SOLAR SCHOOLS

Context, Lessons, and Recommendations for the School District of Philadelphia

PHILADELPHIA ENERGY AUTHORITY

Philadelphia Energy Authority
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ACKNOWLEDGMENTS

This report was only possible with extensive support. Thank you to staff at the School District of Philadelphia (SDP), who helped us collect the data needed to make appropriate recommendations; the Pennsylvania Solar Energy Industries Association (PASEIA), who provided critical insight into our state's unique regulations and markets; and the time and energy from a variety of private sector solar advisors (listed below), who helped us understand all the possible options for installing and financing solar, as well as the key factors that drive costs down.

Representatives from nine school districts across Pennsylvania participated in phone interviews and contributed photos, sharing their experiences building support for, financing, and installing solar on Pennsylvania schools. The Philadelphia Energy Authority (PEA) is grateful for the contributions of: Bethlehem Area School District, Colonial School District, Carlisle Area School District, East Lycoming School District, Bellefonte Area School District, Great Valley School District, Bald Eagle School District, Quakertown Community School District, and Governor Mifflin School District.

PEA is proud to have brought together this unique coalition of contributors to compile the research and recommendations that follow. Nothing in this report substitutes for a formal procurement process, and should only be used to determine feasibility of pursuing solar at the School District of Philadelphia.

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ABOUT THE PHILADELPHIA ENERGY AUTHORITY

The PEA is a municipal authority focused on energy affordability and sustainability for the City and its residents, and provides support, administration and services to City government on energy-related matters. Learn more at www.philaenergy.org.

In February 2016, under the leadership of Council President Darrell Clarke, PEA launched the Philadelphia Energy Campaign, a $1 billion, 10-year initiative leveraging public and private funds for energy efficiency and clean energy projects in four key sectors: city buildings, schools, low-income residential housing and small businesses. PEA expects to create 10,000 jobs, lower energy costs, reduce our carbon footprint, and stabilize neighborhoods across Philadelphia.

ABOUT THE AUTHOR

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Figure 1: Students visit Crane Arts array with Solar States in North Philadelphia.

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Figure 2: Youth Build students visit solar array in North Philadelphia.

EXECUTIVE SUMMARY

This report by the Philadelphia Energy Authority (PEA) aims to inform the School District of Philadelphia (SDP) about the costs and benefits of rooftop solar photovoltaic systems. This report is drawing on the legacy of past efforts to support the SDP in considering solar, including the 2013 Philadelphia Solar Schools Initiative and the 2016 PennEnvironment Solar Schools Report. By examining case studies from across the state and modeling the cost of solar for 18 Philadelphia schools, the PEA has developed a set of cost estimates for an example solar installation.

PART 1: THE STATE OF SOLAR IN PENNSYLVANIA

- The cost of solar technology has been declining since 2009, making **solar more affordable**.
- The Federal Investment Tax Credit can cut the cost of solar by 30%.
- The Pennsylvania Solar Energy Program provided grants toward several solar installations on Pennsylvania schools.
- The price of Alternative Energy Credits (AECs) in Pennsylvania is very low and therefore they provide a limited subsidy for solar in the state.
- The most common way to finance solar is through a **Power Purchase Agreement** (PPA). Other options include a roof site lease and the Morris Model (which combines a bond and PPA).

PART 2: SOLAR ON PUBLIC SCHOOLS IN PENNSYLVANIA

- At least **14 school districts** in Pennsylvania have successfully installed solar, with a total generating capacity of about 10 megawatts.
- Three-quarters of these installations were completed in 2010 and 2011.
- **Over half of them used Power Purchase Agreements** toward part or all of the cost.
- The amount of educational value added by the installations varied by school district. Successful integration with the curriculum depended on individual teachers' enthusiasm, though at least one district organizes district-wide field trips to view the installation.
- Contacts at many of the featured school districts have volunteered to provide guidance to SDP and PEA. Their contact information is included in the version of this report to be shared with SDP.

PART 3: ANALYSIS OF SELECTED PHILADELPHIA SCHOOLS

- PEA examined a sample of 18 schools and found **all of them to be viable sites for solar**.
- The variables impacting the total cost of going solar include: current electricity costs, projected electricity costs, escalators in the contract, installation and maintenance costs, and subsidies.

PART 4: PROPOSED PILOT PROJECT

- The SDP could save about **$100,000 over 25 years** by installing solar on one school.
- With additional subsidy, these savings will exceed $250,000.

Back of the envelope calculations suggest that installing solar at scale on Philadelphia public schools could save the SDP over $1 million per year. The PEA believes that solar provides significant enough savings, educational value, and environmental benefits to make it valuable to pursue, even amidst other capital needs.

The PEA is prepared to support the SDP in issuing a Request for Proposals or provide other procurement assistance as needed. This support will be particularly valuable in developing a list of qualified bidders and in negotiation and design of project details, including escalators. PEA believes that SDP should incorporate solar into the Energy Pilot projects planned for 2017.

INTRODUCTION

As part of the Philadelphia Energy Campaign, the Philadelphia Energy Authority (PEA) is seeking ways for the School District of Philadelphia (SDP) to advance energy efficiency and clean energy for Philadelphia's public schools. There are already two small-scale solar installations on public schools in Philadelphia, including a 5.3 kW array on Albert M. Greenfield Elementary School and a 2.5 kW array on A. Phillip Randolph High School, both of which were made possible by donations. PEA believes that installing solar at-scale across Philadelphia public schools would reduce costs, advance environmental education, and create local jobs. Additionally, such an installation would contribute momentum to the School District's GreenFutures sustainability goals, provide significant opportunities for Education for Sustainability, and catalyze future investments in clean energy and energy efficiency on other Philadelphia schools and in the city at large.

PEA has issued this report in response to SDP's request for more information about rooftop solar. This analysis builds on the political momentum created by the PennEnvironment Solar Schools for Philadelphia report (released in March 2016) and the subsequent City Council hearing (held by Chairwoman Blondell Reynolds Brown, Councilman Derek Green, and the City Council Environment Committee in April 2016). The following report is organized into four parts.

PART 1

The State of Solar in Pennsylvania provides an overview of the solar market and trends in the state. Pennsylvania's unique regulatory and market factors related to solar are outlined in this section.

PART 2

Solar on Public Schools in Pennsylvania features case studies of other school districts in Pennsylvania that have installed solar on their school buildings.

PART 3

Analysis of Selected Philadelphia Schools includes an analysis of the solar potential for a sample of 18 public schools in Philadelphia, considering an array of financing mechanisms. The methods and findings from this analysis are included here, with proprietary data redacted for public consumption. The assessment considered utility costs, rooftop area, and roof condition.

PART 4

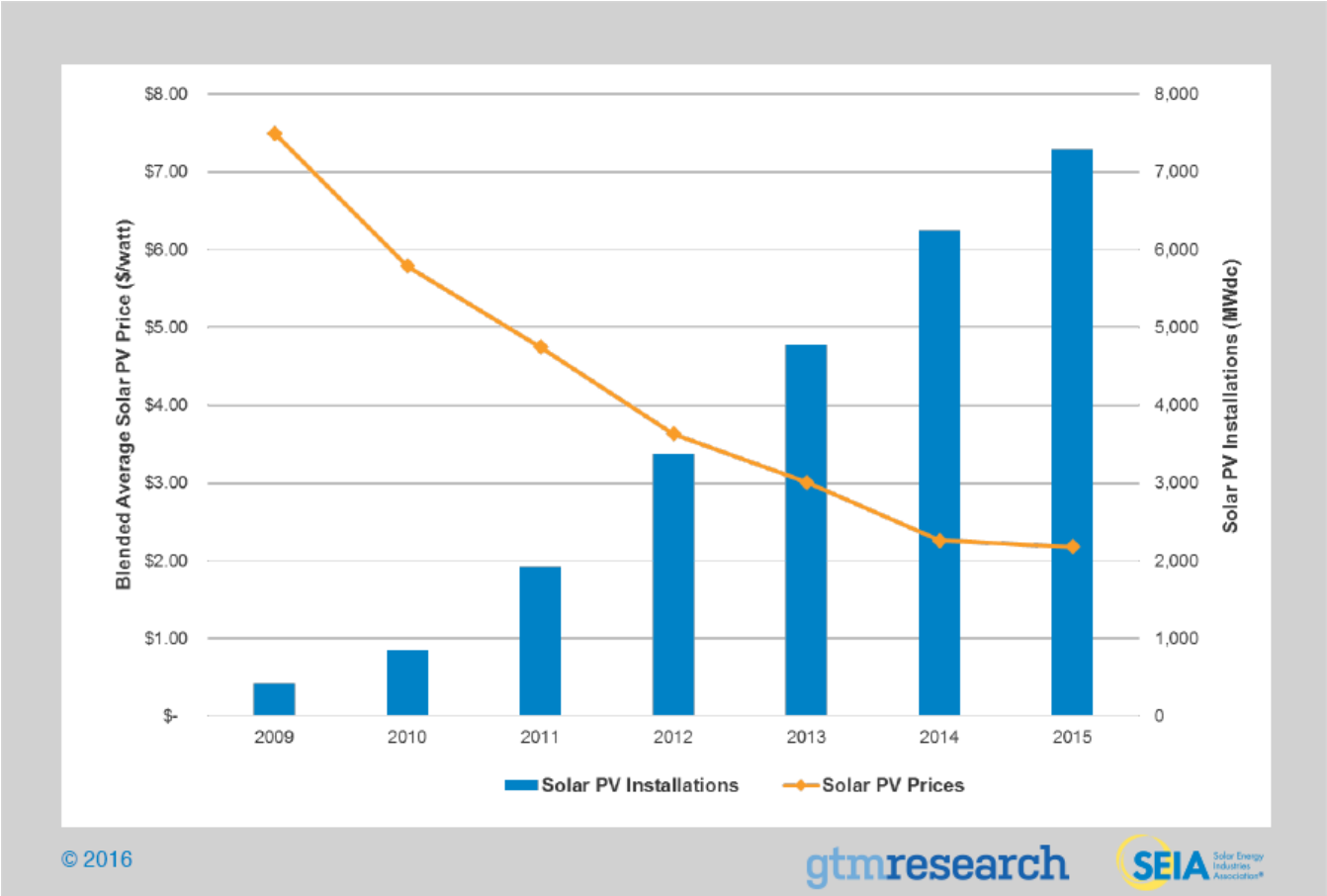
Financing Solar on Philadelphia Schools includes a specific example of the costs of a solar installation on an actual Philadelphia school. A satellite image analysis was performed to confirm shading assumptions. A cash flow analysis of this proposal is included in the appendix.

This analysis contains conservative estimates to ensure that savings meet or exceed these projections in all financial models. All assumptions made in the proposal are clearly delineated. The proposed financing model is intended to be a realistic representation of the cash flow factors at play in an actual SDP pilot solar project. Numbers will be refined as the project is scoped in more detail.

PART 1: THE STATE OF SOLAR IN PENNSYLVANIA

The reality of climate change and rising electricity costs demand a shift toward cleaner energy sources, with solar is a key component. Solar has reached grid parity in many states, and with federal, state, and local incentives- plus advances in solar efficiency in recent years- it is more cost competitive than ever. As shown in the *SEIA chart below*, solar capacity in the US has grown since 2008 as costs have dropped.

Figure 3



FINANCING OPTIONS

Creative financing is essential to expanding access to rooftop solar. While some of the school districts discussed in Part 2 had enough funds to pay the upfront cost of a solar installation, many were unable to afford it. Power Purchase Agreements and Roof Site Leases are two financing options that distribute the cost burden over time, making solar cost-competitive with conventional electricity. Three financing options are discussed below.

Upfront Investment Using Capital Dollars

Some school districts have chosen to invest funds from their capital budget towards part or the whole cost of the solar installation. The Carlisle School District, by opting to take this approach instead of a Power Purchase Agreement (PPA) or grant, has received a 6.8% return on its investment.

Power Purchase Agreements

Many Pennsylvania school districts, especially in recent years, have entered into Power Purchase Agreements (PPAs) with private investors in order to finance solar installation. In a PPA, a private investor pays the upfront cost of the solar installation and owns the array.

The school district signs a contract to purchase the power generated by the solar array from the investor over a specified length of time, typically 20-25 years. Because the school does not take out a loan or provide upfront capital in the PPA model, it is an "off balance sheet" transaction. The investor (or tax equity holder), as owner of the array, is able to sell the SRECs and receive the 30% federal tax incentive (see "Solar Investment Tax Credit" below).

In most cases, the investor increases the price per kilowatt hour of solar electricity over time, through an escalating factor built into the contract. For example, in the East Lycoming School District, the rate that they pay to the investor (PPL Renewable Energy) for the solar energy increases by 3% annually. In other cases, the investor offers the host site a fixed electricity rate over the term of the PPA, without any escalator. As an example, the Colonial Area School District pays a fixed rate of $0.09 per Kilowatt-hour (kWh) while the Bald Eagle School District pays $0.049/kWh.

Roof Site Leases

PEA researched the possibility of a roof site lease as an alternative financing model. Under a site lease, the school district would lease the space on a school's roof to a third-party investor who would install and own solar on the roof. The third-party would pay the school district to lease the space. Like under a PPA, the school district would sign a contract to purchase the power generated by the solar array from the investor. A roof site lease is a less common financing option than a PPA, and PEA could not identify a Pennsylvania school district that has used this model. The unique value provided by a site lease is that the savings from solar are delivered in the form of fixed lease payments.

A NOTE ON FUTURE ELECTRICITY PRICES

When calculating the projected cost savings from installing solar, one must estimate the future costs of electricity provided by the local utility. Some Pennsylvania school districts that installed solar expected the cost of electricity to increase more than it has. With the recent boom in natural gas, electricity costs have remained lower than anticipated. This has meant that the actual savings anticipated from going solar have been lower than expected in some cases. Particularly in the case of a PPA with a built-in escalation factor, if the cost of electricity on the traditional grid drops, then the price paid for the solar energy may surpass conventional electricity. It is possible that a school district in this situation would pay more for the solar energy than power available on the grid, and that was described by at least one school district featured in Part 2.

There are ways to guard against this scenario. For Philadelphia, the U.S. Energy Information Administration estimates our electric prices will increase by 3.53% annually. However, in the analysis to follow, the PEA has taken an even more conservative approach, assuming no increase at all in conventional energy costs over the next 5 years, and a 2.75% annual increase thereafter. Structuring both the electricity cost escalator and the solar PPA rate escalator strategically is critical to creating savings through the project.

Despite the need to hedge a PPA against future energy prices, Pennsylvania school districts have saved millions of dollars from installing solar panels. Additionally, even though electricity prices remain low today, the security of a diversified energy supply protects districts from future cost fluctuations.

GRANT PROGRAMS

Nearly all school district facilities managers interviewed for this report felt that in recent years, government grants available for solar installations have "dried up." Sources of grants that Pennsylvanians have accessed for solar installations since 2008 are listed below.

Pennsylvania Sunshine Solar Program

In 2008, Governor Ed Rendell signed a state law offering a public subsidy for solar installations. The Alternative Energy Investment Act provided a rebate of $1.75-$2.25 per watt of solar installed, depending on the size of the system. This subsidy would cover up to 35% of the installation costs. The state reduced the rebates to $0.25-$0.75 per watt, because of unexpected popularity of the program. Pennsylvania allocated a total of $100 million for this subsidy, which ran out in December 2013. During the time that Sunshine Solar funding was available (from May 2009 to December 2013), over 8,000 solar projects took advantage of the rebate. The Pennsylvania Sunshine Solar program was administered by the Department of Environmental Protection and only home-owners or small businesses were eligible for this funding. School districts could not access this subsidy.

Solar Energy Program

Another subsidy for solar installations was made available by the Pennsylvania Department of Community and Economic Development, through the Commonwealth Financing Authority. The Solar Energy Program targeted those who would not be eligible to receive Sunshine Solar funding, specifically non-profits, large businesses, and public entities like school districts. The Solar Energy Program distributed $80 million towards solar installations throughout the state. This funding was allocated as grants or loans, and provided the lesser of either $1 million per project or $2.25 per watt. The program required matching investment from another source. Many school districts featured in Part 2 took advantage of these grants. The Commonwealth Financing Authority (CFA) reopened this program for applications in November 2016. From the original amount designated for this program, $30 million remains for reallocation to new projects.

Energy Harvest Grant

In 2005, Governor Ed Rendell announced that he would funnel $5.9 million in public funding to diversify Pennsylvania's energy supply. Grants were provided toward clean energy projects, including solar, wind, hydroelectric, biomass, and waste coal. Governor Rendell also aimed to leverage private capital toward clean energy, and provided Energy Harvest funding to projects that already had assembled significant funding. At least two school districts in Pennsylvania received Energy Harvest funds toward solar installations.

Pennsylvania Energy Development Authority (PEDA)

The Pennsylvania Energy Development Authority and Emergency Powers Act in 1982 created PEDA. Through a state executive order in 2004, the Authority was revitalized in order to fulfill its mission of financing clean energy projects in the state. From 2004 to 2014, PEDA provided grants and loans toward various types of alternative energy projects, including solar installations. PEDA disbursed tens of millions of dollars in grants toward energy projects, and also provided loans and loan guarantees.

Pennsylvania Economic Development Financing Authority (PEDFA)

The Pennsylvania Economic Development Financing Authority provides bond financing for clean energy projects in the state. These bonds can also be floated through the Pennsylvania Sustainable Energy Financing Program ("PennSEF"), a new initiative designed to bring bond-financing to energy projects, and may be able to leverage projects from across the state to tap into the best possible bond rates.

American Recovery and Reinvestment Act (ARRA)
A few Pennsylvania school districts shared that they received funding from the federal stimulus package, the American Recovery and Reinvestment Act. Of the $831 billion allocated in ARRA, $3.2 billion was earmarked for Energy Efficiency and Conservation Block Grants. The ARRA 1603 program provided cash payments in lieu of the Investment Tax Credit to cover 30% of the cost of solar installations, even for organizations without a tax appetite. This grant program expired in 2011.

Guaranteed Energy Savings Act
Pennsylvania Act 77 was passed in 2003 and allows for projects to be financed through an Energy Services Company (ESCO) that guarantees the energy savings they deliver. Most often, this mechanism is used for energy efficiency upgrades. However, GESA can also be used to enable solar installations, as was done by the Great Valley School District.

Figure 4: Solar being installed on the Parsippany School District in New Jersey using the Morris Model.

Learning from New Jersey: the Morris Model
The Morris County Improvement Authority pioneered a new model of solar financing, now known as the Morris Model. The Morris Model combines a Power Purchase Agreement with bond financing to further lower the costs of going solar. The Authority issued a bond to pay for the installation of 3.2 MW of solar energy on school and public buildings. The Authority signed a Power Purchase Agreement on behalf of the local units that hosted the solar installations. The Authority is repaying the bond with the PPA payments and sale of the SRECs. Using this model, the Morris County Improvement Authority has installed solar on 12 public schools.

OTHER SOLAR POLICY IMPACTING PENNSYLVANIA

Pennsylvania is also impacted by state and federal policies that reduce the total cost of an installation, listed below.

Pennsylvania Alternative Energy Portfolio Standard (AEPS)

In 2004, Pennsylvania passed the Alternative Energy Portfolio Standard (AEPS), requiring that by 2020, 8% of energy used in the state be sourced from alternative energy sources. The AEPS specified that 0.5% of energy generated come from solar power. Under the current regulations, utilities and electricity generation supplies operating in Pennsylvania must demonstrate that they are meeting this requirement by buying solar renewable energy credits (SRECs) from private owners of distributed solar arrays. By purchasing an SREC, the utility is claiming responsibility for the generation of one Megawatt-hour of solar energy. In 2010, the Pennsylvania SREC market started experiencing an oversupply and the price per SREC dropped from $300 to $7 each. At $7, SRECs are providing only a very minimal subsidy.

Electricity providers in Pennsylvania can currently purchase SRECs from any state in the PJM regional transmission organization territory, so the number of SRECs available on the market already exceed the AEPS policy goal. As a result, the value of SRECs in Pennsylvania has decreased dramatically over recent years, and will not rise without policy change. The state legislature could choose to close the borders on the Pennsylvania SREC market, only allowing alternative energy credits generated in Pennsylvania to be counted toward the AEPS requirements. In this case, the value of SREC's would likely increase significantly. Because improvements to Pennsylvania's AEPS are unpredictable, the proposed financing does not assume any increase in the market value of Pennsylvania SRECs over the next 25 years.

Solar Investment Tax Credit (ITC)

The federal solar investment tax credit was enacted in 2006, and extended in 2015 to cover any projects started before 2024. The policy provides a tax credit worth 30% of the cost of the installation for residential and commercial projects. Non-profits and government entities cannot benefit from a tax credit since they do not pay taxes, but if the solar installed is owned by a private entity, as is the case in a PPA, then the tax credits can be leveraged to reduce the overall cost of the installation.

Modified Accelerated Cost Recovery System (MACRS)

Under the Modified Accelerated Cost Recovery System (MACRS), owners of certain equipment can depreciate that equipment's value over an accelerated timeframe. This allows the investor to access tax deductions faster. MACRS has allocated solar panels a cost recovery period of five years, providing further subsidy to projects.

SREC vs SAEC, a question of semantics

In Pennsylvania, the credits generated by the solar power are called SAECs, which stands for Solar Alternative Energy Credits, instead of Solar Renewable Energy Credits or SRECs, the term used throughout most of the rest of the country. The market for SRECs or SAECs comes from state mandates called Renewable (in Pennsylvania, "Alternative") Energy Portfolio Standards, which require all utility generators to buy a specified percentage of their electricity makeup from renewable or alternative sources. In this report, SAECs are referred to as SRECs, since that is the industry normative term.

Figure 5: The Keystone Solar array is installed in Lancaster, Pennsylvania.

Why do SREC's matter? The potential for above market SREC contracts

When a solar project is developed, the value of Solar Renewable Energy Credits (SRECs) are part of the cost calculation. SRECs can be sold to entities that must meet the AEPS renewable energy requirement or any institution that wants to offset its energy usage. The price of SRECs varies significantly across states, based on the existence and specifics of Alternative Energy Portfolio Standards.

On the Generation Attribute Tracking System (GATS) market, as of December 2016 SRECs were selling in Pennsylvania at $7 each. This contrasts with New Jersey, where SRECs were selling for about $200.

Community Energy Solar employed this strategy to develop the Keystone solar array in Lancaster. The project developer identified willing buyers of the SRECs ahead of time who were willing to make a voluntary, philanthropic commitment to purchasing the SRECs at above market value. Franklin & Marshall College and the Philadelphia Phillies were among the many such sponsors of this 6 megawatt system. The Keystone array was the largest solar array in Pennsylvania when it was installed in 2012.

See: https://communityenergysolar.com/project/keystone-solar/

Figure 6: Micah Gold-Markel of Solar States teaches class about solar energy.

RESOURCES FOR SOLARIZING SCHOOLS

There are resources at the local and national level supporting schools to go solar. Some of these resources are discussed below.

Philadelphia Solar Schools Initiative

In 2013, Solar States, a Philadelphia-based solar installation company, piloted the Philadelphia Solar Schools Initiative (PSSI). Solar States aimed to finance and install 1.5 MW of solar on 20 Philadelphia public schools. Micah Gold-Markel, founder of Solar States, planned to assemble $3.5 million in private investment toward the project. Solar States intended to enter into a PPA with the School District of Philadelphia, providing the solar power at a rate 10-20% less than what they were previously paying. Solar States also planned to provide materials for renewable energy courses to incorporate into the schools' curriculum.

Philadelphians trained at Youth Build Charter School would install the panels as part of a job training program for youth who dropped out of high school. Solar States planned to coordinate a partnership between the GridSTAR Center at the Philadelphia Navy Yard and the YouthBuild program to provide even more educational opportunities for trainees.

Clean Currents committed to purchasing the SRECs from the project at an above-market rate. Originally, other partners included Finanta and SMP Architects.

Solar States intended to involve trainees in developing the detailed proposal for PSSI and to involve students in designing the solar arrays for the roofs of their schools. They started one such class engagement with the Science Leadership Academy in 2013, and lent the curriculum to ultimately design the ongoing YouthBuild solar training program. As of 2014, PSSI was unable to gain the traction needed to move the program forward, but Solar States continues to be engaged in supporting SDP's solar efforts.

National Solar Schools Consortium

The National Solar Schools Consortium is a project of the Solar Foundation. The Consortium aims to provide successful examples and support for schools across the country that are considering installing solar. The Solar Foundation provides free technical assistance to schools considering installing solar, through a grant from the U.S. Department of Energy's Solar Outreach Partnership program. The National Solar Schools Consortium maintains a database of schools with solar through the National Solar Schools Census. As of 2014, they had identified 3,752 schools with solar, 41 of which were in Pennsylvania. The Solar Foundation developed *Steps to a Successful Solar Request for Proposal (RFP)*, a resource to support schools to identify the financier and installer that is the best fit for their district.

Some of the key takeaways from the National Solar Schools Consortium's research include:

- High schools are often superior sites for solar compared with elementary schools because of economies of scale.
- With an increase in school system size, there is an increasing dependence on third-party ownership of the solar, as is the case in a Power Purchase Agreement.
- It is possible to combine bond funding and a PPA through the "Morris Model," which passes capital from a bond to the solar developer, providing them discounted capital, while allowing the project to still take advantage of tax credits because of the private ownership of the array.
- Schools should be aware of whether and how the installation will impact their roof warranty.
- An Energy Services Company (ESCO) can act as the third party in a Power Purchase Agreement and enter into an Energy Services Performance Contract (ESPC) with the school to bundle a solar installation with energy saving measures.

ENERGY STAR

ENERGY STAR is a voluntary program of the Environmental Protection Agency, encouraging energy conservation. Schools with a score of 75 or higher (being in the top 25th percentile of energy efficient users) can apply for ENERGY STAR certification.

US Green Building Council: Center for Green Schools

The U.S. Green Building Council (USGBC) launched the Center for Green Schools to support K-12 schools in advancing sustainable practices. The USGBC describes three components to Green Schools: zero environmental footprint, healthy learning environment, and environmental literacy. The Center for Green Schools provides holistic resources about sustainability practices for schools, including case studies of other schools' green practices. The USGBC also provides a *Guide to LEED Certification*. The local Delaware Valley Green Building Council (DVGBC) supports schools in the Delaware Valley region through their Green Schools Program. The DVGBC supports area schools to apply to be recognized by the Department of Education Green Ribbon Schools program for excellence in sustainability.

PART 2: SOLAR ON PUBLIC SCHOOLS IN PENNSYLVANIA

As demonstrated by the National Solar Schools Census, hundreds of school districts across the country have joined the movement for solar and are reaping the environmental, educational, and economic benefits. Schools are optimally positioned to install solar because of their large, flat roofs and ability to think and act with a long-term perspective. As many schools grapple with under-funding, the savings associated with solar installations can fund other building repairs, energy efficiency programs, student projects and much more. Additionally, schools can use the solar systems as a teaching tool, communicating design and engineering concepts, as well as the global implications of the energy industry- including climate change and the growth of green jobs.

At least 15 school districts across Pennsylvania have already made the choice to install solar, shown in *Table 1*. This is noteworthy because the incentives for solar in Pennsylvania are significantly less than neighboring states, such as New Jersey. It is important to examine school districts operating in more challenging solar policy environments like Pennsylvania in order to provide a realistic model for the School District of Philadelphia's evaluation of solar opportunity. Most of the solar installed on Pennsylvania schools today was installed in 2010 and 2011. With the falling price of SRECs and exhaustion of state and federal subsidies, the quantity of solar installed on schools fell dramatically after 2011, as seen in *Figure 6*.

These school districts used some combination of upfront investment with capital dollars, a Power Purchase Agreement, and grant funding in order to pay for solar. As can be seen in *Figure 7*, districts often combined two or more of these options in order to pay the full cost of the installation. As grant programs were exhausted in 2011, Power Purchase Agreements (PPAs) took on an even more significant role in the financing of solar installations in Pennsylvania.

Table 1: Pennsylvania School Districts with solar installations

YEAR	CASE STUDY	SYSTEM SIZE (KW)
2010	Carlisle	1,200
2010	Great Valley	131
2010	Bellefonte	675
2011	Dallastown	506
2011	Colonial	704
2011	East Lycoming	600
2011	Bald Eagle	930
2011	Upper Nazareth	574
2011	Governor Mifflin	583
2011	Bethlehem	1,600
2012	Lower Moreland	575
2012	Phoenixville	252
2013	Upper Nazareth	600
2016	Quakertown	500
	Total	**9,430**

Figure 7

SOLAR INSTALLED ON PA SCHOOLS

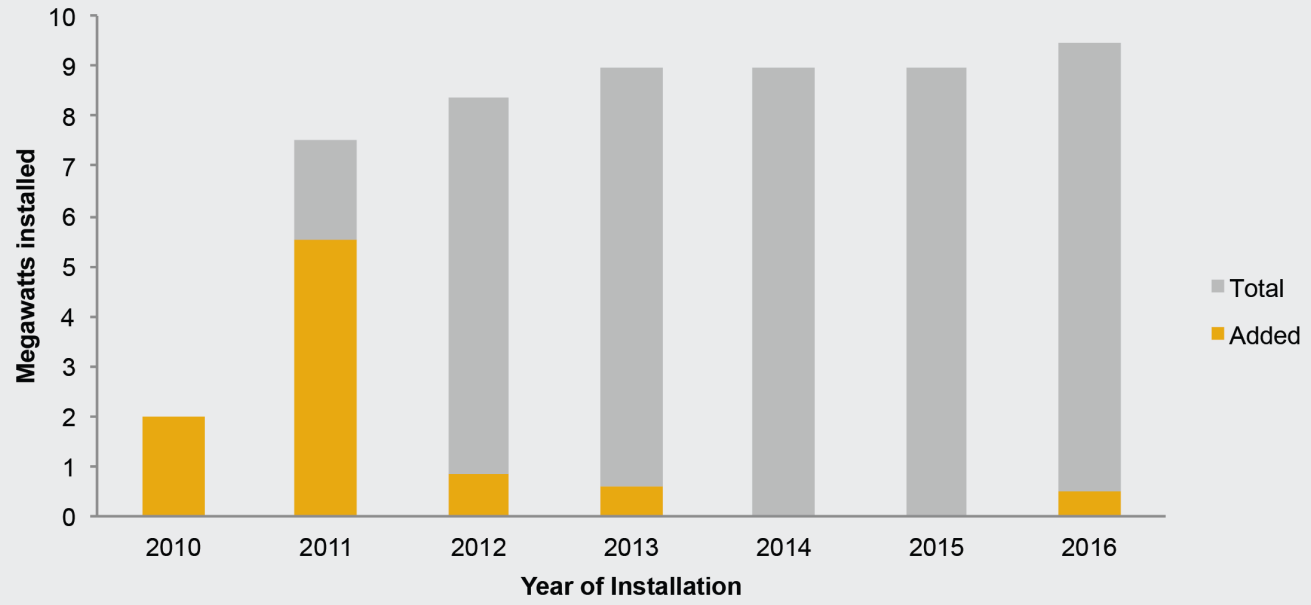
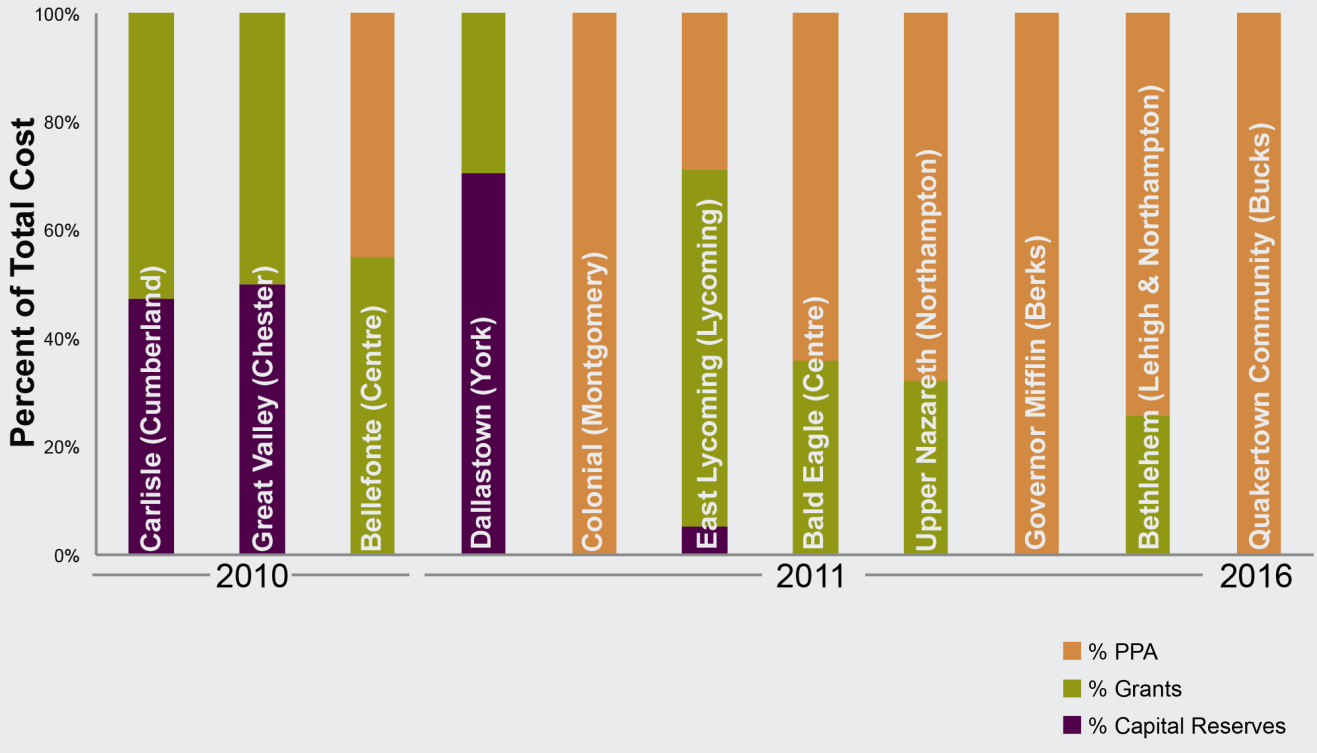


Figure 8

SOLAR FINANCING ON PA SCHOOLS



METHODOLOGY

This report examines a sample of the solar school districts in Pennsylvania. It does not include private or charter schools. Data was collected from online sources and phone calls to the school districts' facilities departments. In cases when the relevant Director of Facilities expressed willingness to serve as a contact and resource for the School District of Philadelphia, their contact information is included for SDP purposes only.

Figure 9: Bethlehem School Solar

Figure 10: Bethlehem School Solar

SCHOOL DISTRICTS WITH SOLAR INSTALLATIONS

BALD EAGLE SCHOOL DISTRICT, CENTRE COUNTY

767 kW | $3.9 million | PPA, grant

In 2011, the Bald Eagle School District installed roof-mounted solar arrays on the Wingate Elementary School and Bald Eagle Middle-High School. The 767 kW solar was installed following a $26 million renovation project on the schools, which included roof replacement. Solar supplies 50% of the district's total electricity needs.

Financing

The district paid none of the $3.9 million total cost of the installations upfront, instead financing the full cost with a 20-year PPA with Smart Energy Capital. Smart Energy Capital applied for and received a $1.4 million Pennsylvania Solar Energy Program grant to use toward the Bald Eagle installations. The grant amount was calculated at $1.84/watt of solar installed. The PPA contained a fixed electricity rate of $0.049/kWh over the course of the 20-year agreement. Smart Energy Capital contracted with Ray Angelini Inc. to do the installation. In 2013, Smart Energy Capital was purchased by NextEra Energy Resources.

Figure 11

BELLEFONTE AREA SCHOOL DISTRICT, CENTRE COUNTY

520 kW | $4 million | PPA, grant

In 2010, the Bellefonte Area School District installed 520 of solar panels on three of the district's six schools. The installations generate 20% of the power used by the Bellefonte Area High School.

Financing

The school district financed all of the $4 million cost of the installations through a Power Purchase Agreement with Smart Energy Capital. Smart Energy Capital took advantage of a $2.2 million state Solar Energy Program grant to cover part of the upfront cost of the installations. The school district started out paying the investor $0.0466/kWh for the solar power, though the 2% escalator built into the contract means that that cost will rise to $0.07 by 2030. Aaron Barto in the facilities department observed that their PPA has been bought and sold several times, such that they have made their payments to different investors over time. However, the terms of the contract have remained consistent.

Production & Savings

The school district is saving approximately $13,000 per year, or $260,000 over the course of the 20-year contract. The Bellefonte Area School District will have the option to buy the solar array at the end of the contract.

Education

Each of the three schools has a screen displaying real-time weather data and the electricity produced by the solar array.

BETHLEHEM AREA SCHOOL DISTRICT, LEHIGH AND NORTHAMPTON COUNTIES

1.6 MW | $7.1 million | PPA, grant

In 2011, the Bethlehem Area School District installed solar on five of the district's 22 schools. The size of the photovoltaic systems varied from school to school. A parking lot solar canopy provides 9% of Freedom High School's electricity needs, while a ground-mounted installation provides 95% of the electricity used by Farmersville Elementary School. One of the ground-mounted arrays is over top of a water detention basin, land that would not be otherwise suitable for development. Hesitations about vandalism of the parking lot canopy proved unfounded.

Financing

The installation of 1.6 MW of solar power across the five schools was made possible by a $1.84 million grant from the Solar Energy Program. For the remainder of the $7.1 million cost, Tangent Energy Solutions, the installer, identified a third party investor who arranged a PPA that bundled all five schools, reducing financing costs. The school district pays a fixed rate of $0.09/kWh for this solar-generated electricity over the term of the PPA. The Bethlehem Area School District expected to save $1.6 million over the course of the 20-year PPA.

Production & Savings

Though the current energy production of these systems is consistent with the original predictions, the cost savings have been less than anticipated. The PPA had assumed that the price of energy would rise, but instead it has fallen. Therefore, compared to utility rates, the school district is paying more per kilowatt to the investor for the electricity generated by the solar. The district had been planning to install even more solar in a second phase (approximately 2 more MW), but without more state grant money available, the School Board put that plan on hold. Though there are benefits to budget stability over time, the school district has not been able to achieve the economic savings they expected.

Education

Each of the five schools has an educational kiosk displaying real time data about the solar array's production. Some teachers have successfully integrated the solar arrays into their curriculum, for example having students graph the amount of carbon emissions that has been avoided as a result of the installation.

Other Energy Projects

The district simultaneously worked with Tangent Energy to complete energy efficiency improvements on district schools including, lighting improvements, and an electricity demand response and peak management program, which reduces electricity consumption during peak times and on particularly hot days. From 2010 to 2014, these improvements alone have saved the district over $6 million. In recognition of this district's pioneering work, the Environmental Protection Agency deemed the Bethlehem Area School District an ENERGY STAR leader in 2013. As of 2014, 16 of the 52 Pennsylvania schools that received ENERGY STAR Certification were in the Bethlehem Area School District.

Figure 12

CARLISLE AREA SCHOOL DISTRICT, CUMBERLAND COUNTY

1 MW | $4.4 million | paid upfront, grants

In 2010, the Carlisle Area School District installed a 1 MW ground-mounted solar panel array. The solar provides about 16% of the district's ten schools' total electricity needs. At the time of its installation, this array was the largest installed by a school district in Pennsylvania. The electricity usage of two of the schools, the Bellaire and Hamilton Elementary Schools are entirely offset by the solar. The system is experimental in that it includes five different types of solar technology, allowing the students to study the differences.

Financing

The school district paid $2 million of the $4.4 million total cost of the installation out of capital funds. The remainder of the cost was paid for with state grant money from the Pennsylvania Department of Environmental Protection, the Pennsylvania Energy Development Authority, the Commonwealth Financing Authority, and Act 129 funding. The Carlisle Area School District also received an American Recovery & Reinvestment Act, Section 1603 ITC grant. The school district expects to save $3 million in electricity costs over 20 years.

Production & Savings

The system was estimated to produce 1 MWh annually but has produced more energy than expected, up to 1.4 MWh per year. The district has seen a 6.8% return on that investment. However, the devaluation of SRECs in Pennsylvania negatively impacted the payback. The district was interested in installing an additional 2 MW but without grant money available, decided against it.

Other Energy Projects

The Carlisle Area School District set out in 2006 to reduce energy costs by 50%, and has effectively achieved that goal. The district started out by performing energy efficiency upgrades, improving the HVAC system, installing LED lighting, and installing motion sensors.

Figure 13

COLONIAL SCHOOL DISTRICT, MONTGOMERY COUNTY

703 kW | $2.1 million | PPA, grant

In 2011, the Colonial School District installed 703 kW of solar on three of the seven district schools. On bright days, the solar arrays provide nearly 100% of the power used by Colonial Middle School. The Colonial School District pursued energy efficiency measures alongside the solar installation, providing a model of a well-rounded energy project.

Financing

The Colonial School District paid nothing upfront for the installation and funded one-third of the total $2.1 million cost with grants from the state. Tangent Energy Solutions identified a third-party investor who paid the remainder of the cost. The Colonial School District then signed a 20-year PPA with Tangent, at a fixed electricity rate of $0.08/kWh for the length of the contract. The Colonial School District expected to save $2 million over the course of the 20-year PPA.

Production & Savings

The Colonial School District solar panels have produced more energy than expected. However, economic savings have been lower than anticipated because the school district assumed that conventional energy costs would rise significantly over coming years. The cost of conventional energy ended up being comparable to or even below the $0.08/kWh rate that the School District was paying for solar energy through the PPA, eliminating much of the anticipated savings. This demonstrates the importance of the escalators built into any contracts related to the future costs of energy.

Education

Tangent Energy Solutions has visited Plymouth Whitemarsh High School to speak about green energy at the district's Girls in Technology program. An online monitoring system allows students to track production of the panels. Each of the three schools has flat screen monitors displaying real time data about the panels' production. The science department teachers have had students perform calculations based on the panels' energy outputs.

Other Energy Projects

The Colonial School District also replaced lighting overtime by investing the savings from more efficient lighting from one year into additional replacement lighting the next year. The district also replaced their boilers with new efficient gas boilers and introduced motion sensor controls lighting. Tangent Energy Solutions installed energy efficiency improvements alongside the solar installation, including a demand response program. From these energy conservation measures combined with the solar installation, the district reduced the amount of electricity they buy off the grid from 9.5 million kWh/year in 2002 to 5.2 million kWh/year in 2016.

Figure 14

DALLASTOWN AREA SCHOOL DISTRICT, YORK COUNTY

506 kW | $3.4 million | paid upfront, grant

In 2011, the Dallastown Area School District installed roof-mounted solar panels on the Dallastown Area Middle-High School building. By installing solar, the district aimed to diversify its energy supply and reduce air pollution and greenhouse gas emissions. The installer Ray Angelini Inc. used union labor, and the installation was completed evenings and weekends so as to not interrupt the school's daytime activities.

Financing

The school district owns the 506 kW array outright. The district paid $2.4 million of the $3.4 million total cost of the installation out of their capital reserves. The remainder of the cost was paid for with a $1 million Solar Energy Program grant.

Figure 15

EAST LYCOMING SCHOOL DISTRICT, LYCOMING COUNTY

600 kW | $3.4 million | paid upfront, PPA, grants

In 2011, the East Lycoming School District installed a ground-mounted solar array. The 600 kilowatt array provides 50-60% of the energy used by the Hughesville High School.

Financing

The school district financed the array through a combination of an upfront payment, grants, and a Power Purchase Agreement. The East Lycoming School District paid $200,000 of the $3.4 million cost of the installation. The district received $2.5 million in grants from the Commonwealth of Pennsylvania and the American Recovery Reinvestment Act 1603 ITC grant. PPL Renewable Energy paid the remaining 40% of the cost, and entered into a PPA with the district. Over the course of the 25-year contract, the East Lycoming district will purchase the solar power being produced from PPL. The contract has a built in escalator, such that the cost per kilowatt will increase by 3% annually. For the portion of the array that the school district owns, the district was able to secure a fixed rate for the SRECs of $237 each for 8 years.

Production & Savings

The SRECs and electricity produced from the solar saved the district nearly $1 million in 5 years.

Education

High school and elementary classes visit the solar array on field trips. The school district also hosts visiting groups from elsewhere who come to learn about East Lycoming's ambitious initiatives.

Other Energy Projects

This solar installation built on a multi-year partnership between the district and PPL. PPL had already served as the district's Energy Services Company (ESCO) for multiple energy efficiency improvement projects. The district had replaced lighting, improved the HVAC system, and installed a biomass-fueled boiler. As part of an overall effort to diversify their energy sources, the East Lycoming School District also installed geothermal heating systems at two of its schools. As a result of their wide-ranging initiatives, all of the East Lycoming schools are ENERGY STAR certified.

Figure 16

GOVERNOR MIFFLIN SCHOOL DISTRICT, BERKS COUNTY

583 kW | PPA

In 2011, the Governor Mifflin School District installed 583 kW of solar panels across three of the district's schools. The installation powers 11% of the school district's electricity needs.

Financing

The school district did not contribute any capital reserves toward the initial cost of the solar installation. Instead, they entered into a 25-year PPA with UGI Performance Solutions. The district pays UGI a fixed rate of $0.09/kWh for the electricity generated by the panels. At the time of the installation, the district expected to save $800,000 over the course of the contract.

GREAT VALLEY SCHOOL DISTRICT, CHESTER COUNTY

131 kW | $1 million | paid upfront, grants

In 2010, the Great Valley School District installed a solar array on the Great Valley Middle School. The 131 kW array provides up to 25% of the power used by that school.

Financing

The total cost of the system was $1 million. The school district paid half of the upfront cost ($500,000) from their capital reserve. The district made up the remainder of capital needed from a $500,000 Pennsylvania Energy Harvest Grant. The school expected to save $80,000 per year, making $1.2 million over 15 years because of this investment.

Production & Savings

The school expected to pay back their investment in six years, however the panels have not yet paid for themselves as of 2016. Savings have been lower than anticipated because of the falling value of SRECs. Even with lower savings than anticipated, the district is glad to have a more diversified energy supply as a hedge against fluctuations in the conventional electricity market.

Education

A 2015 news article described that students in the middle school perform calculations with the solar data. However, apparently, teachers have integrated the panels into the curriculum less than anticipated.

Figure 17

QUAKERTOWN COMMUNITY SCHOOL DISTRICT, BUCKS COUNTY

500 kW | PPA

In 2015, the Quakertown Community School District installed solar as part of $7.1 million renovation project at the Quakertown Community High School. The roof-top installation used innovative technology by tenK Solar which includes reflectors, increasing energy yield by 20%. This 500 kW array provides 50% of the high school's energy needs.

Financing

Moore Energy, the installer, recruited a third-party investor and tax equity holder who paid the full upfront cost of the installation. Through a PPA, the Quakertown Community School District makes monthly payments to the investor in exchange for the clean power, and the investor is able to take the federal investment tax credit which covers 30% of the cost.

Production & Savings

The price per kWh built into the PPA is lower than the local utility's price, such that the school district expects to save $1.5 million over the next 20 years. After the 20-year PPA expires, the Quakertown Community School District will own the panels and meet half of the high school's electricity needs free of charge.

Other Energy Projects

Other renovations pursued alongside the solar installation included geothermal heating and LED lighting.

Figure 18

OTHER SOLAR SCHOOL DISTRICTS IN PENNSYLVANIA

CENTRAL BUCKS SCHOOL DISTRICT, BUCKS COUNTY
30 kW

LOWER MORELAND SCHOOL DISTRICT, MONTGOMERY COUNTY
575 kW | grant

PHOENIXVILLE AREA SCHOOL DISTRICT, CHESTER COUNTY
252 kW | $1.2 million | paid upfront, grant

UPPER NAZARETH TOWNSHIP SCHOOL DISTRICT, NORTHAMPTON COUNTY
1.2 MW | $3 million | grant

Figure 19

SCHOOL DISTRICTS CONSIDERING SOLAR

COATESVILLE AREA SCHOOL DISTRICT, CHESTER COUNTY

In 2012, the Coatesville Area School District was considering installing a 7.2 MW ground-mounted solar array. The local Coatesville Solar Initiative formed to advocate for and finance the solar installation. However, because of concerns about 25-year PPAs (which, at the time, were not as common as they are now) and other issues, the district did not move forward with the project. Keares Electric is currently working with the Coatesville Area School District to develop a new solar installation proposal.

MOON AREA SCHOOL DISTRICT, ALLEGHENY COUNTY

In 2014, the Moon Area School District began considering proposals for solar installations on district schools. The district is determined not to take on additional debt, so is considering a 20-year PPA. The district has been considering a partnership with Keares Electric to arrange the installation and financing. They have not moved forward yet.

SCHOOL DISTRICTS THAT DECIDED AGAINST SOLAR

STROUDSBURG AREA SCHOOL DISTRICT

In 2010, the Stroudsburg Area School District planned to install an 11 MW solar farm to power their school system. If installed it would have been one of the largest such projects in the state. The project was to be financed by a PPA with a company called Energy in the Bank and through SREC sales. Due to delays with the investor and the falling price of SRECs, the project did not move forward.

NESHAMINY SCHOOL DISTRICT

In 2012, the Neshaminy School District considered a proposal to install 3.36 MW of solar at the Maple Point Middle School and Neshaminy High School. The arrays would be distributed on the two buildings' roofs and as a canopy over the school bus parking lot. The solar would have covered 90% of the school district's electricity use. The district was not planning to pay any of the $15 million cost upfront, but rather to contract through Tremco with an investor through a 20-year PPA and to leverage state funding through the Solar Energy Program. Republican Senator Tommy Tomlinson was supporting the school district to apply for grants toward the project. PEA was not able to connect with anyone at the district or Tremco to learn more about why it did not move forward.

CARBON COUNTY SCHOOL DISTRICT

In 2011, the Carbon County School District considered installing solar at the Panther Valley High School. The district was considering applying for $1 million from the state Solar Energy Program, but decided not to move forward when the school board voted against paying a consultant to complete the application. The grant would have covered a quarter of the total $4 million cost of the proposed installation.

PART 3: ANALYSIS OF SELECTED PHILADELPHIA SCHOOLS

In response to SDP's request for a more detailed financial analysis about rooftop solar, the PEA conducted a study of the potential costs and savings that would result from installing solar on school buildings. PEA conducted an analysis of the solar potential for a sample of 18 public schools in Philadelphia and considered an array of financing options. Based on this analysis, PEA developed financing models for a hypothetical 500 kilowatt array on a typical school.

METHODOLOGY

School Selection

PEA evaluated 18 schools as potential host sites for solar panels, though PEA recommends a more extensive selection process for identifying those most suited for a solar pilot. See *Figure 21* for the list of the 18 schools included in this analysis. These schools were chosen based on the size and quality of their roofs, from a list provided by SDP's Director of Capital and supplemented with additional research. This list contained the schools with roofs approximately 50,000 square feet or larger so that installations would reach economies of scale, and those with roofs that were recently replaced or in good condition. Solar companies prefer to install PV equipment on new roofs in order to avoid the need for roof replacement while the solar is on the roof. However, it is worth noting, that many operations and maintenance (O&M) contracts include the cost of removing the array, in the case that roof work is needed. To keep costs low, roofs that are relatively new are ideal candidates for solar. Therefore, despite their smaller roof surface areas, PEA also considered schools with roofs that have recently been replaced or are slated for immanent replacement.

Evaluation of Solar Potential

PEA then consulted with eight solar financers and developers from the private sector for their assessment of the feasibility of installing solar on these 18 schools. PEA chose to contact a variety of company types, ranging from solar aggregators to ESCOs, companies that specialize in institutional projects and local firms, even roofing materials companies who have recently entered the solar finance business. This range of sources allowed for comparisons across different estimates to identify accurate, competitive cost and draw broader conclusions about industry averages and norms. Each partner provided new ideas and different, thoughtful approaches to the analysis.

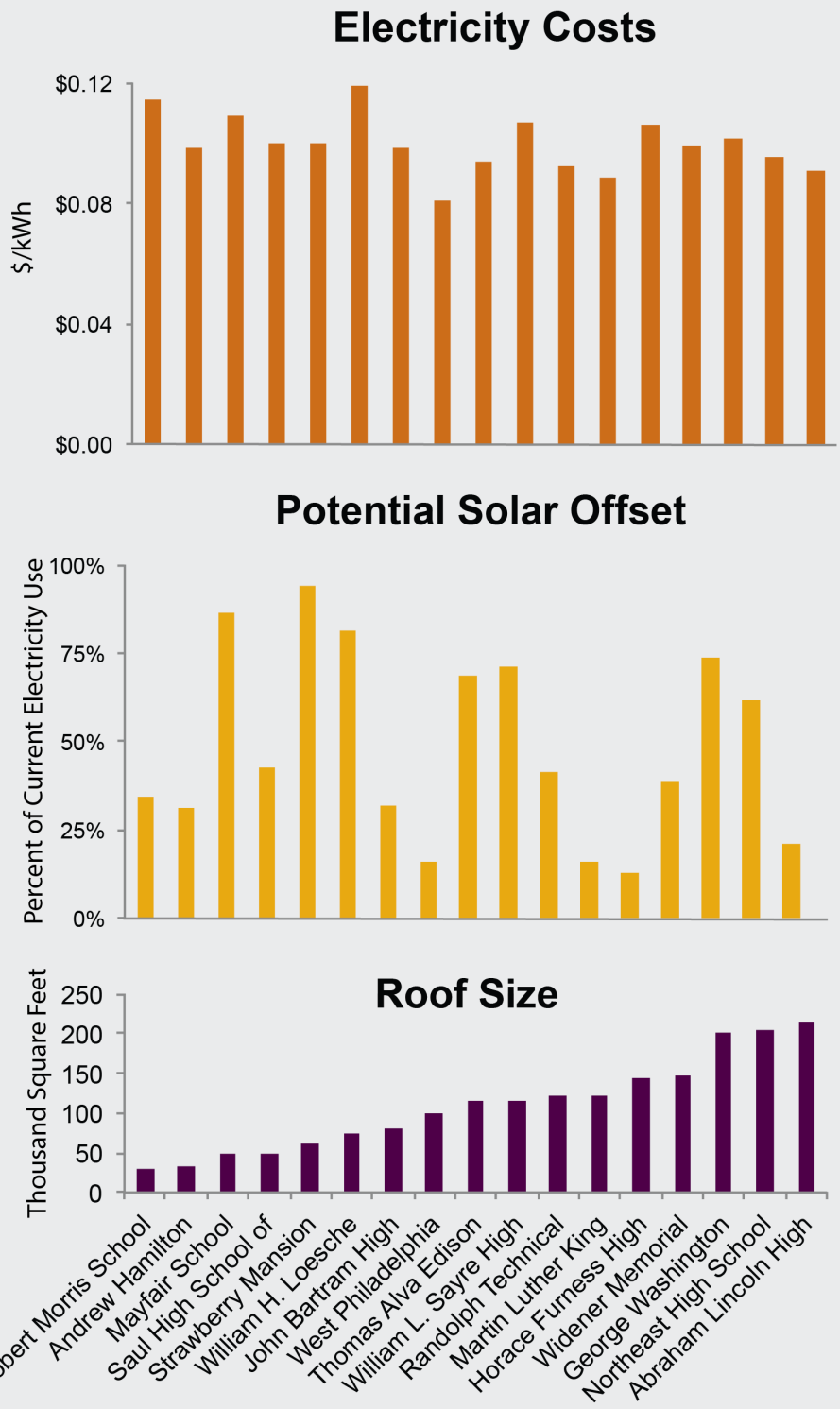
The solar industry representatives who contributed to this report examined the school roofs using Google Earth and provided estimates of the number of solar panels that could fit and how much energy they would generate on each site. Site visits would confirm this analysis and identify shading or rooftop obstacles that might affect the size of the proposed system or viability of the site.

Evaluation of Financing Options

To evaluate the possible financial impact of solar installations on these schools' energy bills, PEA calculated their current electricity rates using a bundled utility rate taken from a sample month of electric bills from each school, provided by SDP. PEA also asked each consultant to propose financing options. Based on SDP's preference for off-balance sheet financing, PEA did not consider financing options that involved debt, such as Clean Renewable Energy Bonds (CREBs). PEA focused on the two financing approaches that are require no upfront payments by SDP: a Power Purchase Agreement and a Roof Site Lease.

Figure 21

PHILADELPHIA SCHOOL SELECTION



FINDINGS

Solar Potential

PEA received feedback that all 18 schools are potential sites for solar, given the unobstructed sun reaching their roofs. The private sector consultants who donated their time to the project proposed installations ranging in scale from 1.4 MW on a single school to 8.9 MW across all 18 schools. The proportion of electricity usage that would be offset by projected solar generation ranged from 13% to 86% of each school's total consumption.

PECO is required to net meter distributed solar energy, crediting customers for the energy they are supplying onto the grid. Third-party electricity suppliers are not required to credit their customers' bills with any solar energy they are feeding onto the grid. Since SDP is currently buying their electricity from a third-party, SDP would need their consent to net meter the energy produced on site from solar or to begin supplying solar schools' electricity through PECO.

Financing Options

SDP could use either a Power Purchase Agreement (PPA) or roof site lease to finance solar on public schools without accruing debt. Under both of these structures, a third-party would own the solar array on the roof of the school. SDP would commit to buying the power generated by the solar panels from the third-party for a set length of time through monthly payments. The quantity of solar energy generated would be deducted from the host school's monthly conventional electric bill through net metering. SDP would pay their conventional supplier for any electricity usage not covered by the solar energy. Under both a PPA and a roof site lease, the cost of the solar power is predetermined for the full length of the contract.

PPAs are generally structured such that the initial cost per kilowatt hour of solar power is lower than what the host site is currently paying for electricity. Thus, to accrue savings under a PPA, the SDP must buy the solar energy at a lower rate than they would have paid for electricity purchased on the competitive market.

A Roof Site Lease is a variation of a PPA, but the electricity price is determined by the estimated cost of conventional electricity. Through a Roof Site Lease, the third-party makes payments to the host site in exchange for use of the roof space. Savings from going solar, under a roof site lease, are typically delivered through these lease payments rather than reduced energy costs, and are usually received once a year. Roof Site Leases are generally structured such that the cost per kilowatt hour of the solar power is equal to what the host site would have otherwise paid for that electricity. See "Projected change in electricity costs" below for more discussion of how retail electricity prices impact savings from solar energy.

VARIABLES AFFECTING COSTS AND SAVINGS

There are many variables that can impact the costs and savings generated by going solar, including current and predicted electricity costs and subsidies.

Current electricity costs

SDP is currently paying between $0.08 and $0.12 per kWh for electricity at these eighteen schools. Because these costs are already relatively low, it is challenging to achieve savings by going solar without additional subsidies. Solar tends to be most cost competitive in areas where the cost of electricity is at or above $0.15/kWh as of 2016, such as in Connecticut where the cost is of electricity for commercial buildings is at $0.16/kWh. In places where there is a lower cost of electricity, such as in New Jersey where commercial customers pay $0.12/kWh as of 2016, solar thrives due to public subsidy. In the case of New Jersey, a robust SREC market makes solar viable.

Projected change in electricity costs

When calculating the price of the solar electricity under a PPA or roof site lease contract, the savings are dependent on the anticipated cost of conventional electricity. Solar financers include an estimate of the future changes in conventional electricity costs in their calculation of anticipated savings. Since 2005, electricity costs have been rising in Pennsylvania. Recognizing this, many PPAs include a rate escalator. This escalator is determined in relation to the utility rate escalator, in an attempt to ensure that the costs of the solar energy through the PPA remain lower than conventional energy. However, in some contracts, the PPA costs have risen above conventional energy costs, eliminating any anticipated savings. This demonstrates the importance of an accurate or at least conservative utility escalation rate.

The initial proposals PEA received included a PPA annual rate escalator of 2-3%, and a comparable assumed utility escalation rate. To triangulate the projection that conventional electricity rates in Pennsylvania will increase 2-3% annually over the coming years, PEA consulted the Energy Escalation Rate Calculator that the Department of Energy developed based on data from the Energy Information Administration (EIA). The DOE calculator produced an estimated annual nominal escalation rate of 3.53% for Pennsylvania for the next 25 years (2017 to 2042).

In an effort to be as conservative as possible, and recognizing that the natural gas boom in Pennsylvania has driven utility costs down rather than up, PEA assumed no utility price escalation in years 1-5, and a 2.75% escalation rate thereafter. For the PPA rate, PEA structured the proposed model to contain a fixed rate in years 1-5, with 1% annual escalation for the next 10 years and 1.5% annual escalation for the remaining 10 years of a 25-year PPA.

Installation and Maintenance costs

Initial cost estimates ranged from $1.60 to $3.00 per watt of solar installed ($1.7 million to $3 million per MW of solar). This rate depends on the cost of labor and equipment, as well as legal fees associated with drafting the terms of the contract. There is precedent for an installation cost of $1.60 per watt in Philadelphia. PEA would bring together the necessary partners to achieve this affordable installation rate. A cost of $1.60 per watt of installed solar translates to a cost of solar energy starting at $0.095 and increasing to $0.125/kWh over a 25-year term PPA, slightly below the current and anticipated prices of conventional electricity for SDP.

The estimates included in this pilot proposal include maintenance, insurance, installation, legal fees, and operating costs. Maintenance for solar panels is minimal, and those costs would be built into any PPA so that SDP is not required to make any additional payments to keep the array operational.

Subsidies

These cost projections are already including the federal Solar Investment Tax Credit (ITC) subsidy. The private third-party owner of the solar equipment would receive this tax credit (cutting the cost of the installation by one third) and pass on a portion of those savings to the SDP. Accessing this subsidy is not possible if the owner of the solar array is a government or non-profit entity, which is why private partners are typically engaged.

Recognizing that the cost projections currently provide limited savings to the SDP, PEA investigated another potential sources of subsidy: above-market SRECs. As discussed in Part 1, the SREC market has collapsed in Pennsylvania such that the AEPS is no longer providing a significant subsidy for solar installations. Upon the recommendation of one of the consultants, PEA investigated the possibility of selling the SRECs from the solar generated on Philadelphia public schools at above market value. If a philanthropic buyer purchases the SRECs from solar on public schools over a several-year contract, the SDP would see more savings from going solar.

PEA has approached the University of Pennsylvania about purchasing above-market SRECs from this project, though no formal agreement has been made. Penn is a Load Serving Entity (LSE), meaning that they must comply with the AEPS, and they purchase SRECs annually for this purpose. Penn is required to buy SRECs to offset 0.2933% of the power they use as of 2016, and will be required to offset 0.5% by 2020, as discussed in Part 1. Penn prides itself in going above and beyond this requirement, voluntarily purchasing additional renewable energy credits (note that these are RECs, which include any type of renewable energy, as differentiated from SRECs which are just representing energy generated by solar). As of 2015, Penn was buying voluntary RECs to offset 51% of the university's electricity needs. The EPA recently recognized Penn for exceeding the other Ivy League schools in its commitment to purchasing green power offsets.

Though Penn's REC costs would increase, PEA believes there is a strong argument to be made for Penn to buy a portion of its RECs from solar energy generated on school roofs. This partnership would provide an opportunity for Penn to engage their students, support the community and strengthen their local sustainability commitment. Currently, most of the RECs that Penn purchases annually are sourced from wind power produced in other states. If Penn or a similar institution were to agree to buy the SRECs from SDP projects at $30 each, the PPA rate could be reduced to $0.08/kWh, delivering 15% in energy cost savings annually.

As discussed in Part 1, the Pennsylvania Solar Energy Program reopened in November 2016 to distribute $30 million in remaining funds. Grants or loans through this program could provide an additional subsidy to an SDP pilot project.

PART 4: SOLAR ON PHILADELPHIA SCHOOLS

The Philadelphia Energy Authority proposes that the SDP install solar on three schools as part of SDP's Energy Pilot Project to demonstrate feasibility and gain experience with on-site clean energy generation. This section provides the actual cost estimates for an installation on a single example school. The numbers included are based on one of the 18 schools included in Part 3, to provide a realistic sense of the expected costs.

According to this analysis, SDP could install a 500 kW solar array on the roof of a pilot school. Such an array would generate approximately 600,000 kWh of electricity each year. This analysis includes a 0.5% annual degradation rate in the amount of power produced by the array, to accommodate for reduced efficiency with the age of the solar panels. A list of the specific assumptions underlying the $1.60/watt cost estimate and the escalation rates are delineated in Appendix A.

FINANCING OPTIONS AND EXPECTED SAVING

PEA evaluated two options for financing a 500 kw solar installation on a public school: a Power Purchase Agreement and a Roof Site Lease. PEA also considered how two different SREC sale prices would impact savings: the market rate value of SRECs ($7/MWh) and a subsidized value ($30/MWh). The outcomes from this analysis indicate the savings estimates over the course of a 25-year contract, assuming that the retail price of conventional electricity stays stable for the first 5 years and rises by 2.75% per year thereafter. Table 2 shows the total and present value of the savings over a 25-year period. See Appendix B for tables of projected cash flows under each of the four scenarios.

For both of the PPA scenarios, the price/kWh of solar energy would be a fixed rate in years 1-5, with 1% annual escalation for the next 10 years, and 1.5% annual escalation for the remaining 10 years. Under a 25-year PPA with SRECs selling for $7 each, SDP would start off paying $0.095/kWh for the approximate 600,000 kWh of solar energy generated by the panels each year. As shown in *Figure* 22, SDP would be paying the same price for the solar energy as conventional energy in Year 1. However, over time, the PPA price would escalate at a rate much lower than the anticipated increase in conventional electricity prices. Overall, SDP would experience savings of $93,488 (at present value) over the 25-year term of the agreement.

Under a 25-year PPA with SRECs sold for $30 each, the PPA rate would be even more attactive, starting at $0.08/kWh for the approximate 600,000 kWh of solar energy generated by the panels each year. This would result in a total PPA savings of $224,296 (at present value) over the course of the agreement.

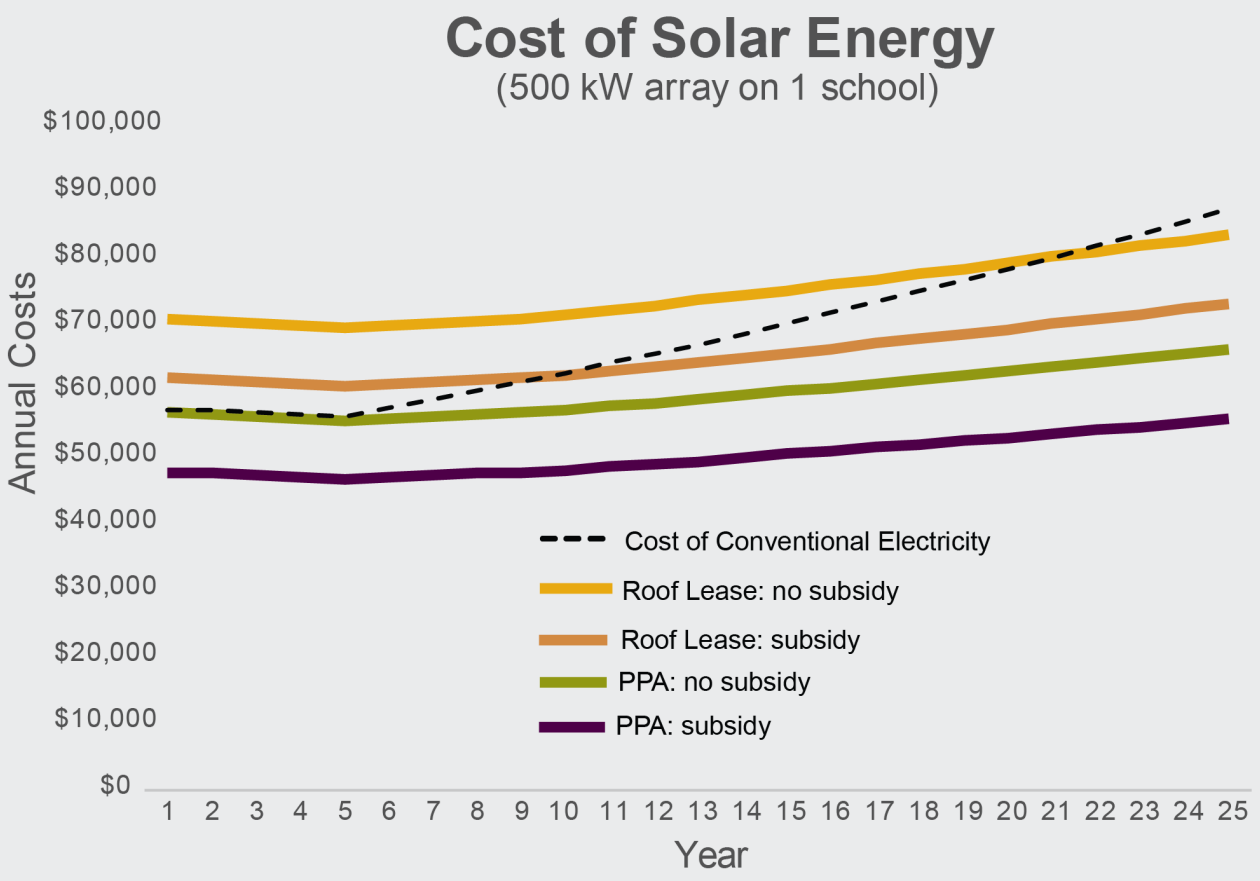
Under a 25-year Roof Site Lease, the savings would be delivered as annual lease payments instead of savings on the electric bill. The SDP would in turn be paying a higher rate through a PPA to purchase the solar energy. With SRECs selling for $7 each, SDP would start off paying $0.127/kWh for the solar electricity and receiving $5,000 annual lease payments. This higher PPA rate would actually result in a loss of $107,908 (at present value) over the course of the agreement.

With SRECs selling for $30 each, the roof site lease payments would remain $5,000 per year but the rate made to purchase the electricity would decrease to a starting price of $0.112/kWh. This would shift the outcome to a net gain for SDP of $22,900 at present value, though during years 1-9 SDP would be paying more for the solar energy than conventional electricity.

Table 2

Scenario	Total 25-year Savings	Net Present Value of 25-year savings
PPA- $7 SRECs	$221,910	$93,488
PPA- $30 SRECs	$458,140	$224,296
Roof Lease- $7 SRECs	-$40,832	-$107,908
Roof Lease- $30 SRECs	$95,398	$22,900

Figure 22



As demonstrated in *Table 2* and *Figure 22*, SDP would experience a net gain over the 25 year period if it finances rooftop solar through a Power Purchase Agreement with or without added subsidy. The roof site lease would pose a cost to SDP without a subsidy, but a slight gain with a subsidy. It is possible that the Roof Site Lease offers fewer savings because it is a less common financing mechanism.

According to this analysis, the most cost-effective off-balance-sheet financing option available to SDP would be a Power Purchase Agreement. With or without subsidy, a Power Purchase Agreement for rooftop solar would deliver immediate savings to SDP. With the sale of the project's SRECs for greater than market value, rooftop solar installations would result in significant savings for the SDP. In conclusion, PEA recommends that SDP pilot rooftop solar installations on public schools as a way to save energy and cut costs.

CONCLUSION

This report demonstrates that SDP could achieve save hundreds of thousands of dollars in electricity costs by installing rooftop solar on a single school. If solar is installed at scale across SDP's buildings, savings could exceed $25 million. Additionally, SDP would achieve a signficant environmental impact through energy savings and greenhouse gas reductions. Rooftop solar also provides remarkable educational opportunities, both for K-12 students and solar apprentices. The analysis presented in Part 4 suggests that a Power Purchase Agreement is the most cost-effective financing option available to SDP. By selling SRECs at above market value, SDP could see significant savings from sourcing its electricity from the sun.

Based on the findings in this report, PEA recommends that the School District of Philadelphia complete a pilot solar installation on three public schools in 2017 as part of the Energy Pilot Project. Powering public schools with solar energy will provide educational opportunities, create green jobs, and reduce the district's carbon emissions. A pilot project will allow SDP to gain familiarity with the procurement and financing processes, develop appropriate contracting language, and demonstrate the benefits of solar energy to the city more broadly.

Next steps to move the pilot forward include selection of the three pilot schools, site visits by industry experts to selected schools to confirm viability, and the release of a Request for Proposals (RFP). PEA is committed to supporting SDP to choose the most cost-effective option for achieving savings through solar on Philadelphia public schools and will continue to provide technical counsel throughout the process.

APPENDIX A: ASSUMPTIONS

SYSTEM ASSUMPTIONS	
System Size (kW_{DC})	767.00
Annual System Output - kWh (Year 1)	920,400
Annual PV Output Derate Factor	0.50%
Year of Inverter Replacement	20
Cost of Inverter Replacement	$25,000
Cost per watt	$1.95
Total Upfront Cost:	**$1,495,650**
ANNUAL SYSTEM OPERATING EXPENSE ASSUMPTIONS	
Developer System Management Fee	$5,000
O&M - cost per kW	$14.00
Insurance - cost per kw	$5.00
Inflation Rate for Expenses	2.0%
SYSTEM REVENUE ASSUMPTIONS	
Default Electricity Prices	
Year 1 Total price per kWh offset by solar	$0.10
Utility price escalation - Years 1 - 5	0.00%
Utility price escalation - Years 6 - 10	2.75%
Utility price escalation - Years 11 - 15	2.75%
Utility price escalation - Years 16 - 20	2.75%
Utility price escalation - Years 21 -25	2.75%
PPA Rate Assumptions	
PPA rate Year 1 price per kWh	$0.12
PPA rate annual escalation- Years 1 - 5	0.0%
PPA rate annual escalation- Years 6 - 10	1.0%
PPA rate annual escalation Years 11 - 15	1.5%
PPA rate annual escalation Years 16 - 20	1.5%
PPA rate annual escalation Years 21 - 25	1.5%
Roof Lease Assumptions	
Annual Roof Lease payments	$5,000.00
Escalation of lease payments	1.0%

SREC ASSUMPTIONS	
Solar Renewable Energy Credits (market-rate)	
SREC value - Year 1	$7.00
SREC value escalation - Years 1 - 15	1.0%
SREC value escalation - Years 16 - 25	0.0%
Solar Renewable Energy Credits (market-rate)	
SREC value - Year 1	$30.00
SREC value escalation - Years 1 - 15	0.0%
SREC value - Year 16	$10.00
SREC value escalation - Years 16 - 25	0.0%

APPENDIX B: CASH FLOW
PPA $0.095/KWH, $7 SRECS

Year	Solar Production (kWh)	Utility Rate Offset by Solar	Annual Utility Cost Avoidance	PPA rate	Annual PPA cost	PPA savings	Net Cash Flow (NPV)
1	600,000	$0.10	$57,500	$0.10	$57,000	$500	$476
2	597,000	$0.10	$57,212	$0.10	$56,715	$497	$451
3	594,015	$0.10	$56,926	$0.10	$56,431	$495	$427
4	591,045	$0.10	$56,642	$0.10	$56,149	$492	$405
5	588,090	$0.10	$56,358	$0.10	$55,869	$490	$384
6	585,149	$0.10	$57,619	$0.10	$56,145	$1,474	$1,100
7	582,224	$0.10	$58,907	$0.10	$56,423	$2,484	$1,765
8	579,312	$0.10	$60,225	$0.10	$56,702	$3,522	$2,384
9	576,416	$0.11	$61,571	$0.10	$56,983	$4,588	$2,958
10	573,534	$0.11	$62,948	$0.10	$57,265	$5,683	$3,489
11	570,666	$0.11	$64,356	$0.10	$57,833	$6,522	$3,814
12	567,813	$0.12	$65,795	$0.10	$58,407	$7,388	$4,114
13	564,974	$0.12	$67,266	$0.10	$58,987	$8,279	$4,391
14	562,149	$0.12	$68,771	$0.11	$59,573	$9,198	$4,646
15	559,338	$0.13	$70,308	$0.11	$60,164	$10,145	$4,880
16	556,541	$0.13	$71,881	$0.11	$60,761	$11,120	$5,094
17	553,759	$0.13	$73,488	$0.11	$61,364	$12,124	$5,290
18	550,990	$0.14	$75,132	$0.11	$61,973	$13,159	$5,468
19	548,235	$0.14	$76,812	$0.11	$62,588	$14,224	$5,629
20	545,494	$0.14	$78,529	$0.12	$63,209	$15,320	$5,774
21	542,766	$0.15	$80,286	$0.12	$63,837	$16,449	$5,904
22	540,052	$0.15	$82,081	$0.12	$64,470	$17,611	$6,020
23	537,352	$0.16	$83,916	$0.12	$65,110	$18,806	$6,123
24	534,665	$0.16	$85,793	$0.12	$65,756	$20,037	$6,213
25	531,992	$0.16	$87,712	$0.12	$66,409	$21,303	$6,291
						TOTAL	**$93,488**

PPA $0.08/KWH, $30 SRECS

Year	Solar Production (kWh)	Utility Rate Offset by Solar	Annual Utility Cost Avoidance	PPA rate	Annual PPA cost	PPA savings	NPV of savings
1	600,000	$0.10	$57,500	$0.08	$48,000	$9,500	$9,047
2	597,000	$0.10	$57,212	$0.08	$47,760	$9,452	$8,574
3	594,015	$0.10	$56,926	$0.08	$47,521	$9,405	$8,124
4	591,045	$0.10	$56,642	$0.08	$47,284	$9,358	$7,699
5	588,090	$0.10	$56,358	$0.08	$47,047	$9,311	$7,296
6	585,149	$0.10	$57,619	$0.08	$47,280	$10,339	$7,715
7	582,224	$0.10	$58,907	$0.08	$47,514	$11,393	$8,097
8	579,312	$0.10	$60,225	$0.08	$47,749	$12,475	$8,444
9	576,416	$0.11	$61,571	$0.08	$47,986	$13,586	$8,757
10	573,534	$0.11	$62,948	$0.08	$48,223	$14,725	$9,040
11	570,666	$0.11	$64,356	$0.09	$48,702	$15,654	$9,153
12	567,813	$0.12	$65,795	$0.09	$49,185	$16,610	$9,249
13	564,974	$0.12	$67,266	$0.09	$49,673	$17,593	$9,330
14	562,149	$0.12	$68,771	$0.09	$50,166	$18,604	$9,396
15	559,338	$0.13	$70,308	$0.09	$50,664	$19,644	$9,449
16	556,541	$0.13	$71,881	$0.09	$51,167	$20,714	$9,489
17	553,759	$0.13	$73,488	$0.09	$51,675	$21,813	$9,517
18	550,990	$0.14	$75,132	$0.09	$52,188	$22,944	$9,534
19	548,235	$0.14	$76,812	$0.10	$52,706	$24,106	$9,540
20	545,494	$0.14	$78,529	$0.10	$53,229	$25,301	$9,536
21	542,766	$0.15	$80,286	$0.10	$53,757	$26,528	$9,522
22	540,052	$0.15	$82,081	$0.10	$54,291	$27,790	$9,500
23	537,352	$0.16	$83,916	$0.10	$54,830	$29,087	$9,470
24	534,665	$0.16	$85,793	$0.10	$55,374	$30,419	$9,432
25	531,992	$0.16	$87,712	$0.11	$55,923	$31,788	$9,387
						TOTAL	**$224,296**

ROOF SITE LEASE $5,000/YEAR, $7 SRECS

Year	Solar Production (kWh)	PPA rate	Annual PPA Cost	Lease Payment	PPA Savings	PPA Savings + Lease	NPV of Savings
1	600,000	$0.13	$76,200	$5,000	-$18,700	-$13,700	-$13,048
2	597,000	$0.13	$75,819	$5,050	-$18,607	-$13,557	-$12,296
3	594,015	$0.13	$75,440	$5,101	-$18,514	-$13,413	-$11,587
4	591,045	$0.13	$75,063	$5,152	-$18,421	-$13,270	-$10,917
5	588,090	$0.13	$74,687	$5,203	-$18,329	-$13,126	-$10,285
6	585,149	$0.13	$75,057	$5,255	-$17,438	-$12,183	-$9,091
7	582,224	$0.13	$75,429	$5,308	-$16,521	-$11,214	-$7,969
8	579,312	$0.13	$75,802	$5,361	-$15,577	-$10,217	-$6,915
9	576,416	$0.13	$76,177	$5,414	-$14,606	-$9,192	-$5,925
10	573,534	$0.13	$76,554	$5,468	-$13,606	-$8,138	-$4,996
11	570,666	$0.14	$77,314	$5,523	-$12,958	-$7,435	-$4,347
12	567,813	$0.14	$78,081	$5,578	-$12,286	-$6,708	-$3,735
13	564,974	$0.14	$78,856	$5,634	-$11,590	-$5,956	-$3,159
14	562,149	$0.14	$79,639	$5,690	-$10,868	-$5,178	-$2,615
15	559,338	$0.14	$80,429	$5,747	-$10,121	-$4,374	-$2,104
16	556,541	$0.15	$81,228	$5,805	-$9,347	-$3,542	-$1,623
17	553,759	$0.15	$82,034	$5,863	-$8,546	-$2,683	-$1,171
18	550,990	$0.15	$82,848	$5,922	-$7,717	-$1,795	-$746
19	548,235	$0.15	$83,670	$5,981	-$6,859	-$878	-$347
20	545,494	$0.15	$84,501	$6,041	-$5,971	$69	$26
21	542,766	$0.16	$85,339	$6,101	-$5,054	$1,047	$376
22	540,052	$0.16	$86,186	$6,162	-$4,106	$2,056	$703
23	537,352	$0.16	$87,042	$6,224	-$3,125	$3,098	$1,009
24	534,665	$0.16	$87,906	$6,286	-$2,113	$4,173	$1,294
25	531,992	$0.17	$88,778	$6,349	-$1,067	$5,282	$1,560
						TOTAL	**-$107,908**

ROOF SITE LEASE $5,000/YEAR $30 SRECS

Year	Solar Production (kWh)	PPA rate	Annual PPA Cost	Lease Payment	PPA Savings	PPA Savings + Lease	NPV of Savings
1	600,000	$0.11	$67,200	$5,000	-$9,700	-$4,700	-$4,476
2	597,000	$0.11	$66,864	$5,050	-$9,652	-$4,602	-$4,174
3	594,015	$0.11	$66,530	$5,101	-$9,603	-$4,503	-$3,890
4	591,045	$0.11	$66,197	$5,152	-$9,555	-$4,404	-$3,623
5	588,090	$0.11	$65,866	$5,203	-$9,508	-$4,305	-$3,373
6	585,149	$0.11	$66,192	$5,255	-$8,573	-$3,318	-$2,476
7	582,224	$0.11	$66,520	$5,308	-$7,613	-$2,305	-$1,638
8	579,312	$0.12	$66,849	$5,361	-$6,624	-$1,264	-$855
9	576,416	$0.12	$67,180	$5,414	-$5,609	-$194	-$125
10	573,534	$0.12	$67,512	$5,468	-$4,564	$904	$555
11	570,666	$0.12	$68,183	$5,523	-$3,827	$1,696	$992
12	567,813	$0.12	$68,859	$5,578	-$3,064	$2,514	$1,400
13	564,974	$0.12	$69,543	$5,634	-$2,276	$3,358	$1,781
14	562,149	$0.12	$70,233	$5,690	-$1,462	$4,228	$2,136
15	559,338	$0.13	$70,930	$5,747	-$621	$5,126	$2,466
16	556,541	$0.13	$71,634	$5,805	$247	$6,052	$2,772
17	553,759	$0.13	$72,345	$5,863	$1,143	$7,006	$3,057
18	550,990	$0.13	$73,063	$5,922	$2,069	$7,990	$3,320
19	548,235	$0.13	$73,788	$5,981	$3,024	$9,004	$3,563
20	545,494	$0.14	$74,520	$6,041	$4,009	$10,050	$3,788
21	542,766	$0.14	$75,260	$6,101	$5,026	$11,126	$3,994
22	540,052	$0.14	$76,007	$6,162	$6,074	$12,236	$4,183
23	537,352	$0.14	$76,761	$6,224	$7,155	$13,379	$4,356
24	534,665	$0.14	$77,523	$6,286	$8,270	$14,556	$4,513
25	531,992	$0.15	$78,293	$6,349	$9,419	$15,768	$4,656
						TOTAL	**$22,900**

SOURCES

RECOMMENDED RESOURCES

Philadelphia Solar Schools Initiative
Video: https://www.indiegogo.com/projects/philadelphia-solar-schools-initiative#/

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