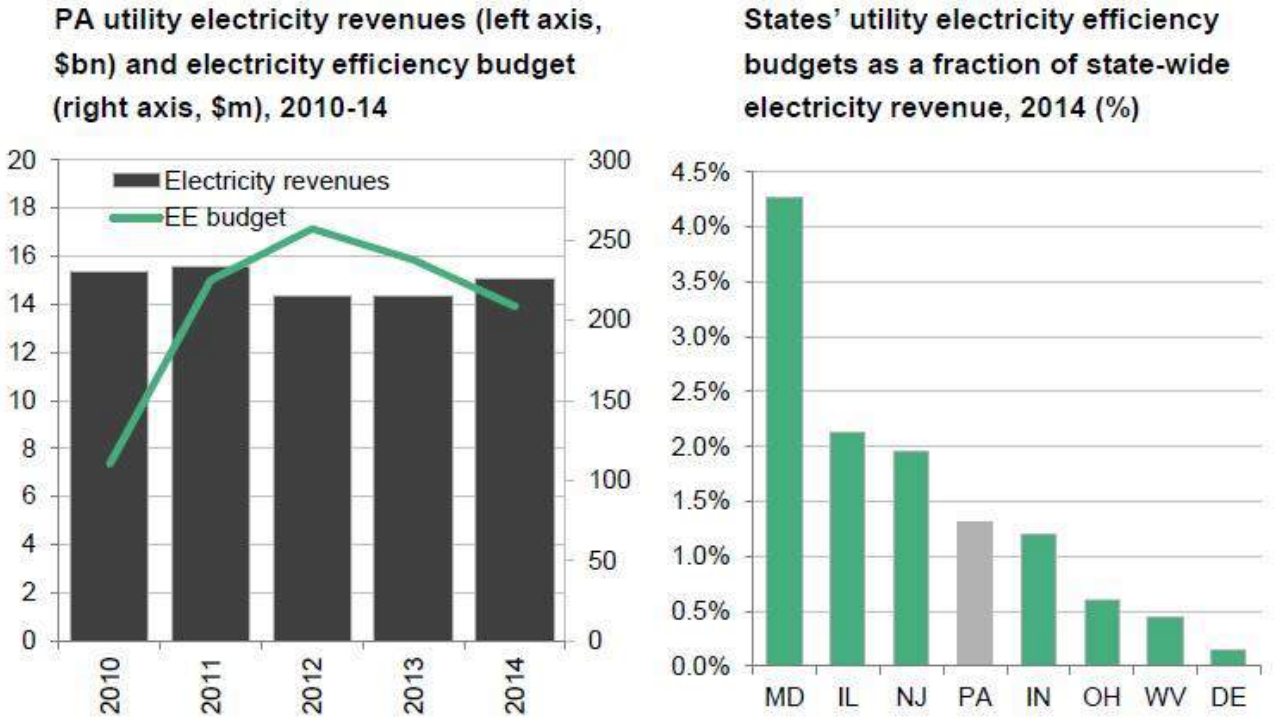
[xix] Note: these figures are estimates of the current total investment value of the economically viable projects in Pennsylvania. The table is not meant to suggest a plan or optimal level of investment. For example, if $9 billion worth of utility-scale solar were implemented in the state, the demand for (and economic viability of) other clean energy projects would decrease. It is also worth noting that thermal efficiency and fuel switching projects may overlap.

Table 14: Utility and Private Spending on Efficiency in PA through Act 129 Programs over Six Years[196]

Savings (MWh)	Utility Incentives Disbursed	Utility Program Overhead[xx]	Total Utility Expense	Participant Expense	Total Expense
7,151,874	$464,990,596	$554,159,912	$1,019,150,508	$1,360,889,376	$2,380,039,884

In the period from 2010-14, electricity revenues in Pennsylvania have been mostly consistent, while the efficiency budget of utilities has risen from a little more than $100 million to a peak of more than $250 million, then fallen to a little more than $200 million. Compared to neighboring states, Pennsylvania's efficiency budget as a share of electricity revenue is in the middle.[197]

Figure 35: PA utilities' energy efficiency budgets compared to revenues & neighboring states 2010-14[198]



Beyond the energy efficiency projects brought about by the utility rebate programs, approximately $1 million in efficiency upgrades are implemented every month through the KeystoneHELP program.

[xx] Utility program overhead costs include design and development; administration, management, and technical assistance; marketing; EDC evaluation costs; and SWE audit costs.

Market Potential

An efficiency market potential study commissioned by PUC and performed by the "Statewide Evaluation Team," or SWE, estimates that the technical potential for electricity efficiency is 25 million MWh, or 17.3% of the 2010 electricity load. The study estimates that Pennsylvania can economically reduce electricity usage by 17 million MWh, or 11.8% of the 2010 load. Yet the study estimates that the achievable potential ranges between reductions of 4.6% to 7.5% of Pennsylvania's 2010 electricity consumption, or savings of 6.75 million MWh and 11 million MWh, respectively. This study only includes electricity and does not include natural gas or other forms of energy efficiency.[199]

Table 15: Pennsylvania Electricity Efficiency Potential by 2020 according to SWE[200]

Statewide Potential by 2020	Electric Savings (MWh)	Share of 2010 Load	Needed Investment ($M)
Technical	25,336,859	17.3%	$7,872
Economical	17,253,764	11.8%	$5,361
Max Achievable	10,983,129	7.5%	$3,412
Base Achievable	6,748,807	4.6%	$2,233

Figure 36: Cumulative Annual Savings Potentials by year 2016-20 according to SWE[201]

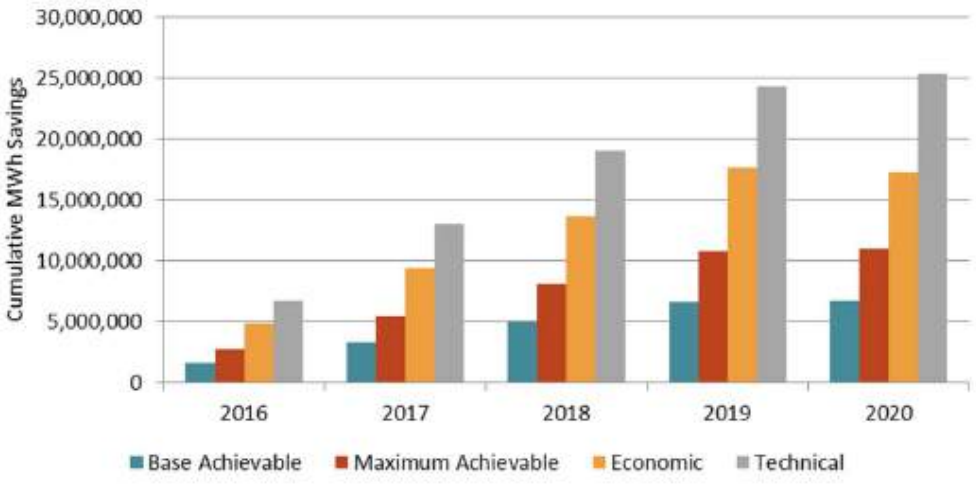
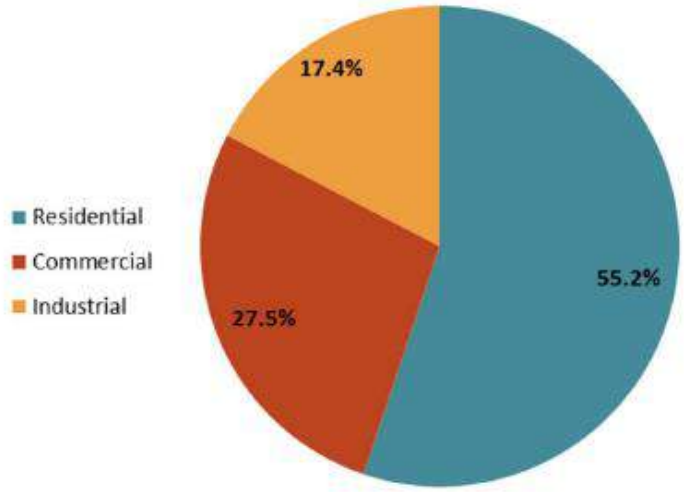


Figure 37: Cumulative Annual Base Achievable Savings Potential by Sector 2020 according to SWE[202]



This market potential study appears to be unduly conservative. The study relies on the PUC's "total resource cost" test, or TRC test, which has a narrow conception of benefits and caps the expected useful life of all measures at 15 years. More problematic however is the fact that this study evaluates the achievable electricity savings potential according to the percentage of the cost of individual measures that are subsidized. This approach neglects the role financing could play—by financing energy efficiency with a long term, low interest loan, there would be no upfront costs for the end user, and the savings from the efficiency could pay for the cost of financing. Considering these factors, one can reasonably conclude that this report's estimates of the achievable electric efficiency are conservative, and that the economic and achievable potentials could be higher in reality.

Another report conducted by the ACEEE found that Pennsylvania's projected energy consumption in 2025 could be reduced by approximately 30% across sectors with approximately $2 billion in investment.[xxi] The report's estimated cost of achieving those savings was significantly lower than the previous report, so the needed investment to achieve these larger savings potentials is much lower.

Table 16*: Summary of Cost-Effective Energy Efficiency Potential by Sector in 2025 according to ACEEE*[xxii]

Statewide Economic Savings Potential	Efficiency Savings	Share of Projected 2025 Usage	Needed Investment ($M)
Electric	50,000 GWh	26%	$636

[xxi] Note: The estimated "needed investment" for electric does not include CHP investments.
[xxii] Note: Savings are represented as a percent of the projected reference case energy consumption in 2025.

Electric (from CHP)	11,000 GWh	6%	$253
Natural Gas	174,000 BBTU	27%	$439
Fuel Oil	44,800 BBTU[xxiii]	29%	$138

This study determines cost-effectiveness from the customer's perspective: if the levelized cost of conserved energy (CCE) of a measure is less than the average retail energy price for a given customer class, it is deemed cost effective. The study states that various market barriers may reduce the achievable energy efficiency potential to between 60% and 90% of the economic potential.

This study also presupposes that financial incentives and top-down policies (such as energy efficiency resource standards and building codes) are the primary means by which the economic potential can be achieved. The study neglects the role that could be played by long term, low interest lending in eliminating upfront costs for end-users and turning energy efficiency measures into cash-flow positive investments.[xxiv] Considering that omission, one could conclude that this study also underestimates the achievable potential of efficiency.

These two efficiency potential studies use different methodologies and estimate differing levels of market potential for energy efficiency in Pennsylvania. Yet these studies are alike in that their methodologies lead them to under-estimate the market potential of energy efficiency. One market participant interviewed in the course of this study described Pennsylvania as the "biggest market for energy efficiency on the east coast, outside of New York and Florida."[203] It follows then that the results from these efficiency studies should be regarded as being at closer to the minimum market potential, with the actual market potential being much higher.

Solar PV Market

Current Market Activity

Pennsylvania has the 16th most installed solar capacity in the nation through 2015, with 273 MW. In 2015, annual installations were the 26th most in the nation, with 13 MW. Total 2015 deployment represents roughly $32 million of investment.[204] In 2016, 37 MW of solar was installed in Pennsylvania, nearly tripling the capacity of solar installations from the previous year.[205] Much of this was driven by national installers

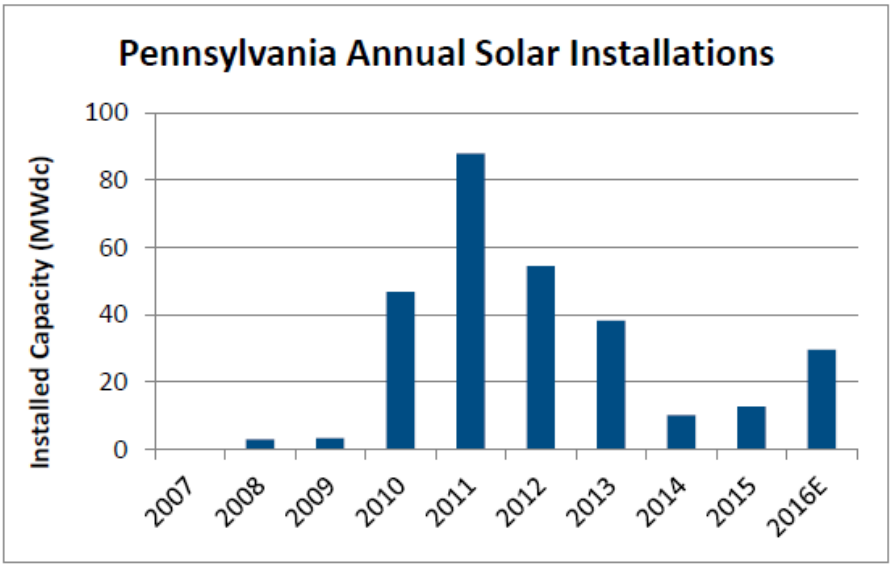
[xxiii] Savings were listed as 320 million gallons of fuel oil, BBTU figure was calculated using the following conversion: 1 gallon of fuel oil contains 140,000 BTU.

[xxiv] Though the study does acknowledge the power of the energy savings performance contract often used by ESCOs to overcome market barriers, there is no consideration of how innovative financing models could impact achievable potentials.

such as SolarCity, which is in its second year of operations in Pennsylvania and is particularly active in the PECO region, and Vivint.[206]

Distributed solar installations dominate the overall solar market. Of the 273 MW of solar in the state in 2016, 64 MW are residential and 187 MW are commercial. Only 22 MW are utility-scale solar installations.[xxv] Two notable utility-scale solar installations are the Pennsylvania Solar Park in Nesquehoning, which was completed in 2014 and has 11.5 MW of capacity,[207] and the Keystone Solar Project in Lancaster County, which was completed in 2012 and has 6 MW of capacity.[208]

Figure 38: Pennsylvania Annual Solar Installations 2007 - 2015[209]



The spike in solar capacity coincides with the Pennsylvania Sunshine Program, which gave generous rebates to homeowners and small business owners installing solar PV systems. The program ran from 2009 through 2013 until the funds were depleted.[xxvi]

According to SEIA, there are 483 solar companies at work in Pennsylvania throughout the solar value chain, which employ 2,498 people in the solar industry.[210] These numbers were higher during the period in which the Sunshine Program was active, but after the close of the program, many Pennsylvania solar companies moved to more active markets or closed down.[211]

[xxv] It should be noted that there is a discrepancy in the reported amounts of installed solar capacity from AEPS (and GATS) and SEIA (and EIA). According to AEPS (and GATS), 265 MW of solar were installed in Pennsylvania through 2016. According to SEIA (and EIA), 273 MW were installed through 2015. This discrepancy may result from solar installations in Pennsylvania that are not registered into the Pennsylvania AEPS program.

[xxvi] This program is discussed at greater length in a previous section.

Two factors that may limit future growth in Pennsylvania's solar market include barriers to grid interconnections and voluntary net metering among ESGs. In the PECO service territory applications for new grid interconnections for distributed solar are being denied in large numbers due to congestion and line voltage issues.[212] Grid interconnection is a vital step in installing a distributed solar project—without a connection to the grid, end users of solar projects are unable to benefit from utility net metering. Barriers to grid interconnection create a bottleneck that slows down growth in the solar market.

Net electricity metering is another vital element of distributed solar projects—net metering allows end users to benefit from reduced electricity bills which are necessary for attractive solar project economics. The PUC issued an order on net metering that requires all EDCs to offer net metering to their customers, yet it allows ESGs to offer net metering on a voluntary basis.[213] Most ESGs do not currently offer net metering. This means that ESG customers are potentially shut out of the benefits of distributed solar projects, and that the potential market size for distributed solar is limited to the customers of EDCs and the few ESGs that have volunteered to offer net metering.

Market Potential

There are two recent studies that attempt to calculate solar PV potential in Pennsylvania—one is produced by NREL and the other was commissioned by the PUC and produced by the Statewide Evaluator.[214] Though both studies find very high levels of technical potential for solar in Pennsylvania, and though the NREL study estimates an economic potential of 62 GW of utility-scale solar, both studies estimate no economic potential for distributed solar. These unduly low estimates of distributed solar stem from three issues—the studies use a "total resource cost" test that rely on narrow conceptions of project benefits or "avoided costs," the methods do not account for the value from the sale of renewable energy credits, and the calculations assume an inappropriately high solar installation cost (using data that are now several years old). Solar installation costs are a key factor in economic viability of solar projects, and the installation costs have been steadily falling in the years since these studies were published. The PUC's study, for example, uses a $4.09/W cost of installation in the residential sector. For comparison, the national average solar installation cost in the second half of 2016 for the residential sector is $2.89/W.[215] Currently in southeast Pennsylvania, solar installation costs are around $3.20/W and can be as low as $2.75/W through group-buying services such as Solarize.[216] Furthermore, the PUC study only accounted for the benefits associated with solar over a period of 15 years,[xxvii] when the industry standard expected useful life of solar panels ranges from 25 to 40 years.[217] All these factors cause these studies to underestimate the current economic potential of solar, particularly distributed solar, in Pennsylvania.

Using a simple method of modeling the levelized cost of energy (LCOE) of distributed solar on a per kWh basis (which accounts for lower installation costs, realistic expected useful life, and value stream from

[xxvii] The authors of this study make this point themselves, and point to a PUC ruling that mandates a maximum of 15 year expected useful life when calculating the avoided costs associated with an energy project.

RECs), it is possible to compare the LCOE per kWh of distributed solar with the prices consumers pay for grid electricity per kWh. When the LCOE of solar energy is below grid prices, the project is economically viable because end-users can make money (in the form of energy bill savings) by installing a solar system on their roofs.

The model was used to calculate the LCOE of solar on a per kWh basis across three financing scenarios—cash purchase, loan, and PPA/lease. The model was used to calculate the LCOE of the three financing scenarios for a hypothetical residential and commercial rooftop systems. Very conservative assumptions about system size, generation, expected useful life, interest rates and discount rates were used in the model.[xxviii] The model was used to calculate the LCOE per kWh of solar across the three financing scenarios with a variety of installation costs and SREC prices. Distributed solar is considered "economically viable" if the LCOE calculated by the model are below the average retail price of electricity paid by customers: 14 cents per kWh for residential customers and 9 cents per kWh commercial customers.[218] If a building owner can pay an LCOE per kWh of self-generated solar electricity that is less than the price of grid electricity, that means they can make money (in the form of energy bill savings) with a distributed solar system, and distributed solar is economically viable.

In certain parts of western Pennsylvania, electricity prices are below the average retail rate. It is assumed that in western Pennsylvania, average residential rates are 12 cents per kWh and average commercial rates are 8 cents per kWh.

The per kWh LCOEs of distributed solar calculated with the model are shown in tables below. Installation costs and SREC prices that produce an LCOE that is below the state average retail electricity price for the given sector are highlighted in green, meaning that solar is economically viable under these conditions. Installation costs and SREC prices that produce an LCOE that is below the western Pennsylvania average retail electricity price for the given sector are highlighted in dark green, meaning that solar is economically viable under these conditions. Installation costs and SREC prices that produce and LCOE that is above the retail electricity price for the given sector are highlighted in red, indicating that they are not economically in these conditions.

[xxviii] The residential system was assumed to be a 7.7 kW system generating 100% of household demand. The commercial system was assumed to be a 58.6 kW system generating 100% of building demand. Expected useful life for both systems was assumed to be 25 years and the capacity factor was assumed to be 16%. The term of the loan was assumed to be 20 years and the interest rate was assumed to be 6%. The term of the PPA/lease was assumed to be 20 years, the cost of capital was assumed to be 9%, no lease payment escalator was included, and the discount rate was assumed to be 4%.

LEGEND	
<14	Solar is cost-effective compared to average utility rates
<12	Solar is cost-effective compared to state's lowest utility rates
>14	Solar is not cost-effective

Figure 39: LCOE of Cash Purchase of Residential Solar System, varying Cost and SREC (cents/kWh)

Residential - Cash

		SREC Price ($/MWh)										
		$0	$10	$20	$30	$40	$50	$60	$70	$80	$90	$100
Cost ($/W)	$3.50	11.76	10.76	9.76	8.76	7.76	6.76	5.76	4.76	3.76	2.76	1.76
	$3.40	11.42	10.42	9.42	8.42	7.42	6.42	5.42	4.42	3.42	2.42	1.42
	$3.30	11.08	10.08	9.08	8.08	7.08	6.08	5.08	4.08	3.08	2.08	1.08
	$3.20	10.75	9.75	8.75	7.75	6.75	5.75	4.75	3.75	2.75	1.75	0.75
	$3.10	10.41	9.41	8.41	7.41	6.41	5.41	4.41	3.41	2.41	1.41	0.41
	$3.00	10.08	9.08	8.08	7.08	6.08	5.08	4.08	3.08	2.08	1.08	0.08
	$2.90	9.74	8.74	7.74	6.74	5.74	4.74	3.74	2.74	1.74	0.74	
	$2.80	9.41	8.41	7.41	6.41	5.41	4.41	3.41	2.41	1.41	0.41	
	$2.70	9.07	8.07	7.07	6.07	5.07	4.07	3.07	2.07	1.07	0.07	
	$2.60	8.73	7.73	6.73	5.73	4.73	3.73	2.73	1.73	0.73		
	$2.50	8.40	7.40	6.40	5.40	4.40	3.40	2.40	1.40	0.40		

Figure 40: LCOE of Loan-Financed Residential Solar System, varying Cost and SREC (cents/kWh)

Residential - Loan

		SREC Price ($/MWh)										
		$0	$10	$20	$30	$40	$50	$60	$70	$80	$90	$100
Cost ($/W)	$3.50	13.93	12.93	11.93	10.93	9.93	8.93	7.93	6.93	5.93	4.93	3.93
	$3.40	13.53	12.53	11.53	10.53	9.53	8.53	7.53	6.53	5.53	4.53	3.53
	$3.30	13.13	12.13	11.13	10.13	9.13	8.13	7.13	6.13	5.13	4.13	3.13
	$3.20	12.74	11.74	10.74	9.74	8.74	7.74	6.74	5.74	4.74	3.74	2.74
	$3.10	12.34	11.34	10.34	9.34	8.34	7.34	6.34	5.34	4.34	3.34	2.34
	$3.00	11.94	10.94	9.94	8.94	7.94	6.94	5.94	4.94	3.94	2.94	1.94
	$2.90	11.54	10.54	9.54	8.54	7.54	6.54	5.54	4.54	3.54	2.54	1.54
	$2.80	11.14	10.14	9.14	8.14	7.14	6.14	5.14	4.14	3.14	2.14	1.14
	$2.70	10.75	9.75	8.75	7.75	6.75	5.75	4.75	3.75	2.75	1.75	0.75
	$2.60	10.35	9.35	8.35	7.35	6.35	5.35	4.35	3.35	2.35	1.35	0.35
	$2.50	9.95	8.95	7.95	6.95	5.95	4.95	3.95	2.95	1.95	0.95	

Figure 41: LCOE of PPA/Lease-Financed Residential Solar System, varying Cost and SREC (cents/kWh)

Residential - PPA/Lease

		SREC Price ($/MWh)										
		$0	$10	$20	$30	$40	$50	$60	$70	$80	$90	$100
Cost ($/W)	$3.50	13.02	12.02	11.02	10.02	9.02	8.02	7.02	6.02	5.02	4.02	3.02
	$3.40	12.65	11.65	10.65	9.65	8.65	7.65	6.65	5.65	4.65	3.65	2.65
	$3.30	12.27	11.27	10.27	9.27	8.27	7.27	6.27	5.27	4.27	3.27	2.27
	$3.20	11.90	10.90	9.90	8.90	7.90	6.90	5.90	4.90	3.90	2.90	1.90
	$3.10	11.53	10.53	9.53	8.53	7.53	6.53	5.53	4.53	3.53	2.53	1.53
	$3.00	11.16	10.16	9.16	8.16	7.16	6.16	5.16	4.16	3.16	2.16	1.16
	$2.90	10.79	9.79	8.79	7.79	6.79	5.79	4.79	3.79	2.79	1.79	0.79
	$2.80	10.41	9.41	8.41	7.41	6.41	5.41	4.41	3.41	2.41	1.41	0.41
	$2.70	10.04	9.04	8.04	7.04	6.04	5.04	4.04	3.04	2.04	1.04	0.04
	$2.60	9.67	8.67	7.67	6.67	5.67	4.67	3.67	2.67	1.67	0.67	
	$2.50	9.30	8.30	7.30	6.30	5.30	4.30	3.30	2.30	1.30	0.30	

Figure 42: LCOE of Cash Purchase of Commercial Solar System, varying Cost and SREC (cents/kWh)

Commercial - Cash

Cost ($/W) \ SREC Price ($/MWh)	$0	$10	$20	$30	$40	$50	$60	$70	$80	$90	$100
$3.00	10.08	9.08	8.08	7.08	6.08	5.08	4.08	3.08	2.08	1.08	0.08
$2.90	9.74	8.74	7.74	6.74	5.74	4.74	3.74	2.74	1.74	0.74	
$2.80	9.41	8.41	7.41	6.41	5.41	4.41	3.41	2.41	1.41	0.41	
$2.70	9.07	8.07	7.07	6.07	5.07	4.07	3.07	2.07	1.07	0.07	
$2.60	8.73	7.73	6.73	5.73	4.73	3.73	2.73	1.73	0.73		
$2.50	8.40	7.40	6.40	5.40	4.40	3.40	2.40	1.40	0.40		
$2.40	8.06	7.06	6.06	5.06	4.06	3.06	2.06	1.06	0.06		
$2.30	7.73	6.73	5.73	4.73	3.73	2.73	1.73	0.73			
$2.20	7.39	6.39	5.39	4.39	3.39	2.39	1.39	0.39			
$2.10	7.05	6.05	5.05	4.05	3.05	2.05	1.05	0.05			
$2.00	6.72	5.72	4.72	3.72	2.72	1.72	0.72				

Figure 43: LCOE of Loan-Financed Commercial Solar System, varying Cost and SREC (cents/kWh)

Commercial - Loan

Cost ($/W) \ SREC Price ($/MWh)	$0	$10	$20	$30	$40	$50	$60	$70	$80	$90	$100
$3.00	11.94	10.94	9.94	8.94	7.94	6.94	5.94	4.94	3.94	2.94	1.94
$2.90	11.54	10.54	9.54	8.54	7.54	6.54	5.54	4.54	3.54	2.54	1.54
$2.80	11.14	10.14	9.14	8.14	7.14	6.14	5.14	4.14	3.14	2.14	1.14
$2.70	10.75	9.75	8.75	7.75	6.75	5.75	4.75	3.75	2.75	1.75	0.75
$2.60	10.35	9.35	8.35	7.35	6.35	5.35	4.35	3.35	2.35	1.35	0.35
$2.50	9.95	8.95	7.95	6.95	5.95	4.95	3.95	2.95	1.95	0.95	
$2.40	9.55	8.55	7.55	6.55	5.55	4.55	3.55	2.55	1.55	0.55	
$2.30	9.15	8.15	7.15	6.15	5.15	4.15	3.15	2.15	1.15	0.15	
$2.20	8.76	7.76	6.76	5.76	4.76	3.76	2.76	1.76	0.76		
$2.10	8.36	7.36	6.36	5.36	4.36	3.36	2.36	1.36	0.36		
$2.00	7.96	6.96	5.96	4.96	3.96	2.96	1.96	0.96			

Figure 44: LCOE of PPA/Lease-Financed Commercial Solar System, varying Cost and SREC (cents/kWh)

Commercial - PPA/Lease

Cost ($/W) \ SREC Price ($/MWh)	$0	$10	$20	$30	$40	$50	$60	$70	$80	$90	$100
$3.00	11.16	10.16	9.16	8.16	7.16	6.16	5.16	4.16	3.16	2.16	1.16
$2.90	10.79	9.79	8.79	7.79	6.79	5.79	4.79	3.79	2.79	1.79	0.79
$2.80	10.41	9.41	8.41	7.41	6.41	5.41	4.41	3.41	2.41	1.41	0.41
$2.70	10.04	9.04	8.04	7.04	6.04	5.04	4.04	3.04	2.04	1.04	0.04
$2.60	9.67	8.67	7.67	6.67	5.67	4.67	3.67	2.67	1.67	0.67	
$2.50	9.30	8.30	7.30	6.30	5.30	4.30	3.30	2.30	1.30	0.30	
$2.40	8.93	7.93	6.93	5.93	4.93	3.93	2.93	1.93	0.93		
$2.30	8.55	7.55	6.55	5.55	4.55	3.55	2.55	1.55	0.55		
$2.20	8.18	7.18	6.18	5.18	4.18	3.18	2.18	1.18	0.18		
$2.10	7.81	6.81	5.81	4.81	3.81	2.81	1.81	0.81			
$2.00	7.44	6.44	5.44	4.44	3.44	2.44	1.44	0.44			

The LCOE of solar can be further decreased, and thus made more attractive to building owners and more economically viable by making low-interest long-term financing available to building owners that want to finance solar systems on their roofs. Such financing could be made available through existing clean energy financing entities or through a potential new statewide clean energy financing entity. Assuming an SREC price of $10 per MWh and installation costs of $3.00 per watt for residential systems and $2.50 per watt for commercial systems, and assuming the system was financed with a loan, the LCOE per kWh of distributed solar was modeled for a variety of interest rates and loan terms. The tables below show the impact lending terms can have on the LCOE of solar, and by extension, the economic viability of solar.

Figure 45: LCOE of Loan-Financed Residential Solar System, varying Rate and Term (cents/kWh)

Residential Loan

SREC = $10
$/W = 3.00

Rate \ Term (yrs)	3	5	7	10	12	15	20	25
10%	10.25	10.83	11.42	12.30	12.88	13.73	15.09	16.34
9%	10.05	10.53	11.02	11.74	12.21	12.90	14.00	15.03
8%	9.85	10.24	10.62	11.18	11.55	12.09	12.95	13.75
7%	9.66	9.94	10.22	10.64	10.91	11.30	11.93	12.51
6%	9.46	9.65	9.83	10.11	10.28	10.54	10.94	11.31
5%	9.27	9.36	9.45	9.59	9.67	9.79	9.99	10.17
4%	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08
3%	8.89	8.80	8.71	8.58	8.50	8.39	8.21	8.04
2%	8.70	8.52	8.35	8.10	7.94	7.72	7.38	7.06
1%	8.51	8.24	7.99	7.63	7.40	7.08	6.59	6.15
0%	8.32	7.97	7.64	7.17	6.88	6.47	5.85	5.30

Figure 46: LCOE of Loan-Financed Commercial Solar System, varying Rate and Term (cents/kWh)

Commercial Loan

SREC = $10
$/W = 2.50

Rate \ Term (yrs)	3	5	7	10	12	15	20	25
10%	8.37	8.86	9.35	10.09	10.57	11.28	12.41	13.45
9%	8.21	8.61	9.01	9.61	10.01	10.58	11.50	12.36
8%	8.04	8.36	8.68	9.15	9.46	9.91	10.62	11.29
7%	7.88	8.12	8.35	8.70	8.92	9.25	9.77	10.26
6%	7.72	7.88	8.03	8.25	8.40	8.61	8.95	9.26
5%	7.56	7.63	7.71	7.82	7.89	8.00	8.16	8.31
4%	7.40	7.40	7.40	7.40	7.40	7.40	7.40	7.40
3%	7.24	7.16	7.09	6.98	6.92	6.82	6.67	6.53
2%	7.08	6.93	6.79	6.58	6.45	6.27	5.98	5.72
1%	6.92	6.70	6.49	6.19	6.00	5.73	5.32	4.96
0%	6.77	6.48	6.20	5.81	5.57	5.22	4.71	4.25

The results of this modeling consistently showed numerous scenarios in which it is cheaper for end users to get their electricity from net-metered distributed solar systems than it was to pay for grid electricity. Distributed solar was shown to be economically viable despite very conservative methodology and assumptions. It is clear that the economic potential for distributed solar in Pennsylvania is significant. It

follows that we are justified in rejecting the studies that determine there is no economic potential for distributed solar in Pennsylvania. Yet determining the precise size of the economical market using these modelling techniques is not part of the scope of this report. So to be fair and conservative, for purposes of this report we have assumed that 25% of the NREL study's projected technical potential, or 9.7 GW, is economical under the conditions. We have further assumed that, of the 9.7 GW of economic potential, 10% of that amount, or 970 MW, is Pennsylvania's market potential for distributed solar. Assuming a $3 per watt installation cost, the investment potential in distributed solar in Pennsylvania would be $2.9 billion. This figure represents a very conservative estimate, and the reality is likely much higher. Similarly, we have assumed that, of the NREL's estimated 62 GW of utility-scale solar that is economical in Pennsylvania, 10% of that amount, or 6,261 MW, is Pennsylvania's market potential for utility-scale solar.

Table 17: Estimate of Solar Power Potential in Pennsylvania

Installation Type	Technical Potential	Economical Potential	Market Potential	Investment Need ($M)
Distributed	38,900 MW	9700 MW	970 MW	$2,910
Utility-Scale	841,600 MW	62,610 MW	6261 MW	$9,078

It is also important to note that the market potential for distributed solar will get bigger as solar panel costs continue to decline and as Pennsylvania gains wider availability of affordable long-term financing, as is demonstrated by the results of the modeling above.

Wind Power Market

Current Market Activity

As of 2015, Pennsylvania had 24 large wind projects installed, representing 720 turbines and 1340 MW of capacity across the state. Pennsylvania also has 26 active wind energy technology manufacturing facilities in the state, representing between 1000 and 2000 jobs in 2015. To date, more than $2 billion of investment has occurred in wind projects across the state.[219] The penetration of wind technology in Pennsylvania can be partly explained by the excellent wind resources at 80 meters and above in and around the Appalachian range in southwestern Pennsylvania.[xxix]

[xxix] According to NREL, the minimum wind speeds needed for wind power development are 5.9 m/s or 13.2 mph at 30m, 6.4 m/s or 14.3 mph at 50m, 7.0 m/s or 15.7 mph at 80m.

Figure 47: Average Annual Wind Speed in Pennsylvania at 80m[220]

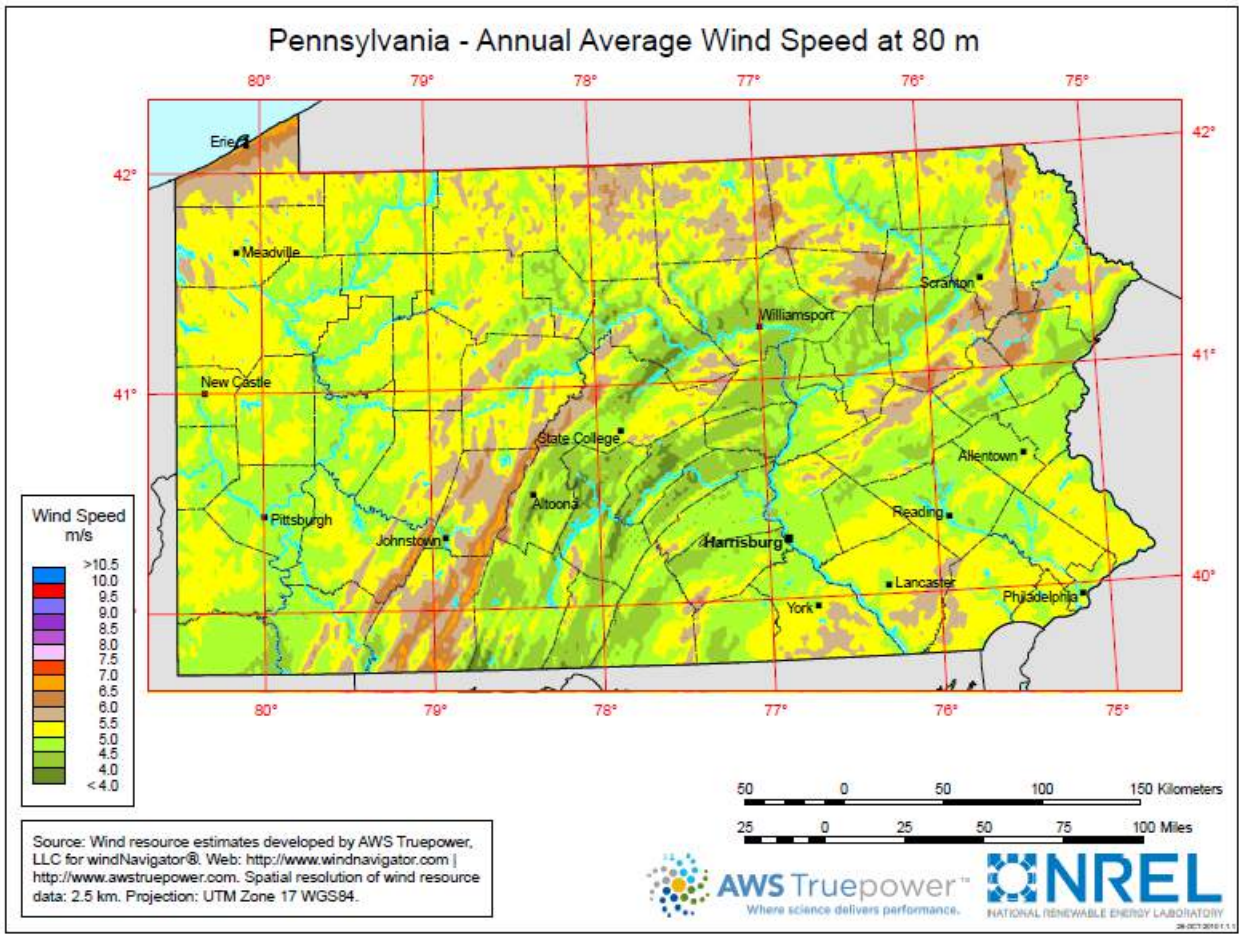
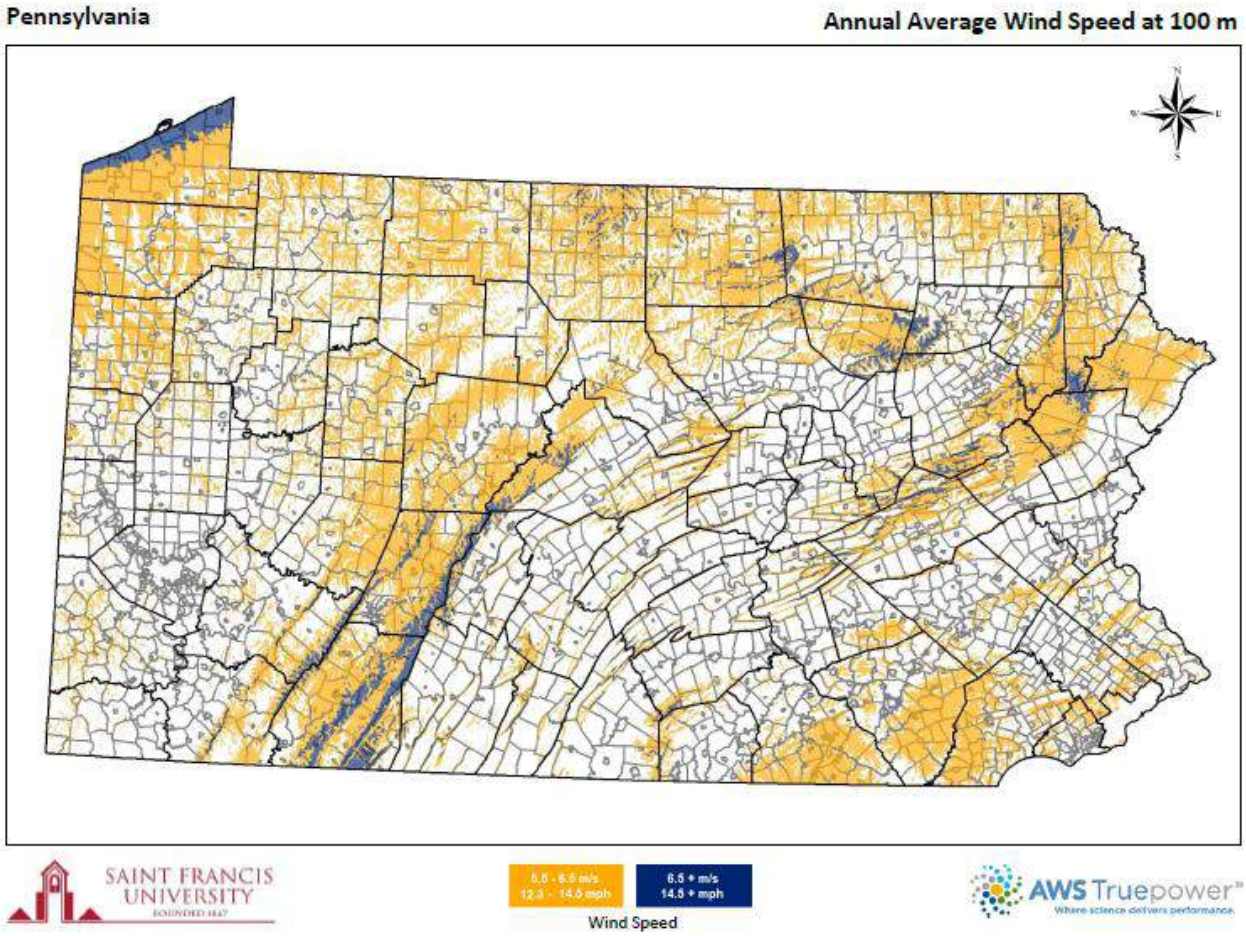


Figure 48: Average Annual Wind Speed in Pennsylvania at 100m[221]



The wind resources in Pennsylvania at lower heights are somewhat less attractive, suggesting the prospects for smaller scale, or distributed, wind projects with turbines that are approximately 30 meters in height are somewhat limited.

Figure 49: Average Annual Wind Speed in Pennsylvania at 50m[222]

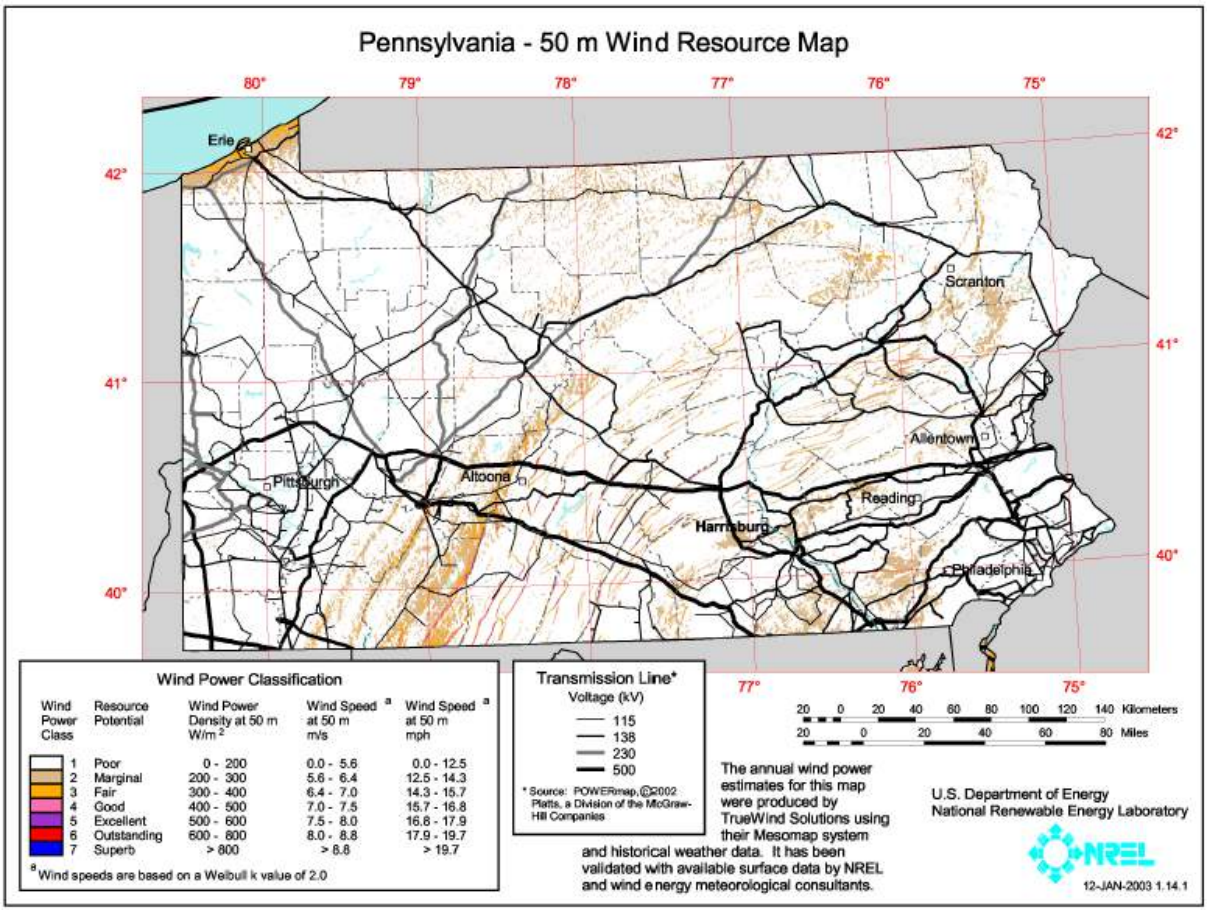
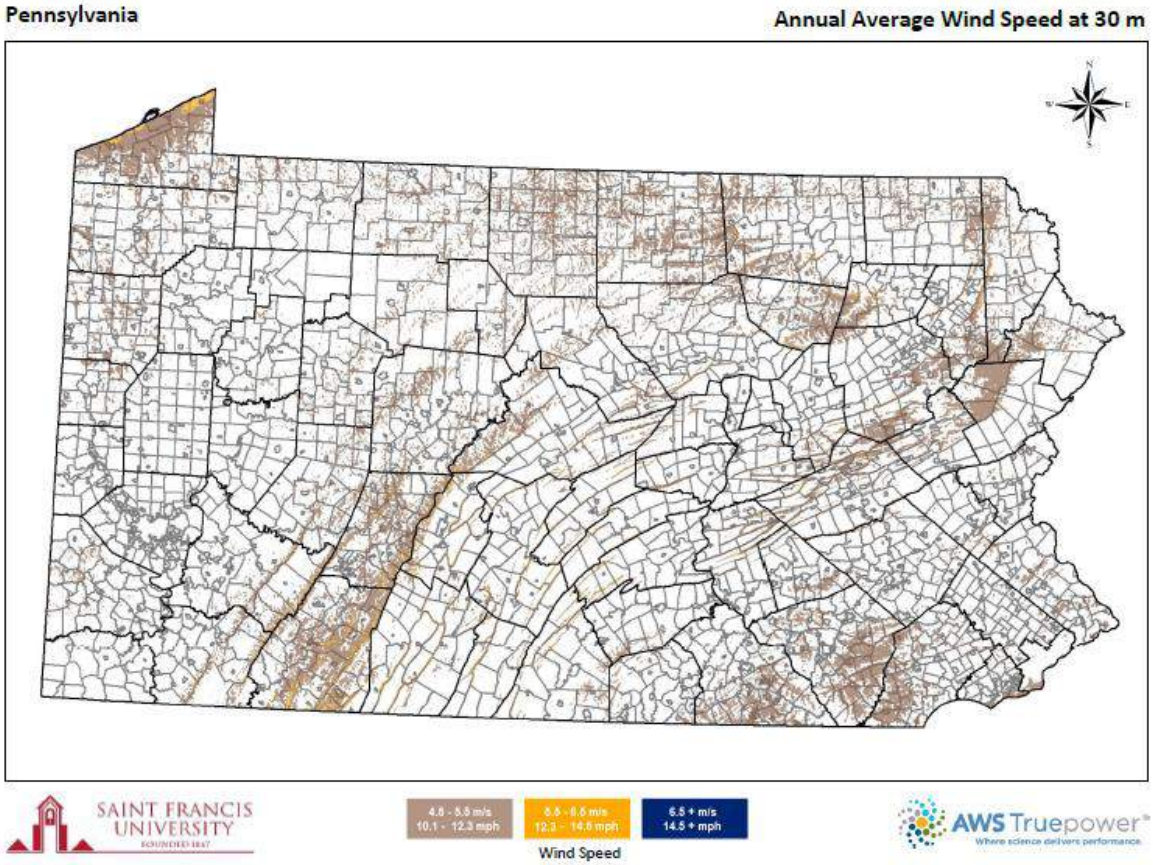


Figure 50: Average Annual Wind Speed in Pennsylvania at 30m[223]



Market Potential

Accounting for the wind resources in the state, NREL produced a technical analysis of the total wind power potential available in Pennsylvania, and found that 12,000 MW of wind are technically feasible at the 80m height. Under various economic scenarios, they found that this technical potential translated to anywhere from 69 to 1100 MW of economically viable wind potential.[224] In addition to this NREL study, the DOE produced its own analysis of economical wind potential. This study found the wind potential to be 878 MW at the 80m height.[225] Assuming an installation cost of $1,710 per kW based on data from the Lawrence Berkeley National Lab,[226] the economical wind potential as estimated by NREL represents up to $1.8 billion in potential investment in the state. Given the slow wind speeds at 50m height and below, it is assumed that there is virtually no market potential for distributed, small-scale wind in Pennsylvania.

Figure 51: Summary of Wind Economic Potential Estimates in Pennsylvania[xxx]

Source	Economical Potential	Investment Need ($M)
DOE Wind Vision	878 MW	$1,501
NREL – Low	69 MW	$117
NREL – High	1100 MW	$1,876

These estimates of the economic potential for wind energy in Pennsylvania at 80m may seem low considering that Pennsylvania has already implemented 1340 MW of economically viable wind energy. This is primarily because estimates of wind potential at 110m in Pennsylvania were so large that they were excluded from this study. AWEA estimates 43,565 MW of economically viable wind potential at 110m, [227] which equates to more than $70 billion of investment using the same installation cost assumption as above, and is greater than the sum of all the other clean energy investment potentials calculated in this report. Large wind projects have not had much trouble accessing capital in Pennsylvania, so whether the economic potential is 1100 MW or 43,565 MW may be irrelevant as long as economic wind potential in Pennsylvania is understood to be very large and economically viable large wind projects continue to benefit from easy access to private capital.

Bioenergy Electric Generation Market

Current Market Activity

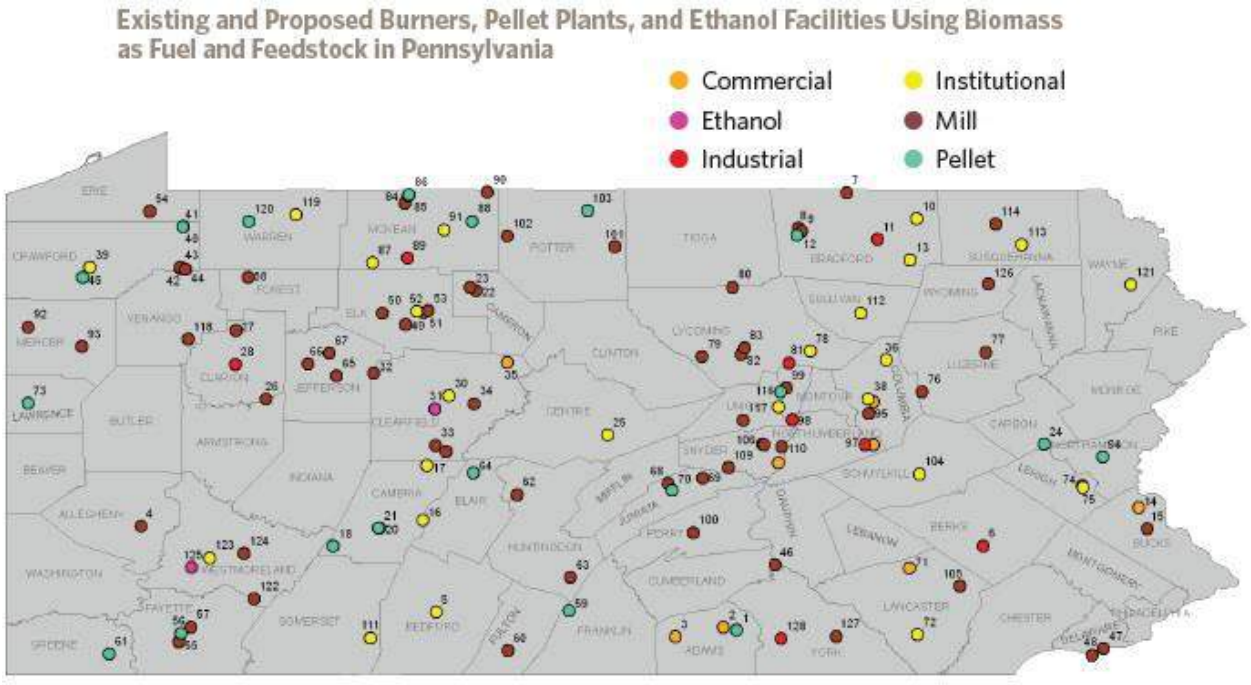
Bioenergy is category of renewable energy that is somewhat expansive—it encompasses numerous different technologies and feedstocks. For example, a wood-burning boiler, an electricity-producing landfill gas facility, and a manure-consuming methane gas-producing anaerobic digester would all be classified as bioenergy. A useful distinction can be made between biomass-consuming facilities, and bio-fuel production facilities, though sometimes a single facility will both produce and consume a given biofuel for electricity, heat, or both. Bioenergy market information is at times patchy, inconsistent, and several years old. Bioenergy projects, are much more heterogeneous than other clean energy technologies, and project economics vary widely as a result of differing technologies, differing feedstocks, feedstock availability, proximity to offtakers, The discussion that follows reflects some of those challenges, and should be considered as only a partial representation of the market realities and potentials.

As of 2014, Pennsylvania had 637 MW of biomass and waste generation capacity, as well as 110 million gallons a year of ethanol production capacity and 111 million gallons a year of biodiesel production capacity. Biomass energy facilities in the state use wood scraps, sawdust, and wood chips produced from

[xxx] All estimates given for 80m turbine height.

mill and forestry operations to produce electricity and heat.[228] Many bioenergy resources are eligible for the state's AEPS, including: biomass, in-state and out-of-state wood pulping and manufacturing byproducts, biologically-derived methane gas, and municipal solid waste.[229] Bioenergy projects are eligible for (and have received) much of the financing described in previous sections. In 2012, Pennsylvania had 128 biomass-burning facilities in operation.[230]

Figure 52: Various Biomass-Burning Facilities in Pennsylvania in 2012[231]



Currently Pennsylvania has 173 operational biogas production systems.[232] There are a total of 29 agricultural anaerobic digesters in the state with a wide range of system types and sizes that use animal feed waste and manure as feedstocks. There are 66 wastewater treatment plants in the state that use anaerobic digesters. There are 42 landfill gas (LFG) facilities and 7 waste-to-energy plants[xxxi] distributed throughout the state. The US Department of Agriculture alone has invested between $2-4 million in 9 anaerobic digesters and between $20-40 million in 66 renewable biomass projects in the state.[233]

[xxxi] Six of these 7 plants accept municipal solid waste, which qualifies them as Tier II energy resources under the Pennsylvania AEPS. The seventh plant only accepts dry industrial waste, and is not technically a bioenergy facility.

Figure 53: Operational and Potential Biogas Systems in Pennsylvania in 2015[234]

Food Waste	
Operational food waste biogas systems	-
Potential food waste biogas systems	26
Agriculture	
Operational biogas systems on farms	29
Potential dairy farm biogas systems	60
Potential swine farm biogas systems	36
Waste Water	
Operational biogas systems at water resource recovery facilities	80
Potential biogas systems at WRRFS	218
Landfills	
Operational landfill gas systems	64
Potential landfill gas systems	8

Figure 54: Feedstocks Available for Biogas Production in PA in 2015[235xxxii]

Manure	
Total Beef Manure	1.6 million gallons per day
Total Dairy Manure	9.5 million gallons per day
Total Swine Manure	1.6 million gallons per day
Total Broiler Manure	27.1 million gallons per day
Total Turkey Manure	1.7 million gallons per day
Total Manure Volume	41.8 million gallons per day
Food Waste	
Total Food Waste Generated	1.3 million tons per year
Waste Water	
Average flow from WRRF's	8.7 million gallons per day

Market Potential

According to the EPA, there are between 56-175 candidate swine farms and between 16-35 candidate dairy farms that are suitable for anaerobic digester projects. [236] Together, these opportunities for anaerobic digester projects could account for 25 to 125 GWh of electricity production per year, and generate between $16 million and $93 million in investment. There are 8-10 candidate landfills in the state for landfill gas projects that would represent anywhere from $23 million to $85 million in investment,

[xxxii] "Water resource recovery facility" is abbreviated here as WRRF.

depending on whether the landfill sites already have capture systems in place and whether they projects capture methane for direct use or for electricity generation.[237]

The American Biogas Council ranks Pennsylvania as the 9th best state in the country for methane production potential from biogas sources. Based on the suitable feedstocks available, Pennsylvania potential to develop approximately 348 new biogas projects. Implementing these projects would generate up to $1 billion in investment and create 696 long-term jobs.[238]

Table 18: Summary of Bioenergy Potential Estimates in Pennsylvania

Source	Technology	Economical Projects	Investment Need ($M)
EPA	Anaerobic Digestors	72 - 210[xxxiii]	$16 - $93
EPA	Landfill Gas	8 - 10	$117
American Biogas Council	Biogas	348	$1,000

Micro Hydro

Current Activity

The EIA identifies 16 hydroelectric power plants in Pennsylvania, ranging from 2.8 MW to 417 MW. These facilities are considered utility-scale. Micro hydro systems are typically 100 kW or less, though some studies include systems up to 1 MW.[239] Micro hydro systems exist in Pennsylvania, yet no public information was available on the number of operational micro hydro systems in the state. Pennsylvania has 83,000 miles of rivers and streams,[240] which include ample resources for micro hydro development. The PUC has a defined permitting process for these systems,[241] and at least one contracting company offers micro hydro installation services in the state.[242]

Market Potential

The DOE estimates more than 200 MW of micro hydro (under 1 MW) potential in Pennsylvania.[243] PECPA published a study in which the unsubsidized installation costs of an NPV-positive micro hydro system were approximately $10.56 per watt.[244] Using those figures, we can estimate that there is $2.1 billion in investment potential for micro hydro in Pennsylvania.

[xxxiii] This would represent approximately 24 - 72 MW of electricity generation capacity. This figure was calculated multiplying the range of candidate sites (72 - 210) and the median anaerobic digester capacity in Pennsylvania (343 kW).

Yet the economic viability of micro hydro in the state may be limited by net metering rules that put a cap on the generation of any such system at 110% of the on-site demand, as well as other rules about the distance of the system from the on-site load, and size restrictions.

So, in an attempt to account for these market-constraining policies on the total economically viable market potential for micro hydro systems in Pennsylvania, we assume 25% of the $2.1 billion figure is economically viable, or $528 million.

Table 19: Market Potential and Investment Need for Micro Hydro in Pennsylvania

Market Potential	Investment Need ($M)
200 MW	$528

Fuel Switching

Current Activity

Switching the fuel used to heat a building is an excellent means of reducing energy costs and improving energy efficiency. Generally fuel switching entails changing the heating equipment in a home such that it consumes natural gas instead of fuel oil, or some other more expensive and dirtier fuel. Though there is no data available on the number of households that have switched fuels in Pennsylvania, there is evidence that changes in commodity prices, need for equipment replacements, and utility-led campaigns are driving Pennsylvania homeowners to convert oil heating systems to natural gas heating systems.[245] Numerous contractors in the state offer gas heating system installation services.[246]

Market Potential

Of the 4.7 million households in Pennsylvania, nearly 860,000 are heated with fuel oil.[247] Though the cost of switching from an oil-consuming heating system to a natural gas-consuming heating system is highly variable, an approximate average cost is $4,900.[248] The DEP estimates $1,127 in average annual savings from switching heating fuels,[249] which would pay for the cost of switching in 4 to 5 years. Assuming that half of the households that use oil convert to gas, we estimate that 429,930 households can viably switch to gas heating systems, which would represent $2.1 billion in investment.

Table 20: Market Potential and Investment Need for Household Fuel Switching in Pennsylvania

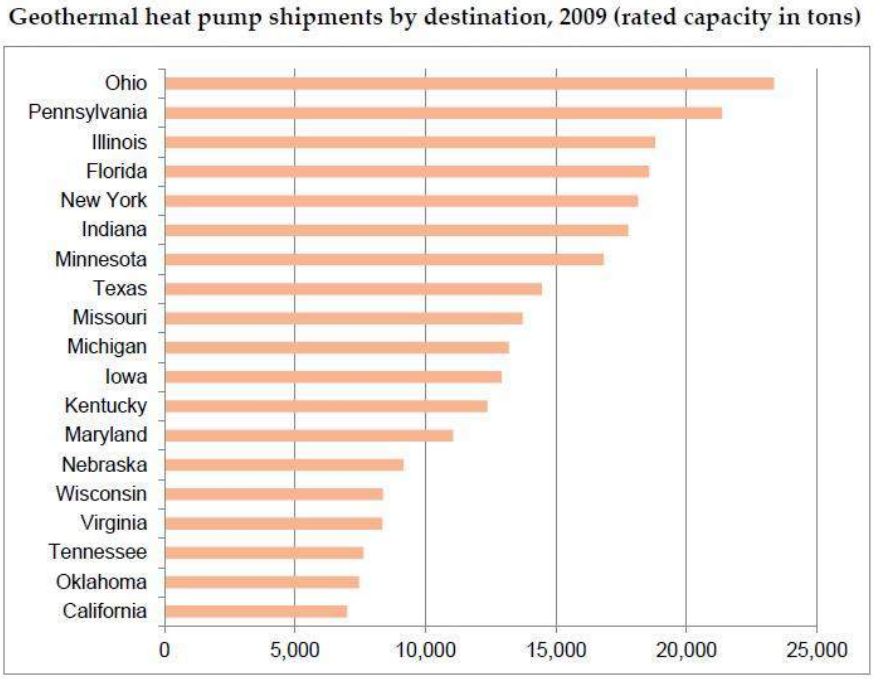
Market Potential	Investment Need ($M)
429,930 households	$2,107

Geothermal Ground Source Heat Pumps

Current Activity

Pennsylvania is considered an attractive geography for geothermal heat pump (GHP) systems.[250] In 2009, Pennsylvania was the second biggest importer of geothermal heat pump technology (in system capacity) in the United States, after Ohio.[251]

Figure 55: Geothermal Heat Pump Shipments by Destination 2009[252]



Pennsylvania is also geologically dormant, which means subsurface temperature variability is limited, reducing the need to gather site-specific temperature data. Pennsylvania is ranked as one of the top-tier states for experienced and competitive installation of GHPs in its urban centers.[253] Numerous contractors offer geothermal heating and cooling system installation services in the state,[254] though no public information was available on the number of geothermal heat pump systems have been installed in Pennsylvania.

Market Potential

The DEP estimates 30% of homeowners in Pennsylvania will have to replace their HVAC systems by 2020 and will want to add air conditioners when doing so. If these homeowners were to install geothermal heat pumps as a means of heating and cooling their houses, their energy savings could be between 30% and 45%.[255] Nearly half of homes in Pennsylvania are heated with electricity (most of which is likely electric-resistance heating), fuel oil, LPG, or other fuels.[256] So there are certainly opportunities for homeowners

to reduce their energy costs related to home-heating and cool their homes more efficiently with geothermal heat pumps.

Yet the high upfront costs of the system may be prohibitive to many potential end users, even if payback periods are less than 5 years. This underscores the need for long term financing. High upfront costs and attractive savings make geothermal heat pumps prime candidates for financing. Financing would allow building-owners to avoid paying upfront costs and use the savings from the geothermal systems to pay off the loan. The achievable market potential may depend on the extent to which affordable long term financing is available for geothermal heat pumps.

Due to a lack of data, no quantitative estimates for market potential were made for geothermal heat pumps.

Takeaways

Taken together, the clean energy market potential estimates range from about $16 to $20 billion in investment opportunities for the technologies investigated in this report. Distributed projects—solar, efficiency, micro hydro, fuel switching, and bioenergy electric generation—represent approximately $7 to $9 billion in investment opportunities. Utility-scale projects—wind and solar—could represent as much as $11 billion of investment potential.

Market & Program Analysis

The following sections contain discussion and analysis of the market and many of the programs within the market as a whole. It includes the lessons from interviews with more than 40 people and organizations working on clean energy in Pennsylvania. Interviews were conducted with project developers, contractors, investors, policymakers, NGOs, program managers, government officials, and regulators. Conversations focused on understanding the current energy landscape, and the process for identifying, financing and developing clean energy projects. Discussions also centered on identifying gaps, opportunities and underserved market segments. Stakeholder expertise and experience was a vital part of the process of identifying key market gaps, barriers to increasing clean energy market activity, and determining opportunities in the Pennsylvania energy landscape.

Unlocking Market Potential

There are large untapped opportunities for clean energy in Pennsylvania. The market potential studies and data referenced in this report, as well as numerous stakeholder interviews, suggest that distributed generation and energy efficiency tend to be more difficult to finance in Pennsylvania, and that current levels of investment are nowhere close to tapping into the market potential. There are large unexploited opportunities for distributed clean energy projects in Pennsylvania that merit attention. Focusing on filling the gaps in investment in the distributed clean energy market should be a priority.

To fully take advantage of those opportunities, the Pennsylvania clean energy market in Pennsylvania must undergo several key changes. To grow the clean energy market in Pennsylvania, both the supply of lending capital for clean energy projects and the end user demand for clean energy projects must increase.

Currently, the supply of capital is limited and mostly in the form of concessional public-purpose funds. To increase supply of capital, market conditions must exist that draw in private capital to supplement the limited public purpose capital already in the market. Access to clean energy financing must be ubiquitous and affordable, as it is for cars and houses. Terms should match the market conditions and the expected useful life of each technology such that clean energy projects can be cash flow positive for end users. Cash flow positive projects are less likely to default, and inspire investor confidence.

Demand for clean energy in Pennsylvania is low, and much of the capital available for clean energy projects is underutilized. To increase demand for clean energy projects and the capital to finance them, marketing efforts, public underwriting criteria, standard-offer lending terms, cash flow positive projects, and contractors familiar with the available financing options are needed. Contractors and end users must know about the relevant technologies and the means to finance them, and end users must be able to enjoy a direct economic benefit from these projects.

The market landscape in Pennsylvania also contributes to the difficulty of connecting capital with projects in Pennsylvania. A complex array of numerous overlapping and variously constrained programs create

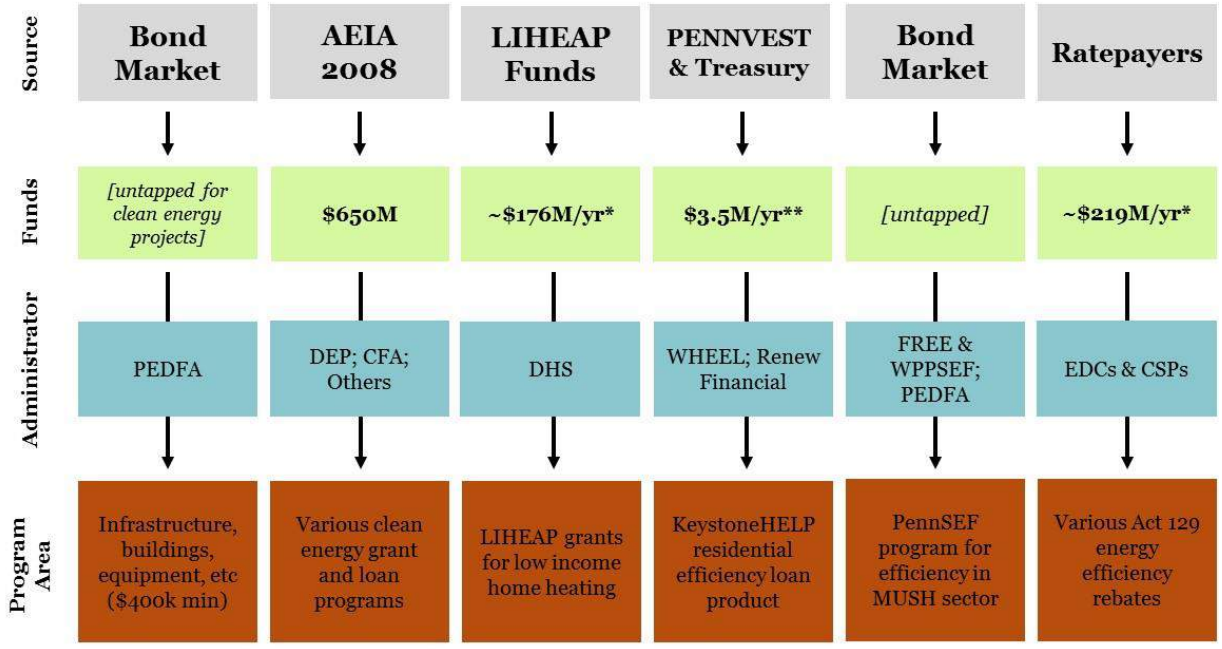
learning curves and transaction costs for potential market participants. The largely concessional nature of these programs may limit private entry in the space. Clean energy programs and products should be built to maximize ease-of-use, and contractors should be trained or certified in how to use them. The market should be transparent, have easy access to information and simple, user-friendly financing programs that encourage entry and private participation. Helpful measures include reducing complexity and transaction costs and improving transparency and consistency in the market. Public-private partnerships, outreach efforts or education seminars for key groups of market participants, and a central clearinghouse for all relevant information and resources could help the market reorient away from concessional public support for clean energy toward public facilitation of increasing private market activity in the clean energy space.

Supply of & Demand for Clean Energy Financing

The market for clean energy projects is small relative to its economically viable potential. Apart from the utility-scale projects, much of the clean energy activity that is taking place in Pennsylvania is relies on grants from government or quasi-governmental clean energy programs, or from utility rebate programs. This program landscape is complicated and difficult to navigate for contractors and project developers. Many of the highest-profile clean energy funding programs have depleted their funds. Most of the programs do not benefit from annual recapitalizations as part of the budget appropriations process, and have finite pools of remaining money. Many of the programs operate as revolving loan funds, but in giving away so much of their funds in the form of grants, they reduce their prospects for self-sufficiency. There is very little independent private financing of clean energy projects that are not utility-scale. Nearly all of the capital available for such clean energy projects is from programs that sit in government agencies or quasi-governmental bodies, and generally provide financing on a concessional, rather than market, basis. The list of such programs is deceptively long. Many of the programs have depleted their funds, are underutilized, have geographical or other constraints that limit their activities, have short terms on loans for long-lived clean energy assets, and give most of their funds away as grants.

Though there are many sources of public clean energy funding in the state, the actual capital available for lending to clean energy projects is somewhat limited and tends to be from public sources. Any significant increase in demand for clean energy financing would quickly deplete the available capital.

Figure 56: Capital Sources for Clean Energy in Pennsylvania



*Annual spending in this program fluctuates.
**PENNVEST has committed $3.5m per year for 7 years to the WHEEL program.

Currently, the capital for clean energy projects that is available through these entities is underutilized. Demand for clean energy capital, particularly for loans, is low in Pennsylvania, as is reflected by the low number of applications received by the clean energy financing programs and low annual loan volumes. Few of the clean energy financing programs in Pennsylvania have dedicated marketing efforts. The outreach efforts that do occur are disjointed. Marketing for individual programs that may only serve a specific geography, technology, or market segment only have a limited impact, and add to market complexity. There is a no unitary source of clean energy market information and resources for contractors and end users. Beyond outreach campaigns, various other market development campaigns, such as developing partnerships with contractors or private co-lenders, or offering subsidized technical assistance, could significantly improve outcomes for the clean energy financing programs.

Few Focused, Market-Oriented Products

There are very few focused, market-oriented financial products. KeystoneHELP and PennSEF are two rare examples, and both are suffering from lower than desired uptake. The CFA's Solar Energy Program's new program guidelines have helped push it in the direction of a focused financial product as well. It is worth noting that none of these three programs are private—they all benefit from public capital or public credit.

Figure 57: Sources of Capital for Clean Energy Projects Smaller than Utility-Scale

Program	Institution	Focus	Terms[xxxiv]
KeystoneHELP	Renew; PENNVEST; Treasury	Residential Energy Efficiency	4.99% 10 years
PennSEF	FREE; Treasury	MUSH Energy Efficiency	Prevailing Tax Exempt Bond Rate
Alternative and Clean Energy Program (ACE)	CFA	Clean Energy	US10Y + 2.5% 10 years
Solar Energy Program (SEP)	CFA	Non-residential Solar	US10Y + 2.5% 22 years
Renewable Energy Program (REP)	CFA	Geothermal & Wind	US10Y + 2.5% 10 years
High Performance Building Program (HPB)	CFA	Building Energy Efficiency	US10Y + 2.5% 10 years
Sustainable Energy Fund	theSEF.org	Non-residential Clean Energy – PPL Territory	Case-by-case
West Penn Power SEF	Energy Institute; Energetics, Inc.	Non-residential Clean Energy – WPP Territory	Case-by-case
Sustainable Development Fund	The Reinvestment Fund	Non-residential Clean Energy – PECO Territory	Case-by-case
Penelec SEF	Community Foundation for the Alleghenies	Non-residential Clean Energy – Penelec Territory	Case-by-case
Met Ed SEF	Berks County Community Foundation	Non-residential Clean Energy – Met Ed Territory	Case-by-case
HEELP	PHFA	Low-Income Energy Efficiency	1% 10 years
Clean and Alternative Energy Funding Program	PEDA	Clean Energy	Case-by-case
Green Energy Loan Fund	DEP; The Reinvestment Fund	Non-residential Energy Efficiency	4-5% 15 years

[xxxiv] United States 10 year Treasury Bonds are abbreviated here as "US10Y."

Program Structures that Limit Impact on Market

The regional SEFs were capitalized a decade or more ago, and have had few if any new capital infusions since then. The SEFs now operate as revolving loan funds. Many of the SEFs have low volumes of applications, and give out few loans each year. Many of the SEFs have lending capacity that is underutilized as a result.

Many of the government lending programs, mostly run by the CFA, were capitalized with the Alternative Energy Investment Act of 2008 and have similarly not received additional capital infusions, and some have suffered from low uptake while others have depleted their available funds. Many of these programs operate as revolving loan funds as well.

A fund, or revolving fund, almost by definition play a lighter role in the market than other purpose-built, lending-focused institutions. Though there are certainly exceptions, low loan volumes, concessional lending terms, little or no marketing efforts, and relatively passive management are common in this space. One way revolving funds may seek to maintain their ability to "revolve" is to shorten the terms of the loans they make to increase the speed with which the capital lent out is returned to the fund. The fact that many of the funds in the state deplete their available capital by disbursing so many grants only contributes to the incentive to offer shorter lending terms. Yet this incentive to reduce the length of terms is bad for clean energy technologies, which generally have long expected useful lives and could benefit from financing terms that match the lifespans of the assets. The longer a term is on a loan for a clean energy project, the more likely the project is to be able to pay for the cost of the financing with the savings it produces. Longer lending terms would allow clean energy projects to be seen as cash flow positive investments by the market, rather than expensive pieces of equipment to be paid for over a few years.

Grants and Equity Investments

Many of the clean energy financing programs in Pennsylvania offer several types of financing—grants, loans, and equity investments. Equity investments support companies that may or may not have an impact on the market, and may or may not provide a return for the program that made the investment. The opportunity cost of those investments is high. Grants can play an important role for facilitating the deployment of technologies that are not yet economically viable, providing an incentive to boost demand, or allowing an entity that could not otherwise afford clean energy technology to enjoy the benefits of it. Yet grants do not help promote autonomy and sustainable private sector participation, and in some cases grants may become a crutch for the private sector, which inhibits market growth and development. Furthermore, the lending capacity of many of the programs which operate as revolvers in Pennsylvania is being depleted by their grant-making and equity-investing activities.

The Sunshine Grant program was a big but temporary boost to solar in the residential and small commercial sectors. Many people took advantage of the grant until the money ran out. The solar market deflated when the program ended. Many solar contractors based in Pennsylvania either went out of

business or left Pennsylvania to do business in neighboring states with stronger solar markets. The solar contractors that remain service a small but growing demand for solar in Pennsylvania. Most of the solar projects in the residential and small commercial space are paid for with cash, credit card debt, or home equity financing. Contractors see long-term financing as a means of serving more segments of the market that may not be able to pay for a solar system in cash. Local and regional contractors also desire long-term financing as a means to achieve cash flow positivity for the end-users of the solar system that is financed. Long-term financing is seen as necessary to compete with national installers such as SolarCity that have begun to enter the Pennsylvania market. Though there are many funds across the state that offer financing for solar, some do not accept applications for residential projects, and most offer terms in the 3 to 7 year range, with 10 years being an outlier, which may not allow projects to be cash flow positive for end users.

Many energy efficiency contractors in Pennsylvania are heavily dependent on Act 129 efficiency rebates. Rebates are only available for electric efficiency, so many thermal efficiency measures (which often confer greater savings) are not supported. Every utility has a unique set of rebates, creating a complex patchwork of programs and making it difficult for contractors to work in more than one territory. Utility rebate programs often target low-income households, though the building stock across sectors throughout the state is old and could benefit from efficiency. Much of the potential market for efficiency projects is neglected—most of the people taking advantage of the Act 129 rebates are low-income households, people replacing a single appliance, and wealthy, environmentally-oriented households that can pay in cash. Many households are left out because they are not low-income and cannot pay in cash. Long-term financing to support home retrofits for efficiency would allow efficiency contractors to reach underserved sections of the market. KeystoneHELP allows some penetration into parts of the energy efficiency market, but more financing options for more market segments would facilitate the development of a more robust market for efficiency.

Policies with Potential to Change the Market Landscape

In addition to greater availability of long-term financing for clean energy projects, there are several policies that could change market dynamics in Pennsylvania: a statewide C-PACE program would allow financing to be repaid on property tax bills, on-bill financing programs that would allow financing to be repaid on utility bills, and changing to a “closed-border” system in which only in-state solar projects could provide credits for compliance with the AEPS. PACE and on-bill financing are finance repayment mechanisms that would make it easier for borrowers to repay loans, provide an additional level of security for lenders, and could potentially result in lower costs of capital for clean energy projects. Closing the borders may increase demand for SRECs derived from Pennsylvania-based solar projects, which could improve the economics of solar projects.

Conclusion

There is tremendous clean energy market potential in Pennsylvania. Yet Pennsylvania's clean energy landscape is complex and current programs and institutions are not well-positioned to tap into the market opportunities. Growth in these markets is constrained by two key factors: various information gaps, transaction costs, and learning curves that inhibit demand for clean energy project financing as well as the fragmented and constrained supply and disposition of affordable, long-term capital. Many funds run by government agencies and third-parties provide capital for clean energy projects, yet they generally offer shorter terms, have limited lending capacity that would quickly be depleted in the event of a large increase in demand, have little or no marketing of their programs, and some have a regional focus. These factors contribute to reduced interest and awareness of these programs among contractors and reduced uptake. There is a clear need for a more focused, market-oriented approach to the clean energy investment in the state. Important features of this effort should include market development programs that provide information and resources to all potential market participants, increased lending capacity at terms that are suited to the technologies financed and market conditions, and standard-offer financing programs and products built for volume and turn-key adoption.

[1] Pennsylvania State Profile and Energy Estimates, EIA 2016. http://www.eia.gov/state/?sid=PA
[2] Ibid.

[3] Ibid.
[4] "2014: United-States: PA" Energy Flow Charts, Lawrence Livermore National Laboratory, 2016. https://flowcharts.llnl.gov/commodities/energy
[5] Pennsylvania State Profile and Energy Estimates, EIA 2016. http://www.eia.gov/state/?sid=PA#tabs-2
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