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Solar Market Report

Prepared for:

Commonwealth Finance Authority

October 23, 2015

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Executive Summary

The Commonwealth Finance Authority (CFA) has retained Gabel Associates to provide solar energy economic modeling advisory services to the CFA for its Solar Energy Program. This includes advising the CFA on the most efficient and effective market incentives to maximize the economic value of new solar deployment in the commercial, industrial, governmental and not-for-profit sectors in the Commonwealth.

As requested by the CFA, this Report includes detailed information about the current solar energy market, with an emphasis on the Pennsylvania market; detailed installation cost breakdowns; solar panel efficiencies and costs/watt; productive life of solar installations; solar energy financing methods and modeling; solar renewable energy credit (SREC) markets; state and federal tax incentives and other trends in the development of solar energy.

In addition to the gathering and analysis of the above information, in formulating our recommendations that maximize the deployment of solar energy in the Commonwealth, we reviewed the previous Commonwealth Solar Energy Program guidelines and evaluation criteria, and interviewed CFA staff and active participants in Pennsylvania's solar market.

The following key factors are identified in the Report:

- With revenue assurance, private sector financing is available for solar projects in the Commonwealth.

- Solar project costs have declined by more than 50% since the CFA solar program was first introduced. At same time SREC prices have declined from a high of $350 to current level of $15.

- Customer benefits from PV can vary across the Commonwealth's utilities, explaining the uneven geographic distribution of PV development throughout Pennsylvania.

- Volatility and low values in the SREC market act as a deterrent to solar project development in the Commonwealth. As shown in other markets in the region, a stable SREC market results in the successful financing and construction of solar projects. The CFA is in a position to address SREC price volatility in the design of its incentive program.

- In the prior Solar Energy Program, loans were the preferred form of incentive, which would create a recurring source of funding for future projects. CFA loans are not needed to develop solar projects if SREC price volatility is addressed.

- Design of an incentive program should make use of competition to ensure that the CFA does not over-pay for solar projects.

- Incentives should enable well-established private sector financing structures such as Power Purchase Agreements (PPAs) that bring private capital to projects to the benefit of customers.

Based on these factors the following Program Design elements are recommended:

Given the resources available (approximately $30 million dollars in funding), it is recommended that eligibility be limited to a) photovoltaic (PV) projects that generate, distribute or store solar energy and (b) projects that manufacture or assemble solar panels or other solar equipment, or are involved in research and development. Separate budget amounts should be set for each category and if awards in the second category do not reach the budgeted amount within a specified time period, funds should be shifted into the PV category.

PV applicants should be awarded a per watt grant with a structure that eliminates SREC risk to the awardees. SREC price volatility is the most significant impediment to PV development in the Commonwealth. Stated differently, there would be no shortage of capital for PV project finance if SREC prices were not so low today and so uncertain in the future. This can be fully addressed by a program design element whereby upon grant award, awardees contractually commit to transfer ownership of the SRECs to the CFA. The CFA will be purchasing the SRECs in exchange for the grant.

Awards to PV applicants should be made based on price competition among applications that meet prequalification criteria. The grant should be paid to awardees upon written evidence of project completion (receipt of permission to operate or PTO from the local utility).

Three objectives are accomplished with this structure: project developers no longer have SREC risk as they have monetized their SREC value at the front end (and can make their projects more readily financeable by private capital that is available in the market); price competition leads to efficiency of funding and stretches the CFA's limited funds; and, the CFA can earn recurring revenue by the sale of SRECs over time. These revenues can then be recycled back into the CFA's Program and be made available for incentives in the future.

With the expiration of the 30% Federal Investment Tax Credit (FITC) for PV at the end of 2016, the timing of project completion is an important consideration. A project qualifying for a 30% tax credit versus a 10% tax credit should require lower grant payments from the CFA to make projects financeable. In order for project applicants to meet the December 31, 2016 deadline to qualify for the 30% ITC, CFA awards should be completed no later than February 2016. Closing on awards by this date will put projects in the best possible position to be under construction by the second half of 2016 and receive Permission to Operate (PTO) from the local utility by December 31, 2016, thereby meeting eligibility for the 30% FITC. To the extent practical, the CFA

should make awards to projects that can meet this deadline, thereby leveraging to the greatest extent, the available Federal incentive.

Given the potential for a rush to complete projects by the end of 2016 to capture the higher incentive, it should be noted that unexpected supply chain delays or interconnection processing delays, including a delay in the timing of the issuance of PTO by the local utility has the potential to frustrate meeting this end of year deadline. Given this, the CFA should be proactive in meeting with utilities and the Public Utility Commission (PUC) to ensure that CFA funded solar applications are processed in a timely fashion.

Introduction and Organization of this Report

The Commonwealth Finance Authority (CFA) has retained Gabel Associates to provide solar energy economic modeling advisory services to the CFA for its Solar Energy Program. This includes advising the CFA on the most efficient and effective market incentives to maximize the economic value of new solar deployment in the Commonwealth.

This Report is organized in accord with the Scope provided by the CFA:

1) Current State of the Solar Market in Pennsylvania

2) Incentives available to solar energy including federal and state loans, tax credits, depreciation benefits, and SRECs

3) Solar energy economic models

4) Review of CFA loan structure model, with delayed loan payments

5) Review of previous solar energy program guidelines and evaluation criteria and recommended changes.

1. Current State of the Solar Market in Pennsylvania

a. Installation Prices for Solar PV

Prices for solar PV systems including panel prices are quoted in prices per watt-dc, although typically PV system sizes are described in kilowatts (kW), where 1000 watts equals 1 kW) as illustrated in the chart that follows on page 9 of this Report.

The costs of solar photovoltaic (PV) systems have declined substantially since CFA introduced its incentive program in 2009. Driven primarily by a steep global

decline in PV panel prices from 2008-2012, system costs (inclusive of panels, inverters, mounting systems and balance of plant) declined in that period from approximately $8.50/watt down to $4.50/watt. Since 2012, costs have continued to decline, averaging around $3.00/watt in 2015 although the more recent cost reductions are driven more by reductions in soft costs.[1] Soft costs include permitting and inspection costs, system design, transaction, marketing and customer acquisition costs. Reducing soft costs is currently the focus of the industry.

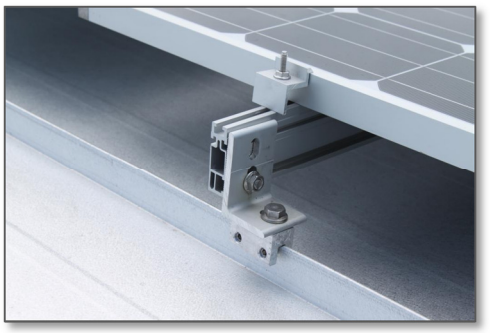
Installation costs for solar PV systems will vary according to system type and system size and are not subject to significant regional cost differences throughout the Commonwealth. Any cost variation based on locality will depend on prevailing wage rates coupled with the experience and comfort of the local jurisdiction with solar PV technology. Lack of experience would add cost to permitting and other permissions required.

Another factor that drives the cost of a PV system is the cost of interconnection. Interconnection costs should not vary significantly from utility to utility. Variation on interconnection costs are very site specific, depending typically on how much PV capacity is on a given circuit and other site specific factors. Utilities have discretion, based on their interconnection analysis, to require upgrades, the costs of which must be borne by the applicant. In some cases, for instance, a transformer upgrade may be required which would drive up the cost of the installation.

Solar systems may be configured as ground mounts, roof mounts (pitched, flat and standing seam roof applications), and solar canopy carports. While solar panel and inverter costs remain the same across all applications, cost differentials are primarily driven by mounting systems and system size. For example, with respect to solar canopies, there is typically more steel involved in

[1] Costs reflect average cost of a commercial PV system <500 kw

construction of a solar canopy compared to any type of roof-mounted system. With respect to a standing seam application, where panels are “clipped” to the standing seam of the roof as seen in the images below, a significant amount of racking is eliminated reducing the cost of materials. Economies of scale will also lead to lower costs, and therefore a small solar canopy of 100 kw will be more costly than a 1,000 kw solar canopy.



Additionally, for any given system, there may be factors that increase cost that are a feature of the particular project. Some typical examples of such factors include the distance and path of wiring back to the point of interconnection, electrical upgrades to facilitate interconnection (upgrades to customer’s electric panel or upgrades to the utility distribution system), grading and/or clearing of land and differentials in the cost of permitting and other soft costs.

For “clean” projects that have no extraordinary costs (as noted in the previous discussion), installation prices for the following type of projects are as follows:

System Type	Price Per Watt-dc	Price Per Watt-dc	Price Per Watt-dc
Roof Mount	**0-50 kW**	**50-500 kW**	**500 -1,000 kW**
Standing Seam	$2.90-$3.00	$2.45-$3.00	$1.75-$2.45
Flat Roof	$3.00-$3.25	$2.50-$3.25	$1.75-$2.50
Pitched Roof	$3.25-$3.50	$3.20-$3.25	$2.25-$3.25
Ground Mount	$2.85-$3.50	$2.55-$3.50	$1.95-$2.25
Solar Canopy	$3.85-$4.00	$3.25-$3.85	$2.95-$3.25

A breakdown of costs is shown below for ground array projects between 50 kW-dc and 500 kW-dc:

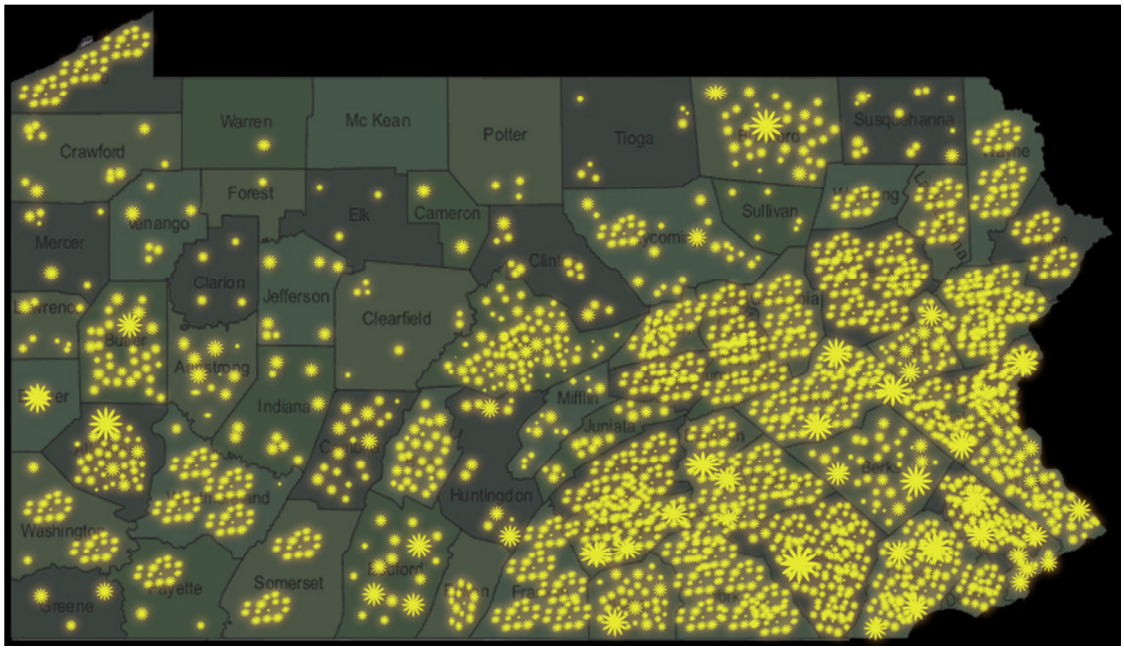
Category	Price per watt-dc
Panels	$0.55 - $0.70
Inverter	$0.13 - $0.30
Racking	$0.42 - $0.50
Labor[2]	$1.00 – $1.50
Balance of Plant (BOP)	$0.10
Permitting and other permissions	$0.10
Insurance, bonding, O&M, warrantees, customer acquisition	$0.25-$0.30[3]
TOTAL	**$2.55 – $3.50**

Experience with PV in the Commonwealth varies geographically. According to data sourced from PJM EIS GATS[4], the map below demonstrates that the majority of PV development has occurred in the southeastern portion of the

[2] Includes electric related labor and assumes prevailing wage
[3] These costs may be higher for public projects.
[4] PJM EIS GATS provides reporting and tracking services of Renewable Energy Credits (RECs)

State. In the previous solar incentive program, CFA's awardees have also followed this trend:

Solar PV Development in the Commonwealth as of October 2016.



In addition, the Sunshine Program Final Report shows nineteen (19) counties that have 0 to 10 systems (including residential systems). Some of these counties likely have limited to no experience with larger scale commercial PV systems.

b. Solar PV System Electric Production

An integrated PV system converts sunlight to grid-quality electric energy. The amount of electricity produced is dependent on the system size, type and efficiency, available sunlight and system design. Maximum system size for an installation is typically limited by available construction area (for grid-supply systems) or on-site electric load (for behind the meter systems). The following installation details impact the level of electric output.

System Size

Pennsylvania has a wide variety of operating PV systems. System sizes for installations physically located in Pennsylvania range from less than 1 kW to 4.2 MW for behind the meter systems, and from 3 MW to 11.5 MW for grid-connected systems. The chart below details the total solar capacity of in-state PV systems in three different categories: less than 50 kW, 50 kW to 499 kW and greater than or equal to 500 kW.

Total MW by Size for Pennsylvania Solar PV Generation

	< 50kW	**50 kW - 499 kW**	**>500 kW**	**Total**
In State	65.4	61.2	93.6	**220.2**

Solar Panel Location, Tilt and Azimuth

The geographic location of the PV system has a significant impact on the level of electric generation. However, solar installers can influence the electric generation at a particular location by changing the tilt of the panels or the azimuth (measured as degrees away from north, e.g. 180 is due south). Lower tilt angles will allow for more solar PV capacity to be installed within a constrained space, but will generate fewer kWh per kW. The azimuth can be adjusted to shift the time of peak generation. Due south will maximize total generation, A more eastern oriented installation will shift generation to the morning hours and a more western orientation will shift generation to the afternoon hours. In Pennsylvania, a slightly western facing PV system may provide more societal value by providing more generation during the afternoon peak pricing period typically observed in PJM during the summer.

Solar Panel Efficiency

There are a variety of solar panels available in the market today with a range of 18% to 22.5% efficiency. Solar panel efficiency relates to watts per square meter, i.e., watts per panel. A higher efficiency panel will provide more kW in a given area, and proportionally higher kWh/year, but will not produce more kWh per kW. For example, given the same panel size and system design, a high efficiency panel might produce 240 Watts whereas a lower efficiency panel might only deliver 200 Watts, but both panels will produce the same kWh/kW. With the same number of panels installed, the high efficiency panels would yield a system that is 20% higher in capacity and that will produce 20% more kWh total output per year.

Typically, higher efficiency panels are sold at a higher price per watt. For instance, a panel with 20% efficiency may cost $0.70/watt while a panel with 18% efficiency may be $0.62/watt. These higher efficiency panels are usually found more in space-constrained installations such as a rooftop solar customer seeking to displace a high electric load. By comparison, a ground-mount PV installation, where the available land is not a constraint to system size, would be more likely to use a less efficient panel if it reduces installation costs and provided better overall project economics. These two examples should not be interpreted as hard-and-fast rules; there are many other factors (warrantees, vendor relationships, and others) that influence a vendor's solar panel choice.

Further, while PV installations in the Commonwealth are typically on a fixed mounting structure, there are motorized tracking systems available that can increase total electric output by continuously positioning the panels such that they always point directly at the sun during daylight hours. However, these systems add up-front capital costs as well as ongoing maintenance costs that can exceed the economic benefits of the higher production. To maximize the value of these tracking systems, a solar developer would likely choose the

highest efficiency panels available. Such systems may have higher incentive requirements, but may also provide additional value to Pennsylvania ratepayers in the form of higher on-peak energy value. Tracking systems are more commonly found in the southern portions of the country, located in areas with milder climates. There is limited experience with the long-term maintenance required of tracking systems in the northeast that are exposed to snow and frost conditions.

Inverter Efficiency

Inverters convert the direct current (DC) generated by the solar panels to grid-quality alternating current (AC). There is some energy lost in the process; quality inverters typically have 98% peak efficiency and somewhat less efficient operation at lower output levels. Because inverters are designed to operate most efficiently near their peak output, it is important to size the inverter(s) appropriately for the system size.

System Design and Construction

In addition to sizing inverters correctly for the installation, other aspects of the overall system design can impact total electric output. Wire runs, electric connectors, localized shading, balance of system component choices and other factors can influence the long-term electricity output of the installation. The attention to these smaller details can save costs, increase system output and improve long-term reliability. In general, this level of engineering and construction detail is more often found with experienced developers.

Integrated System Efficiency – Summary

The PV installation location, size, individual components and system design all contribute to total system output. Panel efficiency contributes to how many kW

are installed (rather than kWh/kW of production), while system design, tilt and azimuth contribute to how much energy (kWh) is produced with the capacity (kW) of panels installed. The table below details the expected output for three different PV designs across various locations throughout the Commonwealth based on location specific, weather-normalized production estimates calculated using NREL's PVWatts (pvwatts.nrel.gov/). The financial analysis models included with this report assume 1,200 kWh/kW, which is a conservative blended average of the below values. Specific systems will likely have higher or lower production values, with rooftop systems being generally lower and ground mount systems being generally higher.

Expected Output for Solar PV in Pennsylvania

City	kWh/kW 5 Deg Tilt	kWh/kW 25 Deg Tilt	kWh/kW 2-Axis Tracking
Philadelphia	1,199	1,322	1,727
Pittsburgh	1,142	1,226	1,547
Allentown	1,179	1,298	1,675
Erie	1,164	1,247	1,590
Scranton	1,139	1,235	1,570
Harrisburg	1,194	1,310	1,715
Williamsport	1,126	1,225	1,555
Bradford	1,159	1,225	1,599
Minimum	**1,126**	**1,225**	**1,547**
Maximum	**1,199**	**1,322**	**1,727**
Average	**1,163**	**1,261**	**1,622**

c. Grid-Connected vs. Retail Behind-the-Meter Projects

There are two types of PV generation projects that may be eligible to receive an incentive from the CFA.

The first type of project is commonly referred to as a net-metered project, customer-sided project or behind-the-meter (BTM) project. BTM projects are

distinguished by interconnection of the solar system “behind” the customer’s utility meter. The electricity created by the solar system, typically located on the customer’s site, is used to offset the electricity load used at the site. Configured this way, the solar system displaces the utility load with direct benefits to customer including savings from the electricity that would have been purchased from the utility, now provided by the on-site solar system.

Customers pursuing such projects apply for interconnection with the local distribution utility under Net Metering interconnection protocols adopted by the Pennsylvania Public Utility Commission. As enabled by statute, utilities are required to provide retail credit to any interconnection customer when those systems send electricity back across the utility meter. This will occur in any instance when a facility is producing more electricity from the PV system that it requires to power its building. The electricity will physically cross over the customer’s utility meter, and will be made available to the grid. Because these systems offset the retail purchase price of electricity, and provide retail value to excess energy exported to the grid, they have additional value.

The second type of system is commonly referred to as grid supply or wholesale. A grid supply project is interconnected at any location in the distribution or transmission system. In such projects, the grid supply project is not offsetting any on-site electrical load, and is functioning like any other power plant – injecting power into the system that is made available to the wholesale electricity market. This means that the value of the electricity that is created will be at the wholesale rate. This is less than for a Net Metered project (where all electricity created receives retail value). By way of example, a wholesale project may receive 4 cents/kWhr for all electricity injected into the grid (the exact value is dependent on the wholesale price of power at the particular location where the electricity is being injected into the grid) where a BTM project might receive 11 cents/kwh for all the electricity it creates (either by displacing electricity that

would have been purchased from the utility at its retail rate, or by receiving retail credit from the utility if the electricity is sent to the grid).

The difference in electricity value is one significant distinction between grid supply projects and behind the meter projects. Because of this difference, grid supply projects will often be multi-megawatt size projects to capture the economies of scale.

The second significant difference between such projects is the cost, process and timeline by which these projects receive interconnection approval from the utility. As discussed above, BTM projects receive approval by applying with the local utility under net metering interconnection protocols. Grid supply project, however, must apply directly through PJM, the Regional Transmission Operator (RTO). Applications are processed by PJM in queues, which are batched twice a year and there is a significantly longer timeline to receive preliminary interconnection approval. Grid supply projects may take anywhere from 4-18 months to receive interconnection approvals.

Benefits provided by grid supply projects include scale and lower price per watt to construct then BTM projects. These projects are typically configured as ground mounted arrays with larger capacity, which are installed for under $2.00/watt in some instances. However, there are no direct customer benefits as occur with net metered projects and grid supply projects have much longer development timelines (due to interconnection and the complexity of siting larger scale projects). **The direct customer benefits associated with net metered projects help commercial customers maintain their economic competitiveness and succeed in Pennsylvania.**

d. Life Expectancy of PV Installations

Although PV installations experience a gradual decline (about 0.5%/year) in electric output, if maintained properly, they can continue generating electricity for 30 years or longer. However, manufacturers' warrantees typically cover manufacturing defects for 5 to 10 years and a guaranteed level of production for 25 years. For example, Trina Solar (a leading solar manufacturer, with more than 11,000 megawatts of PV panels shipped worldwide since 2007) offers a 10-year warrantee for manufacturing defects and a 25-year production warrantee that the panels will degrade no more than 2.5% in the first year and 0.7% per year thereafter. This results in a panel warrantied to produce at least 80.7% of its original output in year 25.

For economic analysis purposes, systems are usually evaluated for the production warrantied period of the solar panels, or 25 years. During this 25-year period, the system will require regular inspection and maintenance, which may include system monitoring, data collection, inverter replacements, panel cleaning, tightening of wire connections, landscape maintenance to avoid excessive shading, faulty panel replacements, and related activities.

While the solar panels lifespan can easily exceed 25 years, PV inverters typically last about 10 years. Although many manufacturers offer extended warrantees of 15 or 20 years, the costs of these warrantees are about the same as replacing the inverter. Because it is uncertain when the inverter(s) will require replacement, the financial models accompanying this report assume a levelized cost of replacing the inverter(s) every 10 years.

Wiring, racking, mounting and other balance of system components are expected to last the lifetime of the solar PV system and not incur any significant future costs to maintain or replace.

e. Solar Renewable Energy Credits (SREC) Markets

The Commonwealth's Renewable Portfolio Standard (RPS) drives the creation and value of SRECs as a revenue source. The RPS mandates that 18% of electricity used by the Commonwealth come from alternative energy resources by compliance year 2020-2021. The compliance obligation covers all investor owned utilities and retail suppliers that supply electricity for the Commonwealth. Inside of the RPS is a solar carve out of 0.5%, which must come from PV by compliance year 2020-2021. Compliance is based on the purchase of solar energy credits (SRECs) where an SREC is equal to a megawatt-hour of qualified PV generation. In other words, in order to be in compliance a supplier must include a specified number of SRECs in its supply mix. The payment to the owners of solar PV generators for these SRECs creates a revenue flow to these generators.

Banking of excess credits is allowed for up to two years thus an SREC's useful life is three years – the year in which it was produced and two subsequent years for which it can be banked. An SREC can come from an eligible generator located within the Commonwealth or the broader PJM region, which is made up of thirteen states. The one exception to this rule is that energy from resources located within the footprint of the Midwest Independent Systems Operator (MISO), which serves a small portion of Pennsylvania, may be used for compliance in areas served by the MISO. This only applies to Pennsylvania Power Company, the only energy supplier currently operating within the part of Pennsylvania located in MISO.

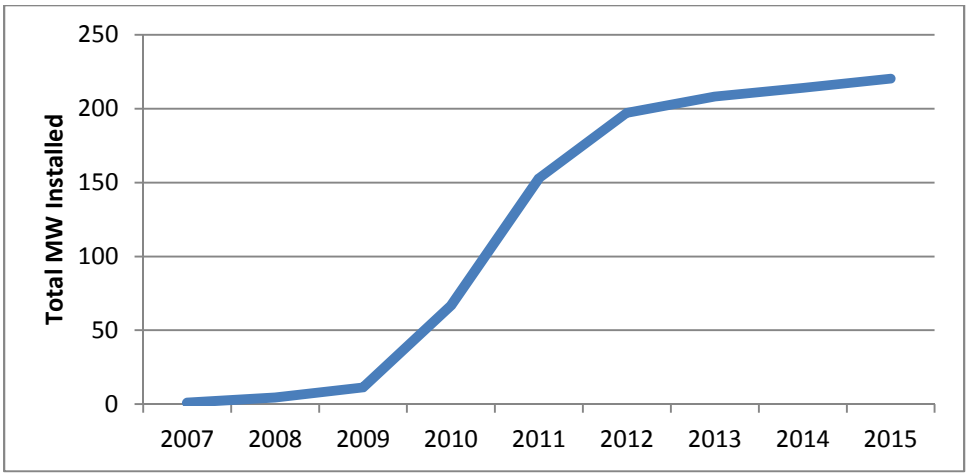
The value of SRECs will depend on market conditions. During energy year 2015, the spot market price for PA-sourced SRECs traded as high as $50/MWh in June 2014 but has declined to about $15/MWh in October due to extensive oversupply of SRECs. There may be additional trades that exceed this range due to pre-existing long-term contracts. It should be noted that even the highest prices experienced over the year are much less than in states with substantial solar

market activity such New Jersey, Massachusetts, Maryland and Washington DC which, collectively, have prices in the $170 (Maryland) - $470 (DC) range and substantially greater solar development activity.

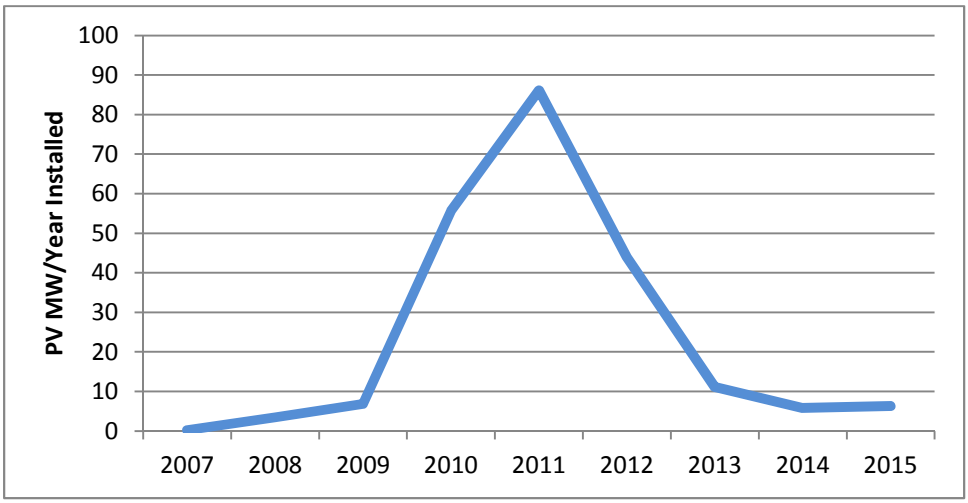
SREC price volatility is a significant factor causing the lack of investment in PV projects in the Commonwealth. In the prior program offered by CFA, a number of projects were never constructed (allowing approximately $30 million to be made available for the program currently under consideration by the CFA). In discussions with developers and CFA staff, it is clear that a significant factor in project cancellation was SREC volatility. In 2009, when the first program was launched, SREC pricing was approximately $200-$300/SREC and then fell to approximately $20/SREC. While the program prohibited awardees from executing a long term (ten-year) SREC contract, it did allow awardees to sell SRECs in the spot market. Therefore, SREC value was a factor in the financial planning assumptions of awardees, and when SREC value decreased by a factor of ten, projects could no longer secure financing.

The current Pennsylvania SREC market is substantially oversupplied. Generally speaking, this has pushed SREC prices too low to currently support new solar development in Pennsylvania. As a result, recent commercial solar development in the Commonwealth has been generally limited to PEDA and other projects receiving financial support. A PEDA grant fills the financing hole that would otherwise be covered in a functioning SREC market where the SREC value supports project development. This reduction in construction is shown in the graphs below, illustrating a leveling off of cumulative solar construction and a sharp decline in current construction.

Cumulative Solar Construction in Pennsylvania

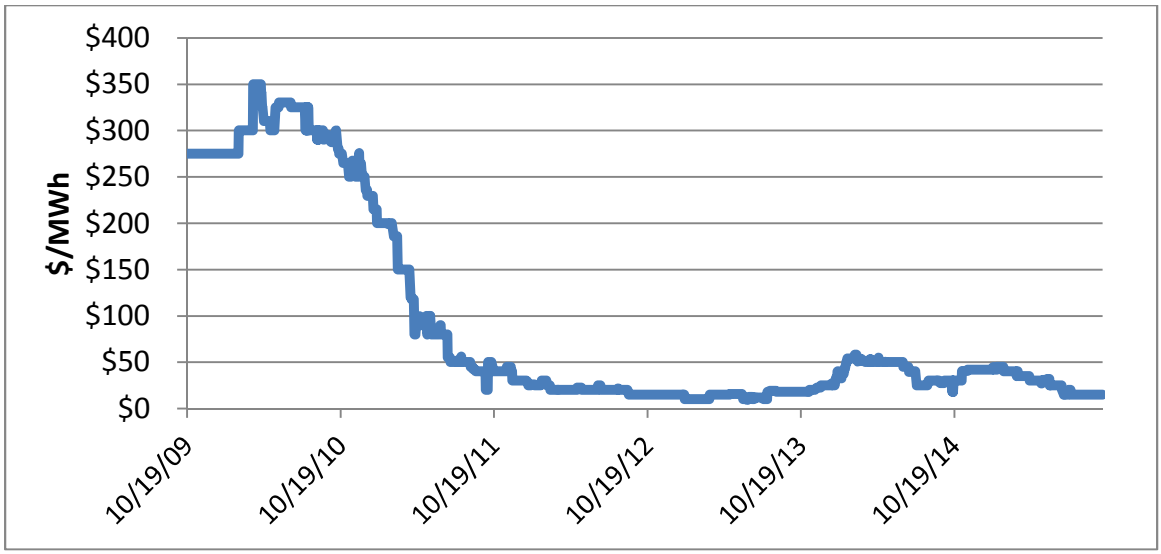


Annual Solar PV Additions in Pennsylvania



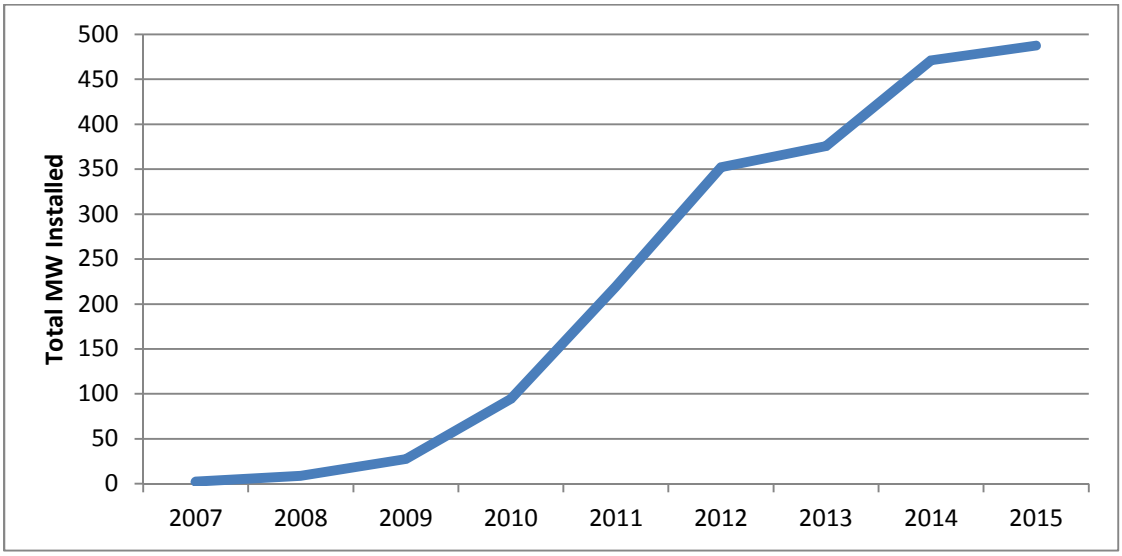
SRECs in Pennsylvania are also eligible as Class I RECs (a class of alternative energy in the Commonwealth that includes other forms of renewable and alternative generation) and many SRECs have been trading as such in recent years. The Class I REC market, which has been recently trading around $15/MWh, effectively provides a backstop for SREC prices as shown in the graph below.

Historic SREC Prices in Pennsylvania



Also impacting the Commonwealth's SREC market is the fact that Pennsylvania allows out-of-state PV to qualify for SRECs. As a result, the total available SREC supply is more than double what it would be if supplied by only in-state generators. The graph below depicts the total capacity eligible for Pennsylvania SRECs.

Cumulative Solar Capacity Eligible for SRECs in Pennsylvania



A key conclusion is that current SREC price levels (in concert with on-going price volatility) are insufficient to attract investment and drive widespread PV development. This issue should be addressed in the CFA's program design.

f. Other Trends in the Development of Solar Energy – Energy Storage

Energy storage technology has made significant advancements since 2009, when CFA launched its incentive program. Energy storage is usually thought of as battery based but can also include other technologies such as compressed air storage, fly wheel technology, and pumped hydro storage. Energy storage can have various purposes depending on the application: to store power for more valued periods; to remove some intermittency from solar production; to reduce peak demands; to be available for resiliency during grid outages; or, for providing reactive services to stabilize the electric grid. As such, energy storage is not one technology, but many, offering multiple values to multiple parties: customers, regulated transmission and distribution companies, traditional wholesale generators, renewable energy suppliers, and the ratepayers at large. Ratepayers can realize significant benefits through reduced costs, improved performance, greater resiliency, and the strategic value of more sustainable sources of power such as solar and wind.

Given cost reductions and improved performance of storage technology over the last several years, CFA should to consider allowing the cost of storage systems as part of a PV project to be eligible for CFA support.

As storage can be designed provide a number of values across any number of values - from resiliency to peak shaving to grid stabilizing services, the cost of storage technology will vary depending on what value or values the system owner is looking to realize. Batteries are tending to be the technology of choice

with respect to storage coupled with behind the meter PV projects. The current cost for lithium ion battery technology is approximately $1,000/kWhr and $0.50/watt, with costs declining at faster than expected rates. Allowing PV coupled with storage to be eligible for CFA support will provide CFA insight into storage costs, an important data point that enables growth of renewables in the Commonwealth, and allows the competitive process for the CFA incentive to sort out if such projects are economic enough to win CFA support.

g. Solar Markets in Neighboring States and Regions

New Jersey: New Jersey has a Renewable Portfolio Standard (RPS) requiring each supplier/provider serving retail customers in the state to procure 22.5% of the electricity it sells in New Jersey from qualifying renewables by Energy Year 2021. The RPS contains a separate solar specific provision requiring suppliers and providers to procure at least 4.1% of sales from qualifying solar electric generation facilities by Energy Year 2028. Unlike the Commonwealth, which allows for out-of-state generation, in order to be considered qualifying solar generation, the PV system must be connected to the distribution network in the State of New Jersey.

New Jersey relies on Solar Renewable Energy Certificates (SRECs) to meet compliance. As in the Commonwealth, 1 SREC is created for every megawatt hour (MWh) of qualifying generation. There is also the Solar Alternative Compliance Payment (SACP) schedule in law through 2028 that acts as a ceiling price above which no SREC will trade. Unlike the Commonwealth, an SREC has a qualification life of 15 years, which means after 15 years of generation, the qualifying solar facility no longer generates SRECs, however it will generate Class I (Tier I) RECs for purpose of compliance with the non-Solar RPS. In New Jersey, SRECs have a five-year life, as opposed to the three-year life in the Commonwealth, which allows for additional SREC banking.

SRECs are a key part of project financing for the majority of solar projects that get constructed in New Jersey. New Jersey has over 1.5 GW of solar generation installed, the majority of which has been financed by reliance on SREC value since 2009. Two to five year contracts for SRECs are available in the market place, and the four investor owned utility all offer long term financing programs for SRECs. Currently the value of SRECs in the spot market is ranging from $200-230/SREC and three-year forward contract pricing is available in the $200-210 range.

Maryland: Maryland has a Renewable Energy Portfolio Standard (RPS) beginning in 2006 requiring all utilities and competitive suppliers to use 1% of retail sales in the state from Tier 1 renewables (which includes solar) and 2.5% from Tier 2 renewables. The renewables requirement increases ultimately reaching a level of 20% from Tier 1 resources in 2022 and beyond and 2.5% from Tier 2 resources from 2006-2018. Tier 2 eventually sunsets and drops to 0% in 2019 and beyond.

Like New Jersey, there is a separate solar provision that requires a total of 2% of retail electricity sales come from solar resources by 2020. Compliance is demonstrated by accumulation of renewable energy credits (RECs). RECs have a three-year life and since 2008, only solar RECs generated within Maryland may be counted towards compliance. A Solar Alternative Compliance Fee Schedule (SACP) is in law through 2023 and acts as a ceiling for REC solar value.

A total of 242 MW of solar have been installed in Maryland since the first quarter of 2015. Like New Jersey, solar RECs are a key part of project financing for solar projects constructed in Maryland. Unique to Maryland is the provision that solar generators are required to offer SRECs for sale to Maryland electricity suppliers prior to offering them for sale to any other buyer. The Public Service Commission operates a web site where generators may post SREC offers. Currently, SREC purchase contracts, for solar projects larger than 10 kw

(known as level 1 facilities) directly between a solar generator and an energy supplier must have a term of at least 15 years.

For these Level 1 facilities only, the purchase must take the form of a single, up-front payment arrived at by calculating the net present value of SRECs over the life of the contract using a standard SREC value of 80% of the SACP and federal secondary credit interest rate in effect as of January 1 of that year as the discount rate. If after 10 days the SREC(s) have not been sold to a Maryland electricity supplier, the facility owner may sell their SRECs to any buyers.

Currently, SREC values in the Maryland spot SREC market are between $165-180/SREC.

Delaware: Delaware's RPS requires retail electricity suppliers to purchase 25% of the electricity sold in the state from renewable sources by Energy Year 2025-2026. There is a separate solar provision that requires that 3.5% of electricity sold in the state come from solar generators by 2025-2026. Compliance for the solar carve out is demonstrated by Solar Renewable Energy Credits (SRECs), where certified generators receive 1 REC for each megawatt-hour (MWh) of energy generated.

An SREC may be used for compliance in any compliance year that begins less than three years after the date the SREC is created. The one exception to this is for any SRECs held by the Delaware Sustainable Energy Utility (SEU), which is required to act as an SREC aggregator for BTM renewable projects, the three-year SREC lifetime is suspended during any period in which a SREC is held by the SEU.

There is a schedule for a Solar Alternative Compliance Payment (SACP) of $400 per MWh of shortfall for the first year in which it is paid. The SACP increases in subsequent years for suppliers who elect to pay it. The State Energy

Coordinator has the authority to review and adjust the SACP given certain market conditions.

Generators may participate in an auction for 20-year SREC contracts with Delmarva. In 2015, SREC bid prices are awarded for the first 10 years of the contract and the last ten years of the contract are fixed at $35. There are three tiers in which a project may participate, depending project size. There is also a set amount of capacity that may be awarded in each tier. Since the end of 2014, a total of 65 MW of solar have been installed in Delaware.

All three of these markets demonstrate that when SREC value can be relied upon through contracting mechanisms of various lengths (3-20 years), solar development is occurs. Mitigating solar value volatility would be a beneficial program design for the CFA.

2. Incentives Available to Solar PV

In addition to SREC revenues, a variety of financial incentives are available for solar PV on the federal, state and local level. These incentives are combined with electric revenues (in BTM projects where retail electric costs are avoided or grid sales into the wholesale power market) and through sale of Solar Renewable Energy Credits (SRECs). However, as discussed above, the variability in SREC prices (and their current low levels) coupled with the expected and scheduled expiration of the 30% federal investment tax credit, makes solar project investments challenging to support and finance within the Commonwealth at this time.

Federal Incentives

The Federal government has two incentives for solar PV. The first is the Solar Investment Tax Credit (FITC), which allows the owner of a solar PV system to take

30% of the total system cost as a tax credit. The tax credit may be used over multiple years and is available for commercial systems. This incentive, given that it is a tax credit, is not available for projects owned by non-tax-paying entities, such as not-for profit entities or public sector facilities. Absent congressional action, the FITC will decline from 30% to 10% on January 1, 2017. This will impact solar project economics and it is expected that solar project pricing will increase to absorb the lost of 20% of the tax credit.

The reduction of the FITC to 10% for projects coming on-line after December 31, 2016, is a key factor in project economics.

Another federal incentive, the Production Tax Credit (PTC), which has been used primarily for wind projects, is being considered by some industry participants as an alternative to a 10% FITC as the PTC has already been extended beyond 2017.

The PTC is an incentive structured as a "pay as you produce" incentive while the tax credit is a one-time credit based on the cost of the project. Whether or not it will make sense for a project to use the PTC in lieu of the 10% FITC (a project is not permitted to use both) will depend on the particular economic profile of a project. Included in such a consideration will be the ability and cost of including tax equity in a project, a factor in the total cost of the project, which is the basis upon which such a decision will likely be made.

The Federal government also allows owners of solar PV systems to be eligible for an accelerated depreciation schedule. Accelerated depreciation is the depreciation of the solar PV system on a front-loaded basis over the first six years. This type of depreciation reduces the amount of taxable income early in the life of a PV system, so that tax liabilities are deferred. This schedule is only available for commercial entities and is not available to a not-for-profit or public sector owner of a solar PV system. The schedule for this accelerated depreciation is shown in the table below.

Accelerated Depreciation Schedule

Year	Depreciation Rate
1	20.0%
2	32.0%
3	19.2%
4	11.5%
5	11.5%
6	5.8%

Public and not for profit entities can realize the benefits of the FITC and accelerated depreciation through a Power Purchase Agreement (PPA) model where the system owner is a private entity, as discussed in more detail below. (The PPA model usually entails a PPA, a lease, or both.) PPAs have become the dominant financing model in healthy solar markets and provide multiple benefits to multiple parties. System owners realize returns on investment and system hosts realize savings on electricity and predictability on electric prices through a set price schedule over the term of the PPA (typically 15 to 20 years). With the ability to fully take advantage of both the 30% FITC and accelerated depreciation schedule, the private owner of a PV system passes on those benefits in the form of lower electricity costs offered under a PPA to a host customer. Owners of projects in a PPA model also accept construction, operational and performance risk.

Based on the ability of private vendors and host customers to realize these benefits, CFA program design should recognize and be permissive toward the PPA model.

<u>Commonwealth Incentives</u>

In addition to SREC revenues, the Commonwealth has several statewide incentives for PV.

Interconnection and Net Metering: Interconnection standards and Net Metering Rules are applicable to all investor owned utilities in the Commonwealth. The rules allow utilities to charge the customer for the cost of grid upgrade necessary to accommodate the system. These provisions apply to generators of distributed generation, including solar PV, up to 5 megawatts (MW) in capacity. Net metering allows distributed generators to receive full retail credit for any electricity that is sent back to the distribution system. The net metering provisions allow on-site solar generators to receive retail value for energy, i.e., solar generated energy allows the user to displace purchases of electricity from the local utility, avoiding charges for generation, transmission and distribution services, as well as applicable sales taxes and utility surcharges.

The Pennsylvania Energy Development Authority (PEDA): PEDA is an independent public financing authority that was created in 1982 by the Pennsylvania Energy Development Authority and Emergency Powers Act and that was revitalized through an April 8, 2004, Executive Order. The authority's mission is to finance clean, advanced energy projects in Pennsylvania. Pennsylvania projects that could potentially qualify for funding from the Authority 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. The authority presently can award grants, loans, and loan guarantees. Tax-exempt and taxable bond financing for clean, advanced energy projects also are available through the Pennsylvania Economic Development Financing Authority (PEDFA).

In-State Regional Incentives

Several incentive programs are available in the Commonwealth for projects located in specific jurisdictions.

a. Philadelphia: PV systems of 10 kw or less installed on 1 or 2 family residential units are eligible for streamlined permitting and a fee reduction. Additionally, the City has committed to supply 20% of the City's electricity needs with green power by 2015.

b. PPL Electric Utilities Corp: A loan program was established, administered by the Sustainable Energy Fund of Central Eastern PA, for eligible renewable technologies including solar PV, with maximum loans up to $1 million over a seven-year term. Funding is available for commercial, industrial, not for profit, schools, and public sectors. The fund collected slightly more than $25 million through a rate surcharge, which expired in 2006.

c. Metropolitan Edison Company: A loan program was established, administered by the Berks County Community Foundation, for eligible renewable technologies including solar PV, with maximum loans up to $500,000, with terms that vary per project. Funding is available for commercial, industrial, not for profit, schools and local government sectors. A total of $8.2 million has been made available for funding projects.

d. West Penn Power Company: A loan program was established, administered by the EMS Energy Institute of Pennsylvania State University, for eligible renewable technologies including solar PV. Funding may include commercial loans, equity investments, subordinated debt and royalty financing.

3. PV System Economic Models

Overview

This section of the Report provides PV project financial models that are flexible and allow users to change a number of inputs (project size, financing variables, wholesale

grid supply vs. behind the meter retail and other project details) to test sensitivities and financial results. These financial models can provide a benchmark for comparison of projects and help identify why some projects may require a higher level of incentive than others.

However, while these models capture a wide variety of project variables, there is no "one-size-fits-all" model to accommodate all the variables associated with PV development in general and the form of financing in particular. Solar projects have unique characteristics including sources and cost of financing which are generally captured by the models presented but do not capture the specifics of an individual project's financing structure. The modeling in this Report provides unlevered rates of return (IROR) as well as simple payback.

The financial evaluation of a PV installation includes consideration of the total revenues and other financial benefits, and total costs associated with constructing, owning and operating the system over time. Depending on the type of ownership structure used to develop and finance the project, there may be several parties sharing the mix of costs and benefits. For example, a solar developer may not have enough tax liability to maximize the economic benefits of tax credits and accelerated depreciation and may seek out a tax-equity partner to monetize the tax benefits of the project. Another example is a business owner that wants to put solar on their roof or parking lot, but doesn't want to (or can't) make the capital investment. This type of customer could partner with a solar developer, which would own and operate the system while selling all of the solar electric output to the host customer at a discount to local utility costs, through a power purchase agreement (PPA).

For the financial models provided, the level of incentive to achieve a specific IROR can be calculated. In addition, as discussed in detail in Section 5, in order to remove SREC price risk from project financing, the CFA should consider a program design whereby it receives the right to SREC value in exchange for a grant. The revenue to the CFA realized by the sale of SRECs is also estimated by the model.

The forms of project structure are summarized below.

User Customizable Financial Models

All of the included Excel file financial models include user-adjustable variables to enable the evaluation of a variety of project details. All of these input variables are highlighted in a light blue on the Assumptions tab and the Electric Cost Savings tab (Self-Own Models only for the Electric Cost Savings). Changing these variables will provide instant updates to the financial results. These input variables include project size, installation and operating cost information, grant amount, PPA rates, SREC prices, ITC percentage, tax rates, financial evaluation periods (currently defaulted to 10, 15 and 25 years) and other project variables.

Direct Ownership (Self-Own)

A business owner may elect to self-own the solar PV installation. In the self-own model the owner is responsible for all the costs of the PV system, accepts the risks of ownership and enjoys all the benefits. Benefits associated with the direct ownership of a solar PV installation may include:

- Tax benefits
- State incentives (rebates, tax benefits, SRECs, etc.)
- Reduced electric utility purchases or wholesale electricity sales
- Hedge against volatile fossil-fuel based electricity prices
- Marketing value of ‘green’ image from PV ownership

A detailed Excel-based Self-Own Solar PV Financial Model and a pro forma analysis are provided in Attachment 1. A summary of a sample analysis for a 1 MW project, with a $2.50/Watt cost, a $0.81/Watt grant and 30% ITC is shown in the table below.

Self-Own Sample Financial Analysis Summary

Quick Summary of Financial Analysis			
Analysis Period	**Project NPV**	**Internal Rate of Return**	**Total CFA SAEC Revenue**
10 Years	**($260,125)**	3.3%	**$275,375**
15 Years	**($76,087)**	7.0%	**$416,625**
25 Years	**$196,120**	9.8%	**$688,750**
Simple Payback	8		

Direct Ownership (Self-Own) of Public Entity or Non-profit

Unlike a corporate entity, non-profits and public entities cannot take advantage of tax credits or depreciation benefits. Therefore they would likely require a higher level of incentive for a successful project. Although a 50% grant does not achieve the same level of IRR as a private sector project, a public entity typically has a lower IRR target for what is considered a desirable investment.

A detailed Excel-based Public Entity Solar PV Financial Model and a pro forma analysis are provided in Attachment 5. A summary of a sample analysis for a 1 MW project, with a $2.50/Watt cost and a $1.25/Watt grant is shown in the table below.

Self-Own Sample Financial Analysis Summary

Quick Summary of Financial Analysis			
Analysis Period	**Project NPV**	**Internal Rate of Return**	**Total CFA SAEC Revenue**
10 Years	**($443,654)**	-1.4%	**$275,375**
15 Years	**($22,609)**	4.8%	**$416,625**
25 Years	**$741,534**	8.8%	**$688,750**
Simple Payback	11		

Power Purchase Agreement (PPA)

In the PPA model, a third party owns the solar PV installation and is responsible for its operation and maintenance (all the costs, risks and benefits of direct ownership, not including the energy savings). This model is the prevalent model in the commercial space today since it is combines tax benefits, and debt and equity financing with a performance based contract structure that assures reduced energy prices to the customer.

In this model, the system owner charges the PPA customer (usually the solar PV installation site host) for the solar-generated electricity. Typically, this PPA rate is at least 10-20% below what the customer would pay the utility for the energy. Sometimes, the solar site host also receives a lease payment for the roof, land or parking space required for the solar installation. Owners of projects in a PPA model also accept construction, operational and performance risk. In a similar structure, payment to the solar vendor is made through a combination of lease payments and PPA payments, or through lease payments alone. With benefits for all participants (the solar system owner and host site) including elimination of the up-front cost and much of the risk for the host, the PPA has become the dominant finance model in mature solar markets.

A detailed Excel-based PPA Solar PV Financial Model is included as a part of this report delivery and a pro forma analysis is provided in Attachment 2. A summary of a sample analysis for a 1 MW project, with a $2.50/Watt cost, a $0.09/kWh PPA and a $1.17/Watt grant and 30% ITC is shown in the table below.

PPA Sample Financial Analysis Summary

Quick Summary of Financial Analysis			
Analysis Period	**Project NPV**	**Internal Rate of Return**	**Total CFA SAEC Revenue**
10 Years	**($166,600)**	4.5%	**$275,375**
15 Years	**($59,162)**	7.0%	**$416,625**
25 Years	**$74,585**	9.0%	**$688,750**
Simple Payback	6		

End of term options under a PPA have been standardized to include the following three options: 1) the host may elect to extend the term of the PPA for an agreed upon electricity price; 2) the host may elect to have system owner remove the system (at the system owner's expense); or 3) the host may pay the system owner Fair Market Value (FMV) to be determined at the end of the term, with the host assuming all rights and obligations of ownership.

With respect to determination of Fair Market Value, valuation methods based on the income approach use the expected economic earnings capacity of the solar asset to estimate value. This approach is generally used by market participants in pricing solar assets, and is usually the most relevant method to estimate FMV because it considers the specific contracts and incentives (like an SREC) applicable to the solar asset. There is also a substantial history of case law and tax authority that indicates that the income approach is most appropriate for determining the fair market value of property that generates income, particularly a consistent income stream over a long period. For solar assets, the income approach is generally developed using the discounted cash flow ("DCF") method. This method will also considers the state of the energy market at the time of termination, including then current and forecasted energy prices and other energy technologies that may be available.

System Lease

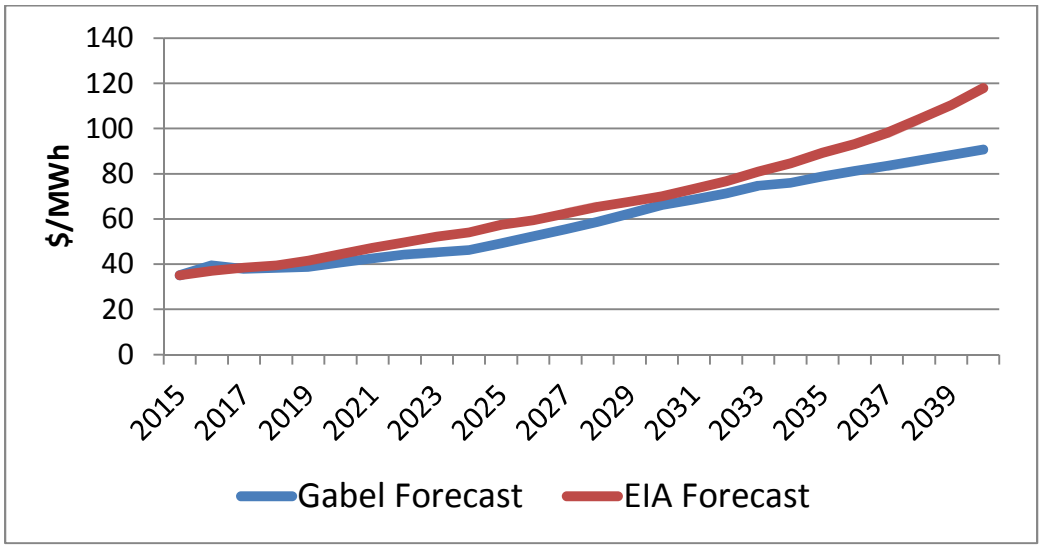
In the Lease model, a lessor funds the construction of the solar PV installation and typically takes the tax benefits, all in exchange for a fixed lease payment. The lessee takes all the benefits of solar electricity production (reduced utility purchases and SRECs) while providing maintenance and operating costs. Solar PV leases are not very common in today's market, which, in the commercial space is dominated by PPA, hybrid PPA and direct ownership models.

Financial modeling in this Report is based on various key assumptions with respect to energy prices, project costs and SREC prices. Key assumptions in the financial modeling of PV projects are discussed below.

Wholesale Energy Forecast

Solar grid-connected projects earn energy revenue by selling energy into the PJM wholesale energy markets. To estimate potential energy market revenue, Gabel conducted a detailed wholesale energy price forecast for the Commonwealth using AURORAxmp energy market simulation software. The resulting market electric energy price forecast is conservatively lower than the EIA forecast from its Annual Energy Outlook for 2015. Although there is uncertainty in any forecast, this lower energy price forecast in used in the financial modeling. A comparison of this forecast to EIA's forecast is shown in the graph below.

Wholesale Electricity Price Forecast Comparison



Retail Energy Forecasts

Electricity prices vary within Pennsylvania depending on the utility service territory. Moreover, because electricity rates are not completely determined on a volumetric basis, the average retail price for energy is not indicative of the savings that can be realized by a behind the meter project. Utilities charge commercial customers based on energy usage and monthly peak demand. Because the demand component of a utility's rate is not avoided by the energy from a PV application, the savings for a PV project are usually less than the utility's average rate. The rate used to calculate savings form a PV project is termed the "price to compare" (PTC). Attachment 5 contains PTC analysis for four major utilities in Pennsylvania: PECO, PPL, WestPenn and Penelec.

Customer benefits from PV (per kWh) can vary considerably across the Commonwealth's utilities, explaining the uneven geographic distribution of PV development throughout Pennsylvania.

SREC Forecast

The current Pennsylvania SREC market is substantially oversupplied through a combination of both in-state and out-of-state eligible solar PV generators. As a result, SREC prices have declined from around $300/MWh in 2010 to $15/MWh in October 2015. It is estimated that increasing requirements for solar energy will absorb this surplus in the next several years.

Pennsylvania's Alternate Energy Portfolio Standard (AEPS) calls for an increase in solar energy supply from 0.114% in Energy Year 2015 to 0.5% in Energy Year 2021. The current supply of PV generators registered in Pennsylvania, historic production rates, RPS/AEPS retirement patterns and estimated future solar construction were analyzed to estimate a supply forecast for SRECs. Based on

this review, it is estimated that that the Pennsylvania SREC market could recover in the 2017 to 2020 timeframe. Although prices are not expected to return to the $300/MWh peaks of 2010, prices could recover from $15/MWh today to around $200/MWh in the 2017 to 2020 timeframe if the increasing RPS demand can absorb the SREC surplus. However, with so many states contributing to Pennsylvania's SREC supply and the 0.5% peak solar requirement, it is difficult to forecast with any certainty that there will be a SREC price recovery. As a result, the most conservative financial analysis utilizes SRECs prices near the Tier 1 REC prices. The financial model examples included with this report assume SREC prices will climb to $25/MWh by 2019 and remain there throughout the analysis period.

The Tier I prices are forecasted to show continued price recovery over the next few years in response to increasing RPS/AES demand throughout the PJM market.

There are substantial uncertainties in this forecast including changes in inter-state SREC/SREC trading, neighboring states' RPS requirements for both solar and Tier I (Class I) AECs/RECs, regulatory changes, future renewable construction rates and costs and federal, state and utility incentives. These uncertainties could result in higher or lower SREC prices in the future than those used in this analysis. This SREC market volatility will continue to contribute to the current difficulties in project financing.

4. Analysis of a loan structure using a 25-year PPA with repayment of loan deferred until year 15

Financial analyses of this structure are contained in Attachment 4. A loan repayment in the out years would require a substantial cash drain in these years. Budgeting for this outlay would significantly change PPA project financing structures that have been

developed throughout the country and may limit sources of capital for projects that seek funding. As important, this structure does not address the most critical issue in capital formation for projects in Pennsylvania: low SREC prices and their continuing uncertainty.

The loan structure has the benefit of allowing the CFA to recapture revenues for subsequent re-use. However, as discussed in section 5 of this Report, a program design that allows the CFA to realize and recapture revenues can be accomplished through a different program design, address SREC price volatility and lower the risk that projects will not be constructed due to inability to obtain project financing. A summary financial analysis of a potential deferred loan project is shown in the table below. It is critical to note that although the IRR summaries may look strong, the delayed repayment of the Grant starting in year 16 causes negative cash flow during the last 10 years of ownership. This significantly reduces the project's NPV and highlights the risk of repayment default and project abandonment by the developer in year 16.

Deferred Loan Sample Financial Analysis Summary

Quick Summary of Financial Analysis			
Analysis Period	**Project NPV**	**Internal Rate of Return**	**Total CFA Loan Payments**
10 Years	**$437,888**	21.8%	**$0**
15 Years	**$578,269**	23.0%	**$0**
25 Years	**$323,594**	22.1%	**$2,136,903**
Simple Payback	**N/A ***		

5. Review PA solar energy program guidelines and evaluation criteria to provide recommendations for changes

This section reviews the provisions of the previous loan program and recommends changes to maximize the deployment of solar energy in the Commonwealth.

Under the Previous Program design $80 million was awarded and $50 million was disbursed, leaving $30 million for use in the Program going forward (Going Forward Program). Based on the analysis and factors discussed in this Report a new Program Design is recommended.

Accordingly, the following sections describe the guidelines of the Previous Program and the recommended guidelines for the Going Forward Program.

1) Eligibility

Previous Program:

Eligible applicants included the following: a) business entities including not for profit entities; b) economic development organizations; and c) political subdivisions (municipalities, counties or school districts).

Eligible solar photovoltaic (PV) and solar thermal projects included the following: a) projects that generate, distribute or store solar energy; b) projects that manufacture or assemble solar panels or other solar equipment; c) the development or construction of facilities used for the research and development of technology related to solar energy.

Eligible Use of Funds included the following:

- Acquisition of land and buildings, rights-of-way, and easements;
- Clearing and preparation of land;
- Construction or renovation of a building to be used for the manufacturing of equipment or conducting research and development related to solar energy systems;
- Engineering costs associated with construction or renovation but not to exceed 10% of grant award;
- Purchase and installation of equipment used for the manufacturing of equipment or to conduct research and development related to solar PV or solar thermal

systems;

- Design, purchase, installation and construction of facilities that generate, distribute or store solar energy or that produce hot water using solar energy;
- For eligible public and not-profit applicants, the preparation of plans, specifications, studies, surveys, necessary or incidental to determining the feasibility or practicability;
- Permit fees;
- Administrative costs of the applicant to administer a Program grant or loan, not to exceed 3% of the Program grant or loan.

Ineligible costs included but were not limited to fees for securing other financing, interest on borrowed funds, refinancing of existing debt, and costs incurred prior to the approval of CFA financing.

Recommended Changes for the Going Forward Program:

Due to limited funds and reduced interest in the marketplace (for a number of reasons) solar thermal projects should either not be eligible for the program, or alternatively the amount of awards to this technology should be limited. Historically, solar thermal projects have been difficult to market and close. While paybacks may be reasonable, the amount of savings offered to most commercial operations is relatively small in the context of their overall business operations. This presents challenges in generating interest in the technology.

It is also recommended that only behind the meter PV projects be considered eligible for CFA PV funding. Grid supply projects take substantially more time to complete (due to the PJM interconnection process and complexities involved in siting and permitting a large scale multi-megawatt project). In addition, behind the meter solar projects provide multiple benefits to multiple parties, unlike grid supply projects where, given there is no local load displaced, and there is no underlying business that will benefit from lower electricity prices. By only funding behind the meter projects the CFA can assure that economic benefits are realized by the participating customer, improving its and the Commonwealth's economic competitiveness.

2) Program Requirements

Previous Program

The following were required as a participant in the program:

- Matching funds requirement: Commitment by applicant of matching investment - $1 for every $1 of Program funds awarded.
- Other requirements included provisions related to Conflict of Interest, Nondiscrimination, Project Records, PA's Prevailing Wage Act, Proof of Notification to County or Host Municipality, Project Audit, Equipment Specifications and Installation, and Guideline Provisions.
- A non-refundable application fee in the amount of $100 for all Solar Energy Program applications, due at time of submission, and a 1% commitment fee on all approved loans.

Going Forward Program

Program Requirements should include a submission of a projected in-service date and supporting documentation to demonstrate that the in-service date is achievable. This demonstration is important as the Program should seek, to the extent practicable, to award funds to PV projects entering service in 2016 to assure receipt of the 30% FITC, thereby reducing the amount of support needed from the CFA.

3) Loans

Previous Program

a) Maximum loan amounts were established as follows:

For a manufacturer of solar equipment: not to exceed $35,000 for every new job projected to be created by the business within three years after approval of the loan.

For a solar energy generation or distribution project: not exceed $5 million or $2.25 per

watt, whichever is less. In calculating the $2.25 per watt cost, CFA did not include the cost of any energy storage equipment. The CFA considered loan requests over $5 million for projects that will significantly impact the Authority's goal to increase the amount of solar energy generated in the Commonwealth. □

For a solar research and development facility or a solar thermal project: not to exceed $5 million.

b) Repayment Term, Interest Rate and Security:

Loans were to be repaid over a period not to exceed 10 years for equipment and 15 years for real estate.

The interest rate for the loan was fixed at the time of approval of the loan and was subject to change based on market conditions.

All loans were secured by a lien on the asset financed. The Authority retained the right to require additional security as necessary, including but not limited to, a pledge of additional assets or securities or dedicated revenues.

Going Forward Program

Loans should only be available to manufacturing, and research and development applicants. Loans are not needed for PV projects, as debt from the marketplace is available for such projects so long as SREC volatility is addressed in program design.

4) Grants

Previous Program

a) Maximum grant amounts were established as follows:

For a manufacturer of solar equipment: not to exceed $5,000 for every job projected to be created by the business within three years after approval of the grant. If the manufacturer fails to create the projected number of jobs, the Authority may require the

full amount of the grant to be repaid.

For a solar energy generation or distribution project: not to exceed $1 million or $2.25 per watt, whichever is less. In calculating the $2.25 per watt cost, CFA will not include the cost of any energy storage equipment. The CFA considered grant requests over $1 million for projects that significantly impacted the Authority's goal to increase the amount of solar energy generated in the Commonwealth.

For a solar research and development facility or a solar thermal project: not to exceed $1 million.

For any grant that will be used solely for planning or feasibility studies: not to exceed 50% of the total cost of the planning project or $175,000, whichever is less.

CFA would consider grant requests for generation projects in instances where there is not a long-term contract of at least 10 years in place for Solar Renewable Energy Credits. For projects that entered into a long-term SREC contract subsequent to CFA approval of a grant, the grant approval would be rescinded and grant funds returned to the CFA.

Additionally, the guidance document stated that the preference of the Authority was to assist solar energy generation projects with low interest loans rather than grants whenever possible.

b) CFA could award grants to applicants that would serve as a guarantee for the financing in the project subject to the following conditions:

- The grant would take the form of a standby letter of credit and issued directly to the company/developer. Projects applying for a loan guarantee from the Authority were required to invest a minimum of 10% in equity as part of the project financing.
- The grant funds may only be drawn upon in the event the company defaults on its financing and there is a deficiency in collateral for the lending institution to

collect upon. The grant pays up to 75% of the deficiency.

- The term of the grant would not be more than 5 years.
- The amount of the grant not to exceed $30 million.

Going Forward Program

Due to the limited funding available, a reduction in the maximum incentive payment to individual sites should be considered. This would include a reduction in the incentive amount to manufacturing applicants, and a reduction in the maximum guarantee level.

Loans and guarantees should only be available to manufacturing, and research and development applicants. PV will be incented though a grant program, discussed below, that eliminates SREC risk to the applicant.

Energy storage should be included as an eligible project cost.

5) Application Process and Evaluation

Previous Program

Applicants were required to submit an electronic on-line Application for Assistance in addition to ten copies of the application and supplemental information to be submitted via US Mail. Applications had to be received at least 60 days prior to the next scheduled CFA meeting in order to be considered for approval at that meeting.

Projects were evaluated per the following criteria:

- The level of non-CFA matching investment in the project;
- The technical and financial feasibility of the project;
- Energy savings generated or peak load reduced by the project;
- The amount of solar energy produced by the project;
- The number and quality of the jobs to be created or preserved in Pennsylvania by

the project including construction jobs;

- The financial need of the project;
- The capital efficiency of the project;
- Project readiness;
- The level to which the project exhibits principles of sound land and water use;
- Environmental benefits arising from the project including the creation of allowances that can be used to facilitate additional economic development in the region;
- The nation and state of origin of equipment used in the solar project.

Going Forward Program

It is recommended that the assessment approach be adjusted to assure that incentive payments are competitively tested and the CFA's limited budget is efficiently utilized. Specifically, the following changes are recommended:

1) Incentive awards should be divided into two separate evaluation categories: 1) PV only and 2) Manufacturing and research and development facilities. Of the $30 million of funds available, the amount allocable to Manufacturing and research and development facilities should be capped at a level in the range of $3 million. It is not likely that multiple manufacturing and research and development facilities will present themselves to the CFA, supporting a ""soft cap" of $3 million for this category. However, in the event of an extraordinary opportunity in this area, the CFA can increase this amount.

2) Manufacturing and research and development applicants should be evaluated in accord with the following criteria:

- The level of non-CFA matching investment in the project;
- The technical and financial feasibility of the project;
- The number and quality of the jobs to be created or preserved in Pennsylvania by

the project including construction jobs;

- The likelihood of benefits to the Commonwealth
- The financial need of the project;
- The capital efficiency of the project;
- Project readiness;
- The level to which the project exhibits principles of sound land and water use

3) PV applicants should be awarded a per watt grant with a structure that eliminates SREC risk to the awardees. Grant payments should be paid upon documented project completion, which is when the project receives its permission to operate or PTO, from the local utility. As discussed elsewhere in this Report, SREC price volatility is the most significant impediment to PV development in the Commonwealth. Stated differently, there would be no shortage of capital for PV project finance if SREC prices were not so low and so uncertain in the future. This can be fully addressed by a program design element whereby upon grant award, awardees contractually commit to transfer ownership of the SRECs to the CFA. The CFA will be purchasing the SRECs in exchange for the grant.

Two objectives are accomplished with this structure: project developers no longer have SREC risk as they have monetized their SREC value at the front end (and can make their projects more readily financeable by capital that is available in the market); and the CFA can earn recurring revenue by the sale of SRECs over time.

An estimate of potential SREC revenues to CFA is shown in the table below, assuming a “medium” SREC value of $25/SREC under various rebate levels. Additional scenarios can be found on Attachment 6 of this Report.

Potential SREC revenue to CFA

Year	0.81/Watt	$1.00/Watt	$1.25/Watt
2017	$746,667	$604,800	$483,840
2018	$875,600	$709,236	$567,390
2019	$1,029,631	$834,001	$667,205
2020	$1,094,537	$886,575	$709,250
2021	$1,089,043	$882,125	$705,700
2022	$1,083,611	$877,725	$702,175
2023	$1,078,179	$873,325	$698,675
2024	$1,072,778	$868,950	$695,175
2025	$1,067,438	$864,625	$691,700
2026	$1,062,099	$860,300	$688,250
2027	$1,056,790	$856,000	$684,800
2028	$1,051,512	$851,725	$681,375
2029	$1,046,235	$847,450	$677,950
2030	$1,041,019	$843,225	$674,575
2031	$1,035,802	$839,000	$671,200
2032	$1,030,617	$834,800	$667,850
2033	$1,025,463	$830,625	$664,500
2034	$1,020,370	$826,500	$661,200
2035	$1,015,247	$822,350	$657,875
2036	$1,010,185	$818,250	$654,575
2037	$1,005,123	$814,150	$651,325
2038	$1,000,093	$810,075	$648,075
2039	$995,093	$806,025	$644,825
2040	$990,123	$802,000	$641,600
2041	$985,185	$798,000	$638,375
Total	**$25,508,441**	**$20,661,837**	**$16,529,460**
NPV	**$17,734,694**	**$14,365,102**	**$11,492,082**

These revenues can then be recycled back into the CFA's Program and be made available for incentives in the future. Securing SREC value has been a component of programs in Delaware, New Jersey and Massachusetts.

Since SRECs in Pennsylvania are generated for as long as a project generates electricity, SRECs created by these projects represent a potential value for an extended term to the CFA. Moreover, since SREC prices are likely to be higher that would be

assumed in a private financial models, CFA can realize an additional upside by owning and selling SRECs. Finally, SRECs may be banked for up to three years (the energy year in which the SREC is created and two subsequent energy years). This gives the CFA additional flexibility in maximizing potential value from the SREC commodity.

Currently, given the state of the SREC market in Pennsylvania, solar developers estimate the value of an SREC closely tracking the value of a PJM Tier 1 (Class 1) REC, currently around $15/MWh. The forecast of the Tier I market in this Report shows a continuing recovery to around $25/MWh.

The amount of the grant required to make a project economically feasible will be dependent on a number of key variables: amount of federal tax credit, system cost, secured revenue to support financing, and others. Based on current market conditions, it is estimated that grant amounts will be in the $0.81/Watt to $1.37/Watt range for 30% ITC projects.

For projects that are eligible for only 10% ITC, the economics are more challenging and developers would likely need $1.00/Watt to $1.50/Watt range and would likely have to retain SRECs for the project to be economically viable.

To evaluate the sensitivity of expected grant requests, several scenarios were modeled, varying installation costs, developer IRR targets and ITC percentage. For all of these scenarios the following Benchmark Unit of the PPA Model was used: $2.50/Watt total cost, 30% ITC and unlevered 15 year IRR of 7%.

The grant amount required under these scenarios as the key variable is changed as is shown in the tables below.

Installation Cost Sensitivity

Install Cost ($/Watt)	Rebate ($/Watt)
$2.25	$0.98
$2.50	$1.17
$2.75	$1.36

Target IRR Sensitivity

15-Year IRR	Rebate ($/Watt)
5%	$0.95
7%	$1.17
9%	$1.37

ITC Percentage Sensitivity

ITC %	Rebate ($/Watt)
30%	$1.17
10%	$1.93

Note that with only 10% ITC, grant levels would have to exceed 50% of project costs for the base project of $2.50/Watt to be economically viable. However, a project cost of $2.11/Watt could reach 7% 15-year IRR with 50% rebate level and developer keeping SRECs.

Without an explicit provision exempting SREC revenue as taxable income, SREC revenue is assumed taxable income. While the solar PV owner would be obligated to relinquish all rights to all SRECs as a condition of accepting a CFA grant, there is no tax impact on the generation owner as there will be no income realized by the generation owner from the sale of SRECs. CFA, the owner of the SRECs, as a public institution,

will not have any income tax obligation from the revenue realized from its sale of the SRECs.

The administration of SREC sales by the CFA would be addressed in the following manner:

The selling of SRECs is managed through the PJM EIS GATS system, which provides a highly developed and easy to use electronic trading platform. To administer the sale of SRECs, CFA would register in PJM EIS GATS as an aggregator, be given the right to operate on behalf of the generation owner(s) within the GATS system and would establish a GATS account.

Generation from all of the solar facilities is uploaded each month, based on monthly meter readings (which can be done remotely) into the CFA GATS account. There is a competitive market for buyers of SRECs, most of whom are power suppliers or brokers. Once SRECs are sold, the SRECs are transferred from CFA's GATS account to the counterparties' GATS accounts and the counterparties transfer payments to CFA.

There is an annual subscription fee of $1,000 for participation in PJM EIS GATS that would apply to CFA. In addition, CFA could elect the services of an SREC broker or consultant to sell SRECs on CFA's behalf and to provide advisory services. Typically, brokerage fees are set as a percentage of the associated revenues of each SREC sale. While brokerage services to sell SRECs typically reside in the 2% range, this is a competitive service that can be negotiated. Although CFA would carry a large SREC portfolio, the number and size of each project may also be factored into pricing considerations. Advisory fees will vary depending on the scope of services and how much CFA manages these sales internally.

4) PV grant awards should be determined through cost competition. In order to preserve CFA's limited funds and incent the most economically efficient projects, award criteria should be heavily price based. Specifically CFA should make a "pre-screening"

determination of eligibility for each application based on consideration of non-price factors such as the technical feasibility of the project and project readiness (status of host agreement, local approvals, confirmed financing, etc.) and those projects that satisfy pre-screening criteria should be ranked from lowest to highest per watt incentive proposed. Establishing panel efficiency as pre-screening criteria is not recommended.

Panel efficiency will be captured in the overall price of the project and the incentive required. There are some applications where lower efficiency panels (at a lower cost), are the most appropriate and cost effective selection for a given project.[5]

Awards should be made from lowest to highest cost until the Budget Amount is reached. Lower costs and efficiency is incented through this approach. This approach also simplifies the administration of the program.

A project design issue that did not have to be addressed in the Previous Program is the fact that, absent Congressional Action, the 30% FITC will be reduced to 10% for all projects that go on-line after December 31, 2016. This presents the CFA with a challenge: it is certainly in the interest of the CFA to fund projects that can take advantage of the 30% FITC as this will further extend CFA funds to more projects. However, in order for projects to meet the in-service deadline for 30% eligibility they must commence development early in 2016. CFA awards should occur by the end of February 2016, to give projects an opportunity to meet the 30% FITC deadline. The CFA should likewise design the Program so projects are not "stranded" with an award based on an expectation that they will go on-line in 2016 and earn the 30% credit but then miss the deadline and be stranded with an award that is too low (and the project does not move forward).

Two approaches can address this issue: limit the dollar amount of 2016 projects that can be awarded to reduce this risk (and evaluate 2016 and post 2016 projects separately); or allow the market to sort this issue out: applicants that believe they can

[5] For projects that are "space constrained" with respect to how much area is available to offset the site load, higher efficiency panels (at a higher cost) may be the preferred choice for the host customer.

make the December 2016 deadline will bid lower incentives. If a project is delayed and does not move forward because its incentive is too low, these funds can be placed back in the program budget for 2017.

CFA should recognize that with a 10% ITC, the level of incentive required may approach or cross over the 50% mark (total incentive greater than 50% of total project costs) that was previously not allowed in the program guidelines. CFA may need to relax this provision if projects that are likely to complete by the 2016 deadline do not absorb the available funds.

Another issue for consideration is the portfolio of winning projects that emerge from the recommended competitive process. It is difficult to assess today how many and what types of commercial projects will apply for an incentive.

One potential scenario resulting from a competitive process that awards to lowest cost proposals is that larger commercial projects could win the majority of the funds available (for example large projects on big box retail facilities). This scenario is put forward to identify the issue of award diversity. If the CFA is concerned that projects be awarded throughout all sectors of economy it can establish program applicant categories in which like projects compete against like projects (that is, a public and not for profit sector, and a commercial and industrial sector) with budget caps on each sector. It should be noted that such an approach will add complexity to the program and should only be considered if the potential outcome described above is an issue of concern to the CFA.

Attachments

Attachment 1 - Self-Own Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
Assumptions
October 19, 2015
With User-Adjustable Inputs

System Size and Output	
Photovoltaic (PV)	
Capacity (kW-DC)	1,000
Production Rate (kWh/kW)	1,200
First Year Generation (kWh)	1,200,000
Annual kWh degredation	0.50%

Economic Variables	
Costs	
Avg PV Installation Cost ($ per W-DC)	$2.40
Solar PV Installation Cost (Tax Basis)	**$2,400,000**
Utility Interconnection	$100,000
Land Cost	$0
Total Solar Installation Cost	**$2,500,000**
Program Grant	
Grant Amount $/Watt	$0.81
Total Grant Amount	$810,000
Exchange Grant for SAECs (Yes/No)	Yes
Electricity Revenue	
PPA Rate	*See Schedule*
PPA Rate Escalation	*See Schedule*
SAEC Rate and Escalation	*See Schedule*
Expenses	
Replacement PV O&M Costs ($/yr) [1]	$8,500
Ongoing PV O&M Costs ($/yr) [1]	$15,000
Insurance Costs ($/yr)	$5,000
O&M Escalation (%)	2.5%
Insurance Escalation (%)	0.0%
Other	
In Service Date	Jan 1, 2016
Project Life (Years)	25
Economic Analysis Period 1 (Years)	10
Economic Analysis Period 2 (Years)	15
Economic Analysis Period 3 (Years)	25
Federal Tax Rate	35%
State Tax Rate	3.07%
Discount Rate	8.0%

Economic Incentives	
Federal Tax Credit (Treasury Grant)	30%
Depreciation (years)	5

SAEC Schedule	
Energy Year	Annual SAEC Value ($/MWh)
2016	$15
2017	$18
2018	$21
2019	$25
2020	$25
2021	$25
2022	$25
2023	$25
2024	$25
2025	$25
2026	$25
2027	$25
2028	$25
2029	$25
2030	$25
2031	$25
2032	$25
2033	$25
2034	$25
2035	$25
2036	$25
2037	$25
2038	$25
2039	$25
2040	$25

Notes:

[1] O&M Costs are broken into ongoing and replacement cost components for PV systems. Replacement costs include one (1) inverter replacements over the 20 year life of the system. Ongoing costs for PV include periodic system inspection and monthly data oversight.

Quick Summary of Financial Analysis			
Analysis Period	**Project NPV**	**Internal Rate of Return**	**Total CFA SAEC Revenue**
10 Years	**($255,032)**	3.3%	**$275,375**
15 Years	**($70,658)**	7.0%	**$416,625**
25 Years	**$203,289**	9.9%	**$688,750**
Simple Payback	8		

Attachment 1 - Self-Own Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
Project Economics - Private Ownership (Includes Depreciation, ITC, and Taxes)
October 19, 2015

		Costs			Expenses			Revenue/Savings			EBITDA	State and Federal Taxes							After Tax Cashflow (ATCF)	
	Year	Project Costs (Tax Basis)	Interconnection and Land Costs	Total Costs	Insurance Expenses	O&M Expenses	Total Expenses	Electricity Cost Savings	Grant Revenue	Total Revenue	Pre-Tax Cashflow	State Depreciation Value	State Taxable Income	State Taxes Payable / (Recoverable)	Federal Depreciation Value	Federal Taxable Income	Fed. Taxes Payable / (Recoverable)	30% ITC	Net ATCF	Cumulative ATCF
0	2015	$2,400,000	$100,000	$2,500,000			$0			$0	($2,500,000)							$0	($2,500,000)	($2,500,000)
1	2016				$5,000	$23,500	$28,500	$132,614	$810,000	$942,614	$914,114	$480,000	$434,114	$13,327	$408,000	$492,787	$172,475	$720,000	$1,448,312	($1,051,688)
2	2017				$5,000	$24,088	$29,088	$131,935	$0	$131,935	$102,847	$768,000	($665,153)	($20,420)	$652,800	($549,953)	($192,483)		$315,751	($735,938)
3	2018				$5,000	$24,690	$29,690	$133,116	$0	$133,116	$103,427	$460,800	($357,373)	($10,971)	$391,680	($288,253)	($100,889)		$215,287	($520,651)
4	2019				$5,000	$25,307	$30,307	$137,533	$0	$137,533	$107,226	$276,000	($168,774)	($5,181)	$234,600	($127,374)	($44,581)		$156,988	($363,662)
5	2020				$5,000	$25,940	$30,940	$142,904	$0	$142,904	$111,965	$276,000	($164,035)	($5,036)	$234,600	($122,635)	($42,922)		$159,923	($203,739)
6	2021				$5,000	$26,588	$31,588	$147,658	$0	$147,658	$116,070	$139,200	($23,130)	($710)	$118,320	($2,250)	($787)		$117,568	($86,172)
7	2022				$5,000	$27,253	$32,253	$151,062	$0	$151,062	$118,809	$0	$118,809	$3,647	$0	$115,162	$40,307		$74,855	($11,316)
8	2023				$5,000	$27,934	$32,934	$153,664	$0	$153,664	$120,730	$0	$120,730	$3,706	$0	$117,024	$40,958		$76,065	$64,749
9	2024				$5,000	$28,632	$33,632	$160,415	$0	$160,415	$126,782	$0	$126,782	$3,892	$0	$122,890	$43,012		$79,879	$144,628
10	2025				$5,000	$29,348	$34,348	$168,945	$0	$168,945	$134,597	$0	$134,597	$4,132	$0	$130,465	$45,663		$84,802	$229,430
11	2026				$5,000	$30,082	$35,082	$177,625	$0	$177,625	$142,543	$0	$142,543	$4,376	$0	$138,167	$48,358		$89,809	$319,238
12	2027				$5,000	$30,834	$35,834	$186,392	$0	$186,392	$150,558	$0	$150,558	$4,622	$0	$145,936	$51,078		$94,858	$414,096
13	2028				$5,000	$31,605	$36,605	$196,300	$0	$196,300	$159,696	$0	$159,696	$4,903	$0	$154,793	$54,178		$100,615	$514,712
14	2029				$5,000	$32,395	$37,395	$206,592	$0	$206,592	$169,197	$0	$169,197	$5,194	$0	$164,002	$57,401		$106,602	$621,313
15	2030				$5,000	$33,205	$38,205	$213,907	$0	$213,907	$175,702	$0	$175,702	$5,394	$0	$170,308	$59,608		$110,700	$732,014
16	2031				$5,000	$34,035	$39,035	$220,686	$0	$220,686	$181,651	$0	$181,651	$5,577	$0	$176,075	$61,626		$114,448	$846,462
17	2032				$5,000	$34,886	$39,886	$229,219	$0	$229,219	$189,333	$0	$189,333	$5,813	$0	$183,521	$64,232		$119,288	$965,751
18	2033				$5,000	$35,758	$40,758	$233,868	$0	$233,868	$193,110	$0	$193,110	$5,928	$0	$187,181	$65,513		$121,668	$1,087,418
19	2034				$5,000	$36,652	$41,652	$239,857	$0	$239,857	$198,205	$0	$198,205	$6,085	$0	$192,120	$67,242		$124,878	$1,212,296
20	2035				$5,000	$37,568	$42,568	$246,084	$0	$246,084	$203,516	$0	$203,516	$6,248	$0	$197,268	$69,044		$128,224	$1,340,521
21	2036				$5,000	$38,507	$43,507	$254,231	$0	$254,231	$210,723	$0	$210,723	$6,469	$0	$204,254	$71,489		$132,765	$1,473,286
22	2037				$5,000	$39,470	$44,470	$262,648	$0	$262,648	$218,178	$0	$218,178	$6,698	$0	$211,480	$74,018		$137,462	$1,610,748
23	2038				$5,000	$40,457	$45,457	$271,345	$0	$271,345	$225,888	$0	$225,888	$6,935	$0	$218,953	$76,634		$142,319	$1,753,067
24	2039				$5,000	$41,468	$46,468	$280,330	$0	$280,330	$233,861	$0	$233,861	$7,180	$0	$226,682	$79,339		$147,343	$1,900,410
25	2040				$5,000	$42,505	$47,505	$289,613	$0	$289,613	$242,108	$0	$242,108	$7,433	$0	$234,675	$82,136		$152,539	$2,052,949

10 Year Analysis Summary

TOTAL	$2,400,000		$2,500,000	$50,000	$263,279	$313,279	$1,459,848	$810,000	$2,269,848	($543,432)			($13,613)			($39,248)	$720,000	$229,430
NPV				$33,550	$173,931	$207,482	$962,640	$750,000	$1,712,640	($994,842)			($13,568)			($59,575)	$666,667	($255,032)

10 Year IRR	**3.3%**

15 Year Analysis Summary

TOTAL	$2,400,000		$2,500,000	$75,000	$421,400	$496,400	$2,440,664	$810,000	$3,250,664	$254,264			$10,876	$2,040,000	$661,069	$231,374	$720,000	$732,014
NPV				$42,797	$232,195	$274,993	$1,322,787	$750,000	$2,072,787	($702,206)			($4,584)	$1,655,041	$113,437	$39,703	$666,667	($70,658)

15 Year IRR	**7.0%**

25 Year Analysis Summary

TOTAL	$2,400,000		$2,500,000	$125,000	$802,707	$927,707	$4,968,545	$810,000	$5,778,545	$2,350,837			$75,241			$942,647	$720,000	$2,052,949
NPV				$53,374	$311,606	$364,980	$1,847,581	$750,000	$2,597,581	($267,399)	$1,947,107	$285,493	$8,765	$1,655,041	$534,895	$187,213	$666,667	$203,289

25 Year IRR	**9.9%**
Simple Payback (years)	**8**

Attachment 1 - Self-Own Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
Retail Electricity Cost Savings
October 19, 2015

	Year	Solar PTC $ per KWH	Solar Generation kWh	Electricity Cost Savings
1	2016	$0.111	1,200,000	$132,614
2	2017	$0.110	1,194,000	$131,935
3	2018	$0.112	1,188,030	$133,116
4	2019	$0.116	1,182,090	$137,533
5	2020	$0.121	1,176,179	$142,904
6	2021	$0.126	1,170,299	$147,658
7	2022	$0.130	1,164,447	$151,062
8	2023	$0.133	1,158,625	$153,664
9	2024	$0.139	1,152,832	$160,415
10	2025	$0.147	1,147,067	$168,945
11	2026	$0.156	1,141,332	$177,625
12	2027	$0.164	1,135,625	$186,392
13	2028	$0.174	1,129,947	$196,300
14	2029	$0.184	1,124,298	$206,592
15	2030	$0.191	1,118,676	$213,907
16	2031	$0.198	1,113,083	$220,686
17	2032	$0.207	1,107,517	$229,219
18	2033	$0.212	1,101,980	$233,868
19	2034	$0.219	1,096,470	$239,857
20	2035	$0.226	1,090,988	$246,084
21	2036	$0.234	1,085,533	$254,231
22	2037	$0.243	1,080,105	$262,648
23	2038	$0.252	1,074,704	$271,345
24	2039	$0.262	1,069,331	$280,330
25	2040	$0.272	1,063,984	$289,613

10 Year Analysis Summary

Total	**11,733,569**	**$1,459,848**
NPV		**$962,640**

15 Year Analysis Summary

Total	**17,383,447**	**$2,440,664**
NPV		**$1,322,787**

25 Year Analysis Summary

Total	**28,267,142**	**$4,968,545**
NPV		**$1,847,581**

Attachment 1 - Self-Own Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
Electric Retail Rate and Solar Price to Compare (SPTC) Forecast
October 19, 2015

		PECO		PPL		West Penn		Penelec		Average	
	Year	Utility Rate	SPTC Rate	Utility Rate	SPTC Rate	Utility Rate	SPTC Rate	Utility Rate	SPTC Rate	Utility Rate	SPTC Rate
1	2016	0.121	0.111	0.121	0.116	0.100	0.097	0.125	0.118	0.117	0.111
2	2017	0.122	0.112	0.123	0.117	0.101	0.098	0.122	0.115	0.117	0.110
3	2018	0.124	0.114	0.125	0.119	0.103	0.099	0.123	0.116	0.119	0.112
4	2019	0.130	0.119	0.130	0.125	0.108	0.104	0.125	0.118	0.123	0.116
5	2020	0.135	0.124	0.136	0.130	0.113	0.109	0.131	0.123	0.129	0.121
6	2021	0.140	0.129	0.141	0.135	0.117	0.113	0.136	0.128	0.133	0.126
7	2022	0.143	0.132	0.144	0.138	0.120	0.116	0.141	0.133	0.137	0.130
8	2023	0.146	0.135	0.147	0.141	0.122	0.118	0.144	0.136	0.140	0.133
9	2024	0.154	0.143	0.156	0.149	0.129	0.125	0.147	0.139	0.147	0.139
10	2025	0.163	0.151	0.165	0.158	0.137	0.133	0.156	0.147	0.155	0.147
11	2026	0.171	0.159	0.174	0.167	0.145	0.141	0.165	0.156	0.164	0.156
12	2027	0.180	0.167	0.183	0.176	0.153	0.148	0.173	0.165	0.172	0.164
13	2028	0.190	0.177	0.194	0.187	0.162	0.158	0.183	0.174	0.182	0.174
14	2029	0.200	0.187	0.205	0.197	0.171	0.167	0.193	0.184	0.192	0.184
15	2030	0.206	0.193	0.212	0.204	0.178	0.173	0.204	0.194	0.200	0.191
16	2031	0.214	0.200	0.220	0.212	0.184	0.179	0.211	0.201	0.207	0.198
17	2032	0.223	0.209	0.230	0.222	0.193	0.188	0.218	0.209	0.216	0.207
18	2033	0.227	0.213	0.234	0.226	0.196	0.191	0.228	0.218	0.221	0.212
19	2034	0.235	0.221	0.242	0.234	0.203	0.198	0.233	0.222	0.228	0.219
20	2035	0.242	0.227	0.249	0.241	0.209	0.204	0.240	0.230	0.235	0.226
21	2036	0.251	0.236	0.259	0.250	0.217	0.212	0.249	0.238	0.244	0.234
22	2037	0.260	0.245	0.269	0.260	0.226	0.221	0.258	0.247	0.253	0.243
23	2038	0.270	0.254	0.279	0.270	0.235	0.230	0.267	0.256	0.263	0.252
24	2039	0.280	0.264	0.290	0.281	0.244	0.239	0.276	0.265	0.272	0.262
25	2040	0.290	0.274	0.301	0.292	0.254	0.248	0.286	0.274	0.283	0.272

* Many variables can influence a customer's electric rate, which may be higher or lower than these examples

Attachment 1 - Self-Own Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
SAEC Revenue Schedule Converting Energy Year to Calendar Year
October 19, 2015

		Jan - May	Jun - Dec						
	Year	Energy Year 1	Energy Year 2	EY1 SAECs Generated	EY2 SAEC Generated	EY1 SAEC $/SAEC	EY2 SAEC $/SAEC	SAEC Revenue	SAEC To CFA
1	2016	2016	2017	480	720	$15	$18	$0	$20,160
2	2017	2017	2018	478	716	$18	$21	$0	$23,640
3	2018	2018	2019	475	713	$21	$25	$0	$27,800
4	2019	2019	2020	473	709	$25	$25	$0	$29,550
5	2020	2020	2021	470	706	$25	$25	$0	$29,400
6	2021	2021	2022	468	702	$25	$25	$0	$29,250
7	2022	2022	2023	466	699	$25	$25	$0	$29,125
8	2023	2023	2024	463	695	$25	$25	$0	$28,950
9	2024	2024	2025	461	692	$25	$25	$0	$28,825
10	2025	2025	2026	459	688	$25	$25	$0	$28,675
11	2026	2026	2027	457	685	$25	$25	$0	$28,550
12	2027	2027	2028	454	681	$25	$25	$0	$28,375
13	2028	2028	2029	452	678	$25	$25	$0	$28,250
14	2029	2029	2030	450	675	$25	$25	$0	$28,125
15	2030	2030	2031	447	671	$25	$25	$0	$27,950
16	2031	2031	2032	445	668	$25	$25	$0	$27,825
17	2032	2032	2033	443	665	$25	$25	$0	$27,700
18	2033	2033	2034	441	661	$25	$25	$0	$27,550
19	2034	2034	2035	439	658	$25	$25	$0	$27,425
20	2035	2035	2036	436	655	$25	$25	$0	$27,275
21	2036	2036	2037	434	651	$25	$25	$0	$27,125
22	2037	2037	2038	432	648	$25	$25	$0	$27,000
23	2038	2038	2039	430	645	$25	$25	$0	$26,875
24	2039	2039	2040	428	642	$25	$25	$0	$26,750
25	2040	2040	2041	426	638	$25	$25	$0	$26,600
							Total	**$0**	**$275,375**
							NPV	**$0**	**$181,501**

Notes:

Pennsylvania Energy Years run from June 1, through May 31 and identified by the year ending date (e.g. June 1, 2015 - May 31, 2016 is EY 2016)
Economic analysis has been done by calendar year. Solar production is split into energy years for accurate SAEC revenue.
Based on PVWatts data, solar production is estimated to be 40% of annual for Jan through May and 60% for Jun through Dec.

Attachment 1 - Self-Own Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
Accelerated Depreciation
October 19, 2015

Federal			
Year	Deprececiation Rate	Depreciation Value	Est. Tax Benefit
2016	20.0%	$408,000	$142,800
2017	32.0%	$652,800	$228,480
2018	19.2%	$391,680	$137,088
2019	11.5%	$234,600	$82,110
2020	11.5%	$234,600	$82,110
2021	5.8%	$118,320	$41,412
2022	0.0%	$0	$0
2023	0.0%	$0	$0
2024	0.0%	$0	$0
2025	0.0%	$0	$0
2026	0.0%	$0	$0
2027	0.0%	$0	$0
2028	0.0%	$0	$0
2029	0.0%	$0	$0
2030	0.0%	$0	$0
2031	0.0%	$0	$0
2032	0.0%	$0	$0
2033	0.0%	$0	$0
2034	0.0%	$0	$0
2035	0.0%	$0	$0
Total	100%	$2,040,000	$714,000

State		
Year	Deprececiation Rate	MACRS Deprec.
2016	20.0%	$480,000
2017	32.0%	$768,000
2018	19.2%	$460,800
2019	11.5%	$276,000
2020	11.5%	$276,000
2021	5.8%	$139,200
2022	0.0%	$0
2023	0.0%	$0
2024	0.0%	$0
2025	0.0%	$0
2026	0.0%	$0
2027	0.0%	$0
2028	0.0%	$0
2029	0.0%	$0
2030	0.0%	$0
2031	0.0%	$0
2032	0.0%	$0
2033	0.0%	$0
2034	0.0%	$0
2035	0.0%	$0
Total	100%	$2,400,000

Attachment 2 - Public Entity Self-Own Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
Assumptions
October 19, 2015
With User-Adjustable Inputs

System Size and Output	
Photovoltaic (PV)	
Capacity (kW-DC)	1,000
Production Rate (kWh/kW)	1,200
First Year Generation (kWh)	1,200,000
Annual kWh degredation	0.50%

Economic Variables	
Costs	
Avg PV Installation Cost ($ per W-DC)	$2.40
Solar PV Installation Cost (Tax Basis)	**$2,400,000**
Utility Interconnection	$100,000
Land Cost	$0
Total Solar Installation Cost	**$2,500,000**
Program Grant	
Grant Amount $/Watt	$1.25
Total Grant Amount	$1,250,000
Exchange Grant for SAECs (Yes/No)	Yes
Electricity Revenue	
PPA Rate	*See Schedule*
PPA Rate Escalation	*See Schedule*
SAEC Rate and Escalation	*See Schedule*
Expenses	
Replacement PV O&M Costs ($/yr) [1]	$8,500
Ongoing PV O&M Costs ($/yr) [1]	$15,000
Insurance Costs ($/yr)	$5,000
O&M Escalation (%)	2.5%
Insurance Escalation (%)	0.0%
Other	
In Service Date	Jan 1, 2016
Project Life (Years)	25
Economic Analysis Period 1 (Years)	10
Economic Analysis Period 2 (Years)	15
Economic Analysis Period 3 (Years)	25
Federal Tax Rate	0%
State Tax Rate	0.00%
Discount Rate	5.0%

Economic Incentives	
Federal Tax Credit (Treasury Grant)	0%
Depreciation (years)	5

SAEC Schedule	
Energy Year	Annual SAEC Value ($/MWh)
2016	$15
2017	$18
2018	$21
2019	$25
2020	$25
2021	$25
2022	$25
2023	$25
2024	$25
2025	$25
2026	$25
2027	$25
2028	$25
2029	$25
2030	$25
2031	$25
2032	$25
2033	$25
2034	$25
2035	$25
2036	$25
2037	$25
2038	$25
2039	$25
2040	$25

Notes:

[1] O&M Costs are broken into ongoing and replacement cost components for PV systems. Replacement costs include one (1) inverter replacements over the 20 year life of the system. Ongoing costs for PV include periodic system inspection and monthly data oversight.

Quick Summary of Financial Analysis			
Analysis Period	**Project NPV**	**Internal Rate of Return**	**Total CFA SAEC Revenue**
10 Years	**($434,676)**	-1.3%	**$275,375**
15 Years	**($12,836)**	4.9%	**$416,625**
25 Years	**$756,139**	8.9%	**$688,750**
Simple Payback	11		

Attachment 2 - Public Entity Self-Own Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
Project Economics - Public Ownership (Excludes Depreciation, ITC, and Taxes)
October 19, 2015

		Costs			Expenses			Revenue/Savings				State and Federal Taxes							After Tax Cashflow (ATCF)	
	Year	Project Costs (Tax Basis)	Interconnection and Land Costs	Total Costs	Insurance Expenses	O&M Expenses	Total Expenses	Electricity Cost Savings	Grant Revenue	Total Revenue	Pre-Tax Cashflow	State Depreciation Value	State Taxable Income	State Taxes Payable / (Recoverable)	Federal Depreciation Value	Federal Taxable Income	Fed. Taxes Payable / (Recoverable)	0% ITC	Net ATCF	Cumulative ATCF
0	2015	$2,400,000	$100,000	$2,500,000			$0			$0	($2,500,000)							$0	($2,500,000)	($2,500,000)
1	2016				$5,000	$23,500	$28,500	$132,614	$1,250,000	$1,382,614	$1,354,114	$0	$0	$0	$0	$0	$0	$0	$1,354,114	($1,145,886)
2	2017				$5,000	$24,088	$29,088	$131,935	$0	$131,935	$102,847	$0	$0	$0	$0	$0	$0		$102,847	($1,043,038)
3	2018				$5,000	$24,690	$29,690	$133,116	$0	$133,116	$103,427	$0	$0	$0	$0	$0	$0		$103,427	($939,612)
4	2019				$5,000	$25,307	$30,307	$137,533	$0	$137,533	$107,226	$0	$0	$0	$0	$0	$0		$107,226	($832,385)
5	2020				$5,000	$25,940	$30,940	$142,904	$0	$142,904	$111,965	$0	$0	$0	$0	$0	$0		$111,965	($720,421)
6	2021				$5,000	$26,588	$31,588	$147,658	$0	$147,658	$116,070	$0	$0	$0	$0	$0	$0		$116,070	($604,350)
7	2022				$5,000	$27,253	$32,253	$151,062	$0	$151,062	$118,809	$0	$0	$0	$0	$0	$0		$118,809	($485,541)
8	2023				$5,000	$27,934	$32,934	$153,664	$0	$153,664	$120,730	$0	$0	$0	$0	$0	$0		$120,730	($364,811)
9	2024				$5,000	$28,632	$33,632	$160,415	$0	$160,415	$126,782	$0	$0	$0	$0	$0	$0		$126,782	($238,029)
10	2025				$5,000	$29,348	$34,348	$168,945	$0	$168,945	$134,597	$0	$0	$0	$0	$0	$0		$134,597	($103,432)
11	2026				$5,000	$30,082	$35,082	$177,625	$0	$177,625	$142,543	$0	$0	$0	$0	$0	$0		$142,543	$39,111
12	2027				$5,000	$30,834	$35,834	$186,392	$0	$186,392	$150,558	$0	$0	$0	$0	$0	$0		$150,558	$189,669
13	2028				$5,000	$31,605	$36,605	$196,300	$0	$196,300	$159,696	$0	$0	$0	$0	$0	$0		$159,696	$349,365
14	2029				$5,000	$32,395	$37,395	$206,592	$0	$206,592	$169,197	$0	$0	$0	$0	$0	$0		$169,197	$518,562
15	2030				$5,000	$33,205	$38,205	$213,907	$0	$213,907	$175,702	$0	$0	$0	$0	$0	$0		$175,702	$694,264
16	2031				$5,000	$34,035	$39,035	$220,686	$0	$220,686	$181,651	$0	$0	$0	$0	$0	$0		$181,651	$875,915
17	2032				$5,000	$34,886	$39,886	$229,219	$0	$229,219	$189,333	$0	$0	$0	$0	$0	$0		$189,333	$1,065,248
18	2033				$5,000	$35,758	$40,758	$233,868	$0	$233,868	$193,110	$0	$0	$0	$0	$0	$0		$193,110	$1,258,358
19	2034				$5,000	$36,652	$41,652	$239,857	$0	$239,857	$198,205	$0	$0	$0	$0	$0	$0		$198,205	$1,456,563
20	2035				$5,000	$37,568	$42,568	$246,084	$0	$246,084	$203,516	$0	$0	$0	$0	$0	$0		$203,516	$1,660,079
21	2036				$5,000	$38,507	$43,507	$254,231	$0	$254,231	$210,723	$0	$0	$0	$0	$0	$0		$210,723	$1,870,802
22	2037				$5,000	$39,470	$44,470	$262,648	$0	$262,648	$218,178	$0	$0	$0	$0	$0	$0		$218,178	$2,088,980
23	2038				$5,000	$40,457	$45,457	$271,345	$0	$271,345	$225,888	$0	$0	$0	$0	$0	$0		$225,888	$2,314,868
24	2039				$5,000	$41,468	$46,468	$280,330	$0	$280,330	$233,861	$0	$0	$0	$0	$0	$0		$233,861	$2,548,729
25	2040				$5,000	$42,505	$47,505	$289,613	$0	$289,613	$242,108	$0	$0	$0	$0	$0	$0		$242,108	$2,790,837

10 Year Analysis Summary

TOTAL	$2,400,000		$2,500,000	$50,000	$263,279	$313,279	$1,459,848	$1,250,000	$2,709,848	($103,432)			$0			$0	$0	($103,432)
NPV				$38,609	$201,291	$239,899	$1,114,748	$1,190,476	$2,305,224	($434,676)			$0			$0	$0	($434,676)

10 Year IRR	**-1.3%**

15 Year Analysis Summary

TOTAL	$2,400,000		$2,500,000	$75,000	$421,400	$496,400	$2,440,664	$1,250,000	$3,690,664	$694,264			$0	$0	$0	$0	$0	$694,264
NPV				$51,898	$285,143	$337,041	$1,633,730	$1,190,476	$2,824,206	($12,836)			$0	$0	$0	$0	$0	($12,836)

15 Year IRR	**4.9%**

25 Year Analysis Summary

TOTAL	$2,400,000		$2,500,000	$125,000	$802,707	$927,707	$4,968,545	$1,250,000	$6,218,545	$2,790,837			$0			$0	$0	$2,790,837
NPV				$70,470	$425,374	$495,843	$2,561,506	$1,190,476	$3,751,982	$756,139	$0	$0	$0	$0	$0	$0	$0	$756,139

25 Year IRR	**8.9%**
Simple Payback (years)	**11**

Attachment 2 - Public Entity Self-Own Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
Retail Electricity Cost Savings
October 19, 2015

	Year	Solar PTC $ per KWH	Solar Generation kWh	Electricity Cost Savings
1	2016	$0.111	1,200,000	$132,614
2	2017	$0.110	1,194,000	$131,935
3	2018	$0.112	1,188,030	$133,116
4	2019	$0.116	1,182,090	$137,533
5	2020	$0.121	1,176,179	$142,904
6	2021	$0.126	1,170,299	$147,658
7	2022	$0.130	1,164,447	$151,062
8	2023	$0.133	1,158,625	$153,664
9	2024	$0.139	1,152,832	$160,415
10	2025	$0.147	1,147,067	$168,945
11	2026	$0.156	1,141,332	$177,625
12	2027	$0.164	1,135,625	$186,392
13	2028	$0.174	1,129,947	$196,300
14	2029	$0.184	1,124,298	$206,592
15	2030	$0.191	1,118,676	$213,907
16	2031	$0.198	1,113,083	$220,686
17	2032	$0.207	1,107,517	$229,219
18	2033	$0.212	1,101,980	$233,868
19	2034	$0.219	1,096,470	$239,857
20	2035	$0.226	1,090,988	$246,084
21	2036	$0.234	1,085,533	$254,231
22	2037	$0.243	1,080,105	$262,648
23	2038	$0.252	1,074,704	$271,345
24	2039	$0.262	1,069,331	$280,330
25	2040	$0.272	1,063,984	$289,613

10 Year Analysis Summary

Total	**11,733,569**	**$1,459,848**
NPV		**$1,114,748**

15 Year Analysis Summary

Total	**17,383,447**	**$2,440,664**
NPV		**$1,633,730**

25 Year Analysis Summary

Total	**28,267,142**	**$4,968,545**
NPV		**$2,561,506**

Attachment 2 - Public Entity Self-Own Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
Electric Retail Rate and Solar Price to Compare (SPTC) Forecast
October 19, 2015

		PECO		PPL		West Penn		Penelec		Average	
	Year	Utility Rate	SPTC Rate	Utility Rate	SPTC Rate	Utility Rate	SPTC Rate	Utility Rate	SPTC Rate	Utility Rate	SPTC Rate
1	2016	0.121	0.111	0.121	0.116	0.100	0.097	0.125	0.118	0.117	0.111
2	2017	0.122	0.112	0.123	0.117	0.101	0.098	0.122	0.115	0.117	0.110
3	2018	0.124	0.114	0.125	0.119	0.103	0.099	0.123	0.116	0.119	0.112
4	2019	0.130	0.119	0.130	0.125	0.108	0.104	0.125	0.118	0.123	0.116
5	2020	0.135	0.124	0.136	0.130	0.113	0.109	0.131	0.123	0.129	0.121
6	2021	0.140	0.129	0.141	0.135	0.117	0.113	0.136	0.128	0.133	0.126
7	2022	0.143	0.132	0.144	0.138	0.120	0.116	0.141	0.133	0.137	0.130
8	2023	0.146	0.135	0.147	0.141	0.122	0.118	0.144	0.136	0.140	0.133
9	2024	0.154	0.143	0.156	0.149	0.129	0.125	0.147	0.139	0.147	0.139
10	2025	0.163	0.151	0.165	0.158	0.137	0.133	0.156	0.147	0.155	0.147
11	2026	0.171	0.159	0.174	0.167	0.145	0.141	0.165	0.156	0.164	0.156
12	2027	0.180	0.167	0.183	0.176	0.153	0.148	0.173	0.165	0.172	0.164
13	2028	0.190	0.177	0.194	0.187	0.162	0.158	0.183	0.174	0.182	0.174
14	2029	0.200	0.187	0.205	0.197	0.171	0.167	0.193	0.184	0.192	0.184
15	2030	0.206	0.193	0.212	0.204	0.178	0.173	0.204	0.194	0.200	0.191
16	2031	0.214	0.200	0.220	0.212	0.184	0.179	0.211	0.201	0.207	0.198
17	2032	0.223	0.209	0.230	0.222	0.193	0.188	0.218	0.209	0.216	0.207
18	2033	0.227	0.213	0.234	0.226	0.196	0.191	0.228	0.218	0.221	0.212
19	2034	0.235	0.221	0.242	0.234	0.203	0.198	0.233	0.222	0.228	0.219
20	2035	0.242	0.227	0.249	0.241	0.209	0.204	0.240	0.230	0.235	0.226
21	2036	0.251	0.236	0.259	0.250	0.217	0.212	0.249	0.238	0.244	0.234
22	2037	0.260	0.245	0.269	0.260	0.226	0.221	0.258	0.247	0.253	0.243
23	2038	0.270	0.254	0.279	0.270	0.235	0.230	0.267	0.256	0.263	0.252
24	2039	0.280	0.264	0.290	0.281	0.244	0.239	0.276	0.265	0.272	0.262
25	2040	0.290	0.274	0.301	0.292	0.254	0.248	0.286	0.274	0.283	0.272

* Many variables can influence a customer's electric rate, which may be higher or lower than these examples

Attachment 2 - Public Entity Self-Own Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
SAEC Revenue Schedule Converting Energy Year to Calendar Year
October 19, 2015

		Jan - May	Jun - Dec						
	Year	Energy Year 1	Energy Year 2	EY1 SAECs Generated	EY2 SAEC Generated	EY1 SAEC $/SAEC	EY2 SAEC $/SAEC	SAEC Revenue	SAEC To CFA
1	2016	2016	2017	480	720	$15	$18	$0	$20,160
2	2017	2017	2018	478	716	$18	$21	$0	$23,640
3	2018	2018	2019	475	713	$21	$25	$0	$27,800
4	2019	2019	2020	473	709	$25	$25	$0	$29,550
5	2020	2020	2021	470	706	$25	$25	$0	$29,400
6	2021	2021	2022	468	702	$25	$25	$0	$29,250
7	2022	2022	2023	466	699	$25	$25	$0	$29,125
8	2023	2023	2024	463	695	$25	$25	$0	$28,950
9	2024	2024	2025	461	692	$25	$25	$0	$28,825
10	2025	2025	2026	459	688	$25	$25	$0	$28,675
11	2026	2026	2027	457	685	$25	$25	$0	$28,550
12	2027	2027	2028	454	681	$25	$25	$0	$28,375
13	2028	2028	2029	452	678	$25	$25	$0	$28,250
14	2029	2029	2030	450	675	$25	$25	$0	$28,125
15	2030	2030	2031	447	671	$25	$25	$0	$27,950
16	2031	2031	2032	445	668	$25	$25	$0	$27,825
17	2032	2032	2033	443	665	$25	$25	$0	$27,700
18	2033	2033	2034	441	661	$25	$25	$0	$27,550
19	2034	2034	2035	439	658	$25	$25	$0	$27,425
20	2035	2035	2036	436	655	$25	$25	$0	$27,275
21	2036	2036	2037	434	651	$25	$25	$0	$27,125
22	2037	2037	2038	432	648	$25	$25	$0	$27,000
23	2038	2038	2039	430	645	$25	$25	$0	$26,875
24	2039	2039	2040	428	642	$25	$25	$0	$26,750
25	2040	2040	2041	426	638	$25	$25	$0	$26,600
							Total	$0	$275,375
							NPV	$0	$210,308

Notes:

Pennsylvania Energy Years run from June 1, through May 31 and identified by the year ending date (e.g. June 1, 2015 - May 31, 2016 is EY 2016)
Economic analysis has been done by calendar year. Solar production is split into energy years for accurate SAEC revenue.
Based on PVWatts data, solar production is estimated to be 40% of annual for Jan through May and 60% for Jun through Dec.

Attachment 3 - Power Purchase Agreement (PPA) Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
Assumptions
October 19, 2015
With User-Adjustable Inputs

System Size and Output	
Photovoltaic (PV)	
Capacity (kW-DC)	1,000
Production Rate (kWh/kW)	1,200
First Year Generation (kWh)	1,200,000
Annual kWh degredation	0.50%

Economic Variables	
Costs	
Avg PV Installation Cost ($ per W-DC)	$2.40
Solar PV Installation Cost (Tax Basis)	**$2,400,000**
Utility Interconnection	$100,000
Land Cost	$0
Total Solar Installation Cost	**$2,500,000**
Program Grant	
Grant Amount $/Watt	$1.17
Grant/Rebate	$1,170,000
Exchange Grant for SAECs (Yes/No)	Yes
Electricity Revenue	
PPA Rate	$0.09
PPA Rate Escalation	*2.0%*
SAEC Rate and Escalation	*See Schedule*
Expenses	
Replacement PV O&M Costs ($/yr) [1]	$8,500
Ongoing PV O&M Costs ($/yr) [1]	$15,000
Insurance Costs ($/yr)	$5,000
O&M Escalation (%)	2.5%
Insurance Escalation (%)	0.0%
Other	
In Service Date	Jan 1, 2016
Project Life (Years)	25
Economic Analysis Period 1 (Years)	10
Economic Analysis Period 2 (Years)	15
Economic Analysis Period 3 (Years)	25
Federal Tax Rate	35%
State Tax Rate	3.07%
Discount Rate	8.0%

Economic Incentives	
Federal Tax Credit (Treasury Grant)	30%
Depreciation (years)	5

SAEC Schedule	
Energy Year	Annual SAEC Value ($/MWh)
2016	$15
2017	$18
2018	$21
2019	$25
2020	$25
2021	$25
2022	$25
2023	$25
2024	$25
2025	$25
2026	$25
2027	$25
2028	$25
2029	$25
2030	$25
2031	$25
2032	$25
2033	$25
2034	$25
2035	$25
2036	$25
2037	$25
2038	$25
2039	$25
2040	$25

Notes:

[1] O&M Costs are broken into ongoing and replacement cost components for PV systems. Replacement costs include one (1) inverter replacements over the 20 year life of the system. Ongoing costs for PV include periodic system inspection and monthly data oversight.

Quick Summary of Financial Analysis			
Analysis Period	**Project NPV**	**Internal Rate of Return**	**Total CFA SAEC Revenue**
10 Years	**($166,600)**	4.5%	**$275,375**
15 Years	**($59,162)**	7.0%	**$416,625**
25 Years	**$74,585**	9.0%	**$688,750**
Simple Payback	6		

Attachment 3 - Power Purchase Agreement (PPA) Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
Project Economics - Private Ownership (Includes Depreciation, ITC, and Taxes)
October 19, 2015

		Costs			Expenses			Revenue/Savings			EBITDA	State and Federal Taxes							After Tax Cashflow (ATCF)	
	Year	Project Costs (Tax Basis)	Interconnection and Land Costs	Total Costs	Insurance Expenses	O&M Expenses	Total Expenses	Electricity Revenue	Grant Revenue	Total Revenue	Pre-Tax Cashflow	State Depreciation Value	State Taxable Income	State Taxes Payable / (Recoverable)	Federal Depreciation Value	Federal Taxable Income	Fed. Taxes Payable / (Recoverable)	30% ITC	Net ATCF	Cumulative ATCF
0	2015	$2,400,000	$100,000	$2,500,000			$0			$0	($2,500,000)							$0	($2,500,000)	($2,500,000)
1	2016				$5,000	$23,500	$28,500	$108,000	$1,170,000	$1,278,000	$1,249,500	$480,000	$769,500	$23,624	$408,000	$817,876	$286,257	$720,000	$1,659,620	($840,380)
2	2017				$5,000	$24,088	$29,088	$109,609	$0	$109,609	$80,522	$768,000	($687,478)	($21,106)	$652,800	($572,278)	($200,297)		$301,925	($538,456)
3	2018				$5,000	$24,690	$29,690	$111,242	$0	$111,242	$81,553	$460,800	($379,247)	($11,643)	$391,680	($310,127)	($108,545)		$201,740	($336,716)
4	2019				$5,000	$25,307	$30,307	$112,900	$0	$112,900	$82,593	$276,000	($193,407)	($5,938)	$234,600	($152,007)	($53,202)		$141,733	($194,983)
5	2020				$5,000	$25,940	$30,940	$114,582	$0	$114,582	$83,642	$276,000	($192,358)	($5,905)	$234,600	($150,958)	($52,835)		$142,383	($52,600)
6	2021				$5,000	$26,588	$31,588	$116,289	$0	$116,289	$84,701	$139,200	($54,499)	($1,673)	$118,320	($33,619)	($11,767)		$98,141	$45,541
7	2022				$5,000	$27,253	$32,253	$118,022	$0	$118,022	$85,769	$0	$85,769	$2,633	$0	$83,136	$29,098		$54,039	$99,580
8	2023				$5,000	$27,934	$32,934	$119,781	$0	$119,781	$86,846	$0	$86,846	$2,666	$0	$84,180	$29,463		$54,717	$154,297
9	2024				$5,000	$28,632	$33,632	$121,565	$0	$121,565	$87,933	$0	$87,933	$2,700	$0	$85,233	$29,832		$55,402	$209,699
10	2025				$5,000	$29,348	$34,348	$123,377	$0	$123,377	$89,028	$0	$89,028	$2,733	$0	$86,295	$30,203		$56,092	$265,791
11	2026				$5,000	$30,082	$35,082	$125,215	$0	$125,215	$90,133	$0	$90,133	$2,767	$0	$87,366	$30,578		$56,788	$322,579
12	2027				$5,000	$30,834	$35,834	$127,081	$0	$127,081	$91,247	$0	$91,247	$2,801	$0	$88,445	$30,956		$57,489	$380,068
13	2028				$5,000	$31,605	$36,605	$128,974	$0	$128,974	$92,369	$0	$92,369	$2,836	$0	$89,534	$31,337		$58,197	$438,265
14	2029				$5,000	$32,395	$37,395	$130,896	$0	$130,896	$93,501	$0	$93,501	$2,870	$0	$90,630	$31,721		$58,910	$497,175
15	2030				$5,000	$33,205	$38,205	$132,846	$0	$132,846	$94,641	$0	$94,641	$2,905	$0	$91,736	$32,108		$59,628	$556,803
16	2031				$5,000	$34,035	$39,035	$134,826	$0	$134,826	$95,791	$0	$95,791	$2,941	$0	$92,850	$32,497		$60,352	$617,155
17	2032				$5,000	$34,886	$39,886	$136,835	$0	$136,835	$96,949	$0	$96,949	$2,976	$0	$93,972	$32,890		$61,082	$678,237
18	2033				$5,000	$35,758	$40,758	$138,873	$0	$138,873	$98,115	$0	$98,115	$3,012	$0	$95,103	$33,286		$61,817	$740,054
19	2034				$5,000	$36,652	$41,652	$140,943	$0	$140,943	$99,291	$0	$99,291	$3,048	$0	$96,242	$33,685		$62,558	$802,612
20	2035				$5,000	$37,568	$42,568	$143,043	$0	$143,043	$100,474	$0	$100,474	$3,085	$0	$97,390	$34,086		$63,303	$865,915
21	2036				$5,000	$38,507	$43,507	$145,174	$0	$145,174	$101,667	$0	$101,667	$3,121	$0	$98,545	$34,491		$64,054	$929,970
22	2037				$5,000	$39,470	$44,470	$147,337	$0	$147,337	$102,867	$0	$102,867	$3,158	$0	$99,709	$34,898		$64,811	$994,781
23	2038				$5,000	$40,457	$45,457	$149,532	$0	$149,532	$104,075	$0	$104,075	$3,195	$0	$100,880	$35,308		$65,572	$1,060,353
24	2039				$5,000	$41,468	$46,468	$151,760	$0	$151,760	$105,292	$0	$105,292	$3,232	$0	$102,060	$35,721		$66,339	$1,126,692
25	2040				$5,000	$42,505	$47,505	$154,022	$0	$154,022	$106,517	$0	$106,517	$3,270	$0	$103,247	$36,136		$67,110	$1,193,802

10 Year Analysis Summary

TOTAL	$2,400,000		$2,500,000	$50,000	$263,279	$313,279	$1,155,368	$1,170,000	$2,325,368	($487,912)			($11,909)			($21,794)	$720,000	$265,791
NPV				$33,550	$173,931	$207,482	$768,068	$1,083,333	$1,851,402	($856,080)			($9,308)			($13,506)	$666,667	($166,600)

10 Year IRR	**4.5%**

15 Year Analysis Summary

TOTAL	$2,400,000		$2,500,000	$75,000	$421,400	$496,400	$1,800,380	$1,170,000	$2,970,380	($26,021)			$2,271	$2,040,000	$385,444	$134,905	$720,000	$556,803
NPV				$42,797	$232,195	$274,993	$1,006,103	$1,083,333	$2,089,437	($685,556)			($4,073)	$1,655,041	$126,701	$44,345	$666,667	($59,162)

15 Year IRR	**7.0%**

25 Year Analysis Summary

TOTAL	$2,400,000		$2,500,000	$125,000	$802,707	$927,707	$3,242,724	$1,170,000	$4,412,724	$985,017			$33,310			$477,905	$720,000	$1,193,802
NPV				$53,374	$311,606	$364,980	$1,308,371	$1,083,333	$2,391,705	($473,275)	$1,947,107	$79,617	$2,444	$1,655,041	$332,464	$116,363	$666,667	$74,585

25 Year IRR	**9.0%**
Simple Payback (years)	**6**

Attachment 3 - Power Purchase Agreement (PPA) Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
Electricity Revenue
October 19, 2015

	Year	PPA Rate $ per KWH	Solar Generation kWh	Electricity Revenue
1	2016	$0.090	1,200,000	$108,000
2	2017	$0.092	1,194,000	$109,609
3	2018	$0.094	1,188,030	$111,242
4	2019	$0.096	1,182,090	$112,900
5	2020	$0.097	1,176,179	$114,582
6	2021	$0.099	1,170,299	$116,289
7	2022	$0.101	1,164,447	$118,022
8	2023	$0.103	1,158,625	$119,781
9	2024	$0.105	1,152,832	$121,565
10	2025	$0.108	1,147,067	$123,377
11	2026	$0.110	1,141,332	$125,215
12	2027	$0.112	1,135,625	$127,081
13	2028	$0.114	1,129,947	$128,974
14	2029	$0.116	1,124,298	$130,896
15	2030	$0.119	1,118,676	$132,846
16	2031	$0.121	1,113,083	$134,826
17	2032	$0.124	1,107,517	$136,835
18	2033	$0.126	1,101,980	$138,873
19	2034	$0.129	1,096,470	$140,943
20	2035	$0.131	1,090,988	$143,043
21	2036	$0.134	1,085,533	$145,174
22	2037	$0.136	1,080,105	$147,337
23	2038	$0.139	1,074,704	$149,532
24	2039	$0.142	1,069,331	$151,760
25	2040	$0.145	1,063,984	$154,022

10 Year Analysis Summary

Total	**11,733,569**	**$1,155,368**
NPV		**$768,068**

15 Year Analysis Summary

Total	**17,383,447**	**$1,800,380**
NPV		**$1,006,103**

25 Year Analysis Summary

Total	**28,267,142**	**$3,242,724**
NPV		**$1,308,371**

Attachment 3 - Power Purchase Agreement (PPA) Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
SAEC Revenue Schedule Converting Energy Year to Calendar Year
October 19, 2015

		Jan - May	Jun - Dec						
	Year	Energy Year 1	Energy Year 2	EY1 SAECs Generated	EY2 SAEC Generated	EY1 SAEC $/SAEC	EY2 SAEC $/SAEC	SAEC Revenue	SAEC To CFA
1	2016	2016	2017	480	720	$15	$18	$0	$20,160
2	2017	2017	2018	478	716	$18	$21	$0	$23,640
3	2018	2018	2019	475	713	$21	$25	$0	$27,800
4	2019	2019	2020	473	709	$25	$25	$0	$29,550
5	2020	2020	2021	470	706	$25	$25	$0	$29,400
6	2021	2021	2022	468	702	$25	$25	$0	$29,250
7	2022	2022	2023	466	699	$25	$25	$0	$29,125
8	2023	2023	2024	463	695	$25	$25	$0	$28,950
9	2024	2024	2025	461	692	$25	$25	$0	$28,825
10	2025	2025	2026	459	688	$25	$25	$0	$28,675
11	2026	2026	2027	457	685	$25	$25	$0	$28,550
12	2027	2027	2028	454	681	$25	$25	$0	$28,375
13	2028	2028	2029	452	678	$25	$25	$0	$28,250
14	2029	2029	2030	450	675	$25	$25	$0	$28,125
15	2030	2030	2031	447	671	$25	$25	$0	$27,950
16	2031	2031	2032	445	668	$25	$25	$0	$27,825
17	2032	2032	2033	443	665	$25	$25	$0	$27,700
18	2033	2033	2034	441	661	$25	$25	$0	$27,550
19	2034	2034	2035	439	658	$25	$25	$0	$27,425
20	2035	2035	2036	436	655	$25	$25	$0	$27,275
21	2036	2036	2037	434	651	$25	$25	$0	$27,125
22	2037	2037	2038	432	648	$25	$25	$0	$27,000
23	2038	2038	2039	430	645	$25	$25	$0	$26,875
24	2039	2039	2040	428	642	$25	$25	$0	$26,750
25	2040	2040	2041	426	638	$25	$25	$0	$26,600
							Total	$0	$275,375
							NPV	$0	$181,501

Notes:

Pennsylvania Energy Years run from June 1, through May 31 and identified by the year ending date (e.g. June 1, 2015 - May 31, 2016 is EY 2016)
Economic analysis has been done by calendar year. Solar production is split into energy years for accurate SAEC revenue.
Based on PVWatts data, solar production is estimated to be 40% of annual for Jan through May and 60% for Jun through Dec.

Attachment 3 - Power Purchase Agreement (PPA) Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
Electric Retail Rate and Solar Price to Compare (SPTC) Forecast
October 19, 2015

		PECO		PPL		West Penn		Penelec		Average	
	Year	Utility Rate	SPTC Rate	Utility Rate	SPTC Rate	Utility Rate	SPTC Rate	Utility Rate	SPTC Rate	Utility Rate	SPTC Rate
1	2016	0.121	0.111	0.121	0.116	0.100	0.097	0.125	0.118	0.117	0.111
2	2017	0.122	0.112	0.123	0.117	0.101	0.098	0.122	0.115	0.117	0.110
3	2018	0.124	0.114	0.125	0.119	0.103	0.099	0.123	0.116	0.119	0.112
4	2019	0.130	0.119	0.130	0.125	0.108	0.104	0.125	0.118	0.123	0.116
5	2020	0.135	0.124	0.136	0.130	0.113	0.109	0.131	0.123	0.129	0.121
6	2021	0.140	0.129	0.141	0.135	0.117	0.113	0.136	0.128	0.133	0.126
7	2022	0.143	0.132	0.144	0.138	0.120	0.116	0.141	0.133	0.137	0.130
8	2023	0.146	0.135	0.147	0.141	0.122	0.118	0.144	0.136	0.140	0.133
9	2024	0.154	0.143	0.156	0.149	0.129	0.125	0.147	0.139	0.147	0.139
10	2025	0.163	0.151	0.165	0.158	0.137	0.133	0.156	0.147	0.155	0.147
11	2026	0.171	0.159	0.174	0.167	0.145	0.141	0.165	0.156	0.164	0.156
12	2027	0.180	0.167	0.183	0.176	0.153	0.148	0.173	0.165	0.172	0.164
13	2028	0.190	0.177	0.194	0.187	0.162	0.158	0.183	0.174	0.182	0.174
14	2029	0.200	0.187	0.205	0.197	0.171	0.167	0.193	0.184	0.192	0.184
15	2030	0.206	0.193	0.212	0.204	0.178	0.173	0.204	0.194	0.200	0.191
16	2031	0.214	0.200	0.220	0.212	0.184	0.179	0.211	0.201	0.207	0.198
17	2032	0.223	0.209	0.230	0.222	0.193	0.188	0.218	0.209	0.216	0.207
18	2033	0.227	0.213	0.234	0.226	0.196	0.191	0.228	0.218	0.221	0.212
19	2034	0.235	0.221	0.242	0.234	0.203	0.198	0.233	0.222	0.228	0.219
20	2035	0.242	0.227	0.249	0.241	0.209	0.204	0.240	0.230	0.235	0.226
21	2036	0.251	0.236	0.259	0.250	0.217	0.212	0.249	0.238	0.244	0.234
22	2037	0.260	0.245	0.269	0.260	0.226	0.221	0.258	0.247	0.253	0.243
23	2038	0.270	0.254	0.279	0.270	0.235	0.230	0.267	0.256	0.263	0.252
24	2039	0.280	0.264	0.290	0.281	0.244	0.239	0.276	0.265	0.272	0.262
25	2040	0.290	0.274	0.301	0.292	0.254	0.248	0.286	0.274	0.283	0.272

* Many variables can influence a customer's electric rate, which may be higher or lower than these examples

Attachment 3 - Power Purchase Agreement (PPA) Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
Accelerated Depreciation
October 19, 2015

Federal			
Year	Deprececiation Rate	Depreciation Value	Est. Tax Benefit
2016	20.0%	$408,000	$142,800
2017	32.0%	$652,800	$228,480
2018	19.2%	$391,680	$137,088
2019	11.5%	$234,600	$82,110
2020	11.5%	$234,600	$82,110
2021	5.8%	$118,320	$41,412
2022	0.0%	$0	$0
2023	0.0%	$0	$0
2024	0.0%	$0	$0
2025	0.0%	$0	$0
2026	0.0%	$0	$0
2027	0.0%	$0	$0
2028	0.0%	$0	$0
2029	0.0%	$0	$0
2030	0.0%	$0	$0
2031	0.0%	$0	$0
2032	0.0%	$0	$0
2033	0.0%	$0	$0
2034	0.0%	$0	$0
2035	0.0%	$0	$0
Total	100%	$2,040,000	$714,000

State		
Year	Deprececiation Rate	MACRS Deprec.
2016	20.0%	$480,000
2017	32.0%	$768,000
2018	19.2%	$460,800
2019	11.5%	$276,000
2020	11.5%	$276,000
2021	5.8%	$139,200
2022	0.0%	$0
2023	0.0%	$0
2024	0.0%	$0
2025	0.0%	$0
2026	0.0%	$0
2027	0.0%	$0
2028	0.0%	$0
2029	0.0%	$0
2030	0.0%	$0
2031	0.0%	$0
2032	0.0%	$0
2033	0.0%	$0
2034	0.0%	$0
2035	0.0%	$0
Total	100%	$2,400,000

Attachment 4 - Power Purchase Agreement (PPA) with Deferred Loan Repayment Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
Assumptions
October 19, 2015
With User-Adjustable Inputs

System Size and Output	
Photovoltaic (PV)	
Capacity (kW-DC)	1,000
Production Rate (kWh/kW)	1,200
First Year Generation (kWh)	1,200,000
Annual kWh degredation	0.50%

Economic Variables	
Costs	
Avg PV Installation Cost ($ per W-DC)	$2.40
Solar PV Installation Cost (Tax Basis)	**$2,400,000**
Utility Interconnection	$100,000
Land Cost	$0
Total Solar Installation Cost	**$2,500,000**
Program Grant	
Grant Amount $/Watt	$1.17
Grant Total Amount (As Loan)	**$1,170,000**
Exchange Grant for SAECs (Yes/No)	No
Electricity Revenue	
PPA Rate	$0.09
PPA Rate Escalation	*2.0%*
SAEC Rate and Escalation	*See Schedule*
Expenses	
Replacement PV O&M Costs ($/yr) [1]	$8,500
Ongoing PV O&M Costs ($/yr) [1]	$15,000
Insurance Costs ($/yr)	$5,000
O&M Escalation (%)	2.5%
Insurance Escalation (%)	0.0%
Other	
In Service Date	Jan 1, 2016
Project Life (Years)	25
Economic Analysis Period 1 (Years)	10
Economic Analysis Period 2 (Years)	15
Economic Analysis Period 3 (Years)	25
Financing Period	10
Federal Tax Rate	35%
State Tax Rate	3.07%
Cost of Money	3.0%
Discount Rate	8.0%

Economic Incentives	
Federal Tax Credit (Treasury Grant)	30%
Depreciation (years)	5

SAEC Schedule	
Energy Year	Annual SAEC Value ($/MWh)
2016	$15
2017	$18
2018	$21
2019	$25
2020	$25
2021	$25
2022	$25
2023	$25
2024	$25
2025	$25
2026	$25
2027	$25
2028	$25
2029	$25
2030	$25
2031	$25
2032	$25
2033	$25
2034	$25
2035	$25
2036	$25
2037	$25
2038	$25
2039	$25
2040	$25

Notes:

[1] O&M Costs are broken into ongoing and replacement cost components for PV systems. Replacement costs include one (1) inverter replacements over the 20 year life of the system. Ongoing costs for PV include periodic system inspection and monthly data oversight.

Quick Summary of Financial Analysis			
Analysis Period	**Project NPV**	**Internal Rate of Return**	**Total CFA Loan Payments**
10 Years	**$437,888**	21.8%	**$0**
15 Years	**$578,269**	23.0%	**$0**
25 Years	**$323,594**	22.1%	**$2,136,903**
Simple Payback	**N/A ***		

*Note that although the IRR summaries may look strong, the delayed repayment of Grant starting in year 16 causes negative cashflow during the last 10 years of ownership which highlights a risk of default

Attachment 4 - Power Purchase Agreement (PPA) with Deferred Loan Repayment Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
Project Economics - Private Ownership (Includes Depreciation, ITC, Debt Service and Taxes)
October 19, 2015

		Costs			Expenses			Revenue/Savings			EBITDA	Debt Service			State and Federal Taxes (less Depreciation and Interest)						After Tax Cashflow (ATCF)	
	Year	Project Costs (Tax Basis)		Total Costs	Insurance Expenses	O&M Expenses	Total Expenses	Electricity Revenue	SAEC Revenue	Total Revenue	Pre-Tax Cashflow	Principle Payment	Interest Payment	Total Payment	State Depreciation Value	State Taxable Income	State Taxes Payable / (Recoverable)	Federal Depreciation Value	Federal Taxable Income	Fed. Taxes Payable / (Recoverable)	30% ITC	Net ATCF	Cumulative ATCF
0	2015	$2,400,000	$100,000	$2,500,000			$0			$0	($2,500,000)			($1,170,000)							$0	($1,330,000)	($1,330,000)
1	2016				$5,000	$23,500	$28,500	$108,000	$20,160	$128,160	$99,660	$0	$0	$0	$480,000	($380,340)	($11,676)	$408,000	($308,340)	($107,919)	$720,000	$939,255	($390,745)
2	2017				$5,000	$24,088	$29,088	$109,609	$23,640	$133,249	$104,162	$0	$0	$0	$768,000	($663,838)	($20,380)	$652,800	($548,638)	($192,023)		$316,565	($74,180)
3	2018				$5,000	$24,690	$29,690	$111,242	$27,800	$139,042	$109,353	$0	$0	$0	$460,800	($351,447)	($10,789)	$391,680	($282,327)	($98,815)		$218,957	$144,777
4	2019				$5,000	$25,307	$30,307	$112,900	$29,550	$142,450	$112,143	$0	$0	$0	$276,000	($163,857)	($5,030)	$234,600	($122,457)	($42,860)		$160,033	$304,810
5	2020				$5,000	$25,940	$30,940	$114,582	$29,400	$143,982	$113,042	$0	$0	$0	$276,000	($162,958)	($5,003)	$234,600	($121,558)	($42,545)		$160,590	$465,401
6	2021				$5,000	$26,588	$31,588	$116,289	$29,250	$145,539	$113,951	$0	$0	$0	$139,200	($25,249)	($775)	$118,320	($4,369)	($1,529)		$116,255	$581,656
7	2022				$5,000	$27,253	$32,253	$118,022	$29,125	$147,147	$114,894	$0	$0	$0	$0	$114,894	$3,527	$0	$111,367	$38,978		$72,389	$654,045
8	2023				$5,000	$27,934	$32,934	$119,781	$28,950	$148,731	$115,796	$0	$0	$0	$0	$115,796	$3,555	$0	$112,242	$39,285		$72,957	$727,002
9	2024				$5,000	$28,632	$33,632	$121,565	$28,825	$150,390	$116,758	$0	$0	$0	$0	$116,758	$3,584	$0	$113,173	$39,611		$73,563	$800,565
10	2025				$5,000	$29,348	$34,348	$123,377	$28,675	$152,052	$117,703	$0	$0	$0	$0	$117,703	$3,613	$0	$114,090	$39,931		$74,158	$874,723
11	2026				$5,000	$30,082	$35,082	$125,215	$28,550	$153,765	$118,683	$0	$0	$0	$0	$118,683	$3,644	$0	$115,039	$40,264		$74,776	$949,499
12	2027				$5,000	$30,834	$35,834	$127,081	$28,375	$155,456	$119,622	$0	$0	$0	$0	$119,622	$3,672	$0	$115,949	$40,582		$75,367	$1,024,866
13	2028				$5,000	$31,605	$36,605	$128,974	$28,250	$157,224	$120,619	$0	$0	$0	$0	$120,619	$3,703	$0	$116,916	$40,921		$75,996	$1,100,861
14	2029				$5,000	$32,395	$37,395	$130,896	$28,125	$159,021	$121,626	$0	$0	$0	$0	$121,626	$3,734	$0	$117,892	$41,262		$76,630	$1,177,491
15	2030				$5,000	$33,205	$38,205	$132,846	$27,950	$160,796	$122,591	$0	$0	$0	$0	$122,591	$3,764	$0	$118,828	$41,590		$77,238	$1,254,729
16	2031				$5,000	$34,035	$39,035	$134,826	$27,825	$162,651	$123,616	$159,006	$54,685	$213,690	$0	$68,931	$2,116	$0	$66,815	$23,385		($115,576)	$1,139,153
17	2032				$5,000	$34,886	$39,886	$136,835	$27,700	$164,535	$124,649	$163,776	$49,914	$213,690	$0	$74,734	$2,294	$0	$72,440	$25,354		($116,690)	$1,022,463
18	2033				$5,000	$35,758	$40,758	$138,873	$27,550	$166,423	$125,665	$168,689	$45,001	$213,690	$0	$80,664	$2,476	$0	$78,188	$27,366		($117,867)	$904,596
19	2034				$5,000	$36,652	$41,652	$140,943	$27,425	$168,368	$126,716	$173,750	$39,941	$213,690	$0	$86,775	$2,664	$0	$84,111	$29,439		($119,078)	$785,518
20	2035				$5,000	$37,568	$42,568	$143,043	$27,275	$170,318	$127,749	$178,962	$34,728	$213,690	$0	$93,021	$2,856	$0	$90,166	$31,558		($120,355)	$665,164
21	2036				$5,000	$38,507	$43,507	$145,174	$27,125	$172,299	$128,792	$184,331	$29,359	$213,690	$0	$99,432	$3,053	$0	$96,380	$33,733		($121,684)	$543,479
22	2037				$5,000	$39,470	$44,470	$147,337	$27,000	$174,337	$129,867	$189,861	$23,829	$213,690	$0	$106,038	$3,255	$0	$102,782	$35,974		($123,053)	$420,427
23	2038				$5,000	$40,457	$45,457	$149,532	$26,875	$176,407	$130,950	$195,557	$18,133	$213,690	$0	$112,817	$3,463	$0	$109,354	$38,274		($124,477)	$295,950
24	2039				$5,000	$41,468	$46,468	$151,760	$26,750	$178,510	$132,042	$201,424	$12,267	$213,690	$0	$119,775	$3,677	$0	$116,098	$40,634		($125,960)	$169,990
25	2040				$5,000	$42,505	$47,505	$154,022	$26,600	$180,622	$133,117	$207,466	$6,224	$213,690	$0	$126,893	$3,896	$0	$122,997	$43,049		($127,518)	$42,472

10 Year Analysis Summary

TOTAL	$2,400,000		$2,500,000	$50,000	$263,279	$313,279	$1,155,368	$275,375	$1,430,743	($1,382,537)	$0	$0	($1,170,000)	$2,400,000	($1,282,537)	($39,374)	$2,040,000	($936,817)	($327,886)	$720,000	$874,723
NPV				$33,550	$173,931	$207,482	$768,068	$181,501	$949,569	($1,757,912)	$0	$0	($1,170,000)	$1,947,107	($1,205,020)	($36,994)	$1,655,041	($920,399)	($322,140)	$666,667	$437,888

10 Year IRR	**21.8%**

15 Year Analysis Summary

TOTAL	$2,400,000		$2,500,000	$75,000	$421,400	$496,400	$1,800,380	$416,625	$2,217,005	($779,396)	$0	$0	($1,170,000)	$2,400,000	($679,396)	($20,857)	$2,040,000	($352,192)	($123,267)	$720,000	$1,254,729
NPV				$42,797	$232,195	$274,993	$1,006,103	$233,788	$1,239,891	($1,535,102)	$0	$0	($1,170,000)	$1,947,107	($982,209)	($30,154)	$1,655,041	($704,429)	($246,550)	$666,667	$578,269

15 Year IRR	**23.0%**

25 Year Analysis Summary

TOTAL	$2,400,000		$2,500,000	$125,000	$802,707	$927,707	$3,242,724	$688,750	$3,931,474	$503,767	$1,822,822	$314,081	$966,903	$2,400,000	$289,685	$8,893	$2,040,000	$587,138	$205,498	$720,000	$42,472
NPV				$53,374	$311,606	$364,980	$1,308,371	$291,532	$1,599,903	($1,265,077)	$378,452	$73,567	($717,981)	$1,947,107	($785,751)	($24,123)	$1,655,041	($514,002)	($179,901)	$666,667	$323,594

25 Year IRR	**22.1%**
Simple Payback (years)	**N/A**

Attachment 4 - Power Purchase Agreement (PPA) with Deferred Loan Repayment Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
Electric Cost Savings
October 19, 2015

	Year	PPA Rate $ per KWH	Solar Generation kWh	Electricity Revenue
1	2016	$0.090	1,200,000	$108,000
2	2017	$0.092	1,194,000	$109,609
3	2018	$0.094	1,188,030	$111,242
4	2019	$0.096	1,182,090	$112,900
5	2020	$0.097	1,176,179	$114,582
6	2021	$0.099	1,170,299	$116,289
7	2022	$0.101	1,164,447	$118,022
8	2023	$0.103	1,158,625	$119,781
9	2024	$0.105	1,152,832	$121,565
10	2025	$0.108	1,147,067	$123,377
11	2026	$0.110	1,141,332	$125,215
12	2027	$0.112	1,135,625	$127,081
13	2028	$0.114	1,129,947	$128,974
14	2029	$0.116	1,124,298	$130,896
15	2030	$0.119	1,118,676	$132,846
16	2031	$0.121	1,113,083	$134,826
17	2032	$0.124	1,107,517	$136,835
18	2033	$0.126	1,101,980	$138,873
19	2034	$0.129	1,096,470	$140,943
20	2035	$0.131	1,090,988	$143,043
21	2036	$0.134	1,085,533	$145,174
22	2037	$0.136	1,080,105	$147,337
23	2038	$0.139	1,074,704	$149,532
24	2039	$0.142	1,069,331	$151,760
25	2040	$0.145	1,063,984	$154,022

10 Year Analysis Summary

Total	**11,733,569**	**$1,155,368**
NPV		**$768,068**

15 Year Analysis Summary

Total	**17,383,447**	**$1,800,380**
NPV		**$1,006,103**

25 Year Analysis Summary

Total	**28,267,142**	**$3,242,724**
NPV		**$1,308,371**

Attachment 4 - Power Purchase Agreement (PPA) with Deferred Loan Repayment Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
SAEC Revenue Schedule Converting Energy Year to Calendar Year
October 19, 2015

		Jan - May	Jun - Dec						
	Year	Energy Year 1	Energy Year 2	EY1 SAECs Generated	EY2 SAEC Generated	EY1 SAEC $/SAEC	EY2 SAEC $/SAEC	SAEC Revenue	SAEC To CFA
1	2016	2016	2017	480	720	$15	$18	$20,160	$0
2	2017	2017	2018	478	716	$18	$21	$23,640	$0
3	2018	2018	2019	475	713	$21	$25	$27,800	$0
4	2019	2019	2020	473	709	$25	$25	$29,550	$0
5	2020	2020	2021	470	706	$25	$25	$29,400	$0
6	2021	2021	2022	468	702	$25	$25	$29,250	$0
7	2022	2022	2023	466	699	$25	$25	$29,125	$0
8	2023	2023	2024	463	695	$25	$25	$28,950	$0
9	2024	2024	2025	461	692	$25	$25	$28,825	$0
10	2025	2025	2026	459	688	$25	$25	$28,675	$0
11	2026	2026	2027	457	685	$25	$25	$28,550	$0
12	2027	2027	2028	454	681	$25	$25	$28,375	$0
13	2028	2028	2029	452	678	$25	$25	$28,250	$0
14	2029	2029	2030	450	675	$25	$25	$28,125	$0
15	2030	2030	2031	447	671	$25	$25	$27,950	$0
16	2031	2031	2032	445	668	$25	$25	$27,825	$0
17	2032	2032	2033	443	665	$25	$25	$27,700	$0
18	2033	2033	2034	441	661	$25	$25	$27,550	$0
19	2034	2034	2035	439	658	$25	$25	$27,425	$0
20	2035	2035	2036	436	655	$25	$25	$27,275	$0
21	2036	2036	2037	434	651	$25	$25	$27,125	$0
22	2037	2037	2038	432	648	$25	$25	$27,000	$0
23	2038	2038	2039	430	645	$25	$25	$26,875	$0
24	2039	2039	2040	428	642	$25	$25	$26,750	$0
25	2040	2040	2041	426	638	$25	$25	$26,600	$0
							Total	**$275,375**	**$0**
							NPV	**$181,501**	**$0**

Notes:

Pennsylvania Energy Years run from June 1, through May 31 and identified by the year ending date (e.g. June 1, 2015 - May 31, 2016 is EY 2016)
Economic analysis has been done by calendar year. Solar production is split into energy years for accurate SAEC revenue.
Based on PVWatts data, solar production is estimated to be 40% of annual for Jan through May and 60% for Jun through Dec.

Attachment 4 - Power Purchase Agreement (PPA) with Deferred Loan Repayment Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
Accelerated Depreciation
October 19, 2015

Federal			
Year	Deprececiation Rate	Depreciation Value	Est. Tax Benefit
2016	20.0%	$408,000	$142,800
2017	32.0%	$652,800	$228,480
2018	19.2%	$391,680	$137,088
2019	11.5%	$234,600	$82,110
2020	11.5%	$234,600	$82,110
2021	5.8%	$118,320	$41,412
2022	0.0%	$0	$0
2023	0.0%	$0	$0
2024	0.0%	$0	$0
2025	0.0%	$0	$0
2026	0.0%	$0	$0
2027	0.0%	$0	$0
2028	0.0%	$0	$0
2029	0.0%	$0	$0
2030	0.0%	$0	$0
2031	0.0%	$0	$0
2032	0.0%	$0	$0
2033	0.0%	$0	$0
2034	0.0%	$0	$0
2035	0.0%	$0	$0
Total	100%	$2,040,000	$714,000

State		
Year	Deprececiation Rate	MACRS Deprec.
2016	20.0%	$480,000
2017	32.0%	$768,000
2018	19.2%	$460,800
2019	11.5%	$276,000
2020	11.5%	$276,000
2021	5.8%	$139,200
2022	0.0%	$0
2023	0.0%	$0
2024	0.0%	$0
2025	0.0%	$0
2026	0.0%	$0
2027	0.0%	$0
2028	0.0%	$0
2029	0.0%	$0
2030	0.0%	$0
2031	0.0%	$0
2032	0.0%	$0
2033	0.0%	$0
2034	0.0%	$0
2035	0.0%	$0
Total	100%	$2,400,000

Attachment 4 - Power Purchase Agreement (PPA) with Deferred Loan Repayment Sample Analysis
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
Capital Sevice
October 19, 2015

Total Cost	$2,500,000
Capital Investment	$1,330,000
Loan Amount	$1,170,000
Loan Plus Accruued Interest	$1,822,822
Cost of Money	3%
Years	10
Annual Payment	$213,690

Starting Balance	Interest	Principle Payment	Payment	Balance	Year	
$1,170,000	$35,100	$0	$0	$1,205,100	2016	0
$1,205,100	$36,153	$0	$0	$1,241,253	2017	0
$1,241,253	$37,238	$0	$0	$1,278,491	2018	0
$1,278,491	$38,355	$0	$0	$1,316,845	2019	0
$1,316,845	$39,505	$0	$0	$1,356,351	2020	0
$1,356,351	$40,691	$0	$0	$1,397,041	2021	0
$1,397,041	$41,911	$0	$0	$1,438,952	2022	0
$1,438,952	$43,169	$0	$0	$1,482,121	2023	0
$1,482,121	$44,464	$0	$0	$1,526,585	2024	0
$1,526,585	$45,798	$0	$0	$1,572,382	2025	0
$1,572,382	$47,171	$0	$0	$1,619,554	2026	0
$1,619,554	$48,587	$0	$0	$1,668,140	2027	0
$1,668,140	$50,044	$0	$0	$1,718,184	2028	0
$1,718,184	$51,546	$0	$0	$1,769,730	2029	0
$1,769,730	$53,092	$0	$0	$1,822,822	2030	0
$1,822,822	$54,685	$159,006	$213,690	$1,663,816	2031	1
$1,663,816	$49,914	$163,776	$213,690	$1,500,040	2032	2
$1,500,040	$45,001	$168,689	$213,690	$1,331,351	2033	3
$1,331,351	$39,941	$173,750	$213,690	$1,157,601	2034	4
$1,157,601	$34,728	$178,962	$213,690	$978,639	2035	5
$978,639	$29,359	$184,331	$213,690	$794,308	2036	6
$794,308	$23,829	$189,861	$213,690	$604,447	2037	7
$604,447	$18,133	$195,557	$213,690	$408,890	2038	8
$408,890	$12,267	$201,424	$213,690	$207,466	2039	9
$207,466	$6,224	$207,466	$213,690	$0	2040	10
TOTAL	$966,903	$1,822,822	$2,136,903			

Attachment 5 - Electric Retail Rate and Solar Price to Compare (SPTC) Forecast
Created for the Pennsylvania Commonwealth Finance Authority
Gabel Associates
October 19, 2015

		PECO		PPL		West Penn		Penelec		Average	
	Year	Utility Rate	SPTC Rate	Utility Rate	SPTC Rate	Utility Rate	SPTC Rate	Utility Rate	SPTC Rate	Utility Rate	SPTC Rate
1	2016	0.121	0.111	0.121	0.116	0.100	0.097	0.125	0.118	0.117	0.111
2	2017	0.122	0.112	0.123	0.117	0.101	0.098	0.122	0.115	0.117	0.110
3	2018	0.124	0.114	0.125	0.119	0.103	0.099	0.123	0.116	0.119	0.112
4	2019	0.130	0.119	0.130	0.125	0.108	0.104	0.125	0.118	0.123	0.116
5	2020	0.135	0.124	0.136	0.130	0.113	0.109	0.131	0.123	0.129	0.121
6	2021	0.140	0.129	0.141	0.135	0.117	0.113	0.136	0.128	0.133	0.126
7	2022	0.143	0.132	0.144	0.138	0.120	0.116	0.141	0.133	0.137	0.130
8	2023	0.146	0.135	0.147	0.141	0.122	0.118	0.144	0.136	0.140	0.133
9	2024	0.154	0.143	0.156	0.149	0.129	0.125	0.147	0.139	0.147	0.139
10	2025	0.163	0.151	0.165	0.158	0.137	0.133	0.156	0.147	0.155	0.147
11	2026	0.171	0.159	0.174	0.167	0.145	0.141	0.165	0.156	0.164	0.156
12	2027	0.180	0.167	0.183	0.176	0.153	0.148	0.173	0.165	0.172	0.164
13	2028	0.190	0.177	0.194	0.187	0.162	0.158	0.183	0.174	0.182	0.174
14	2029	0.200	0.187	0.205	0.197	0.171	0.167	0.193	0.184	0.192	0.184
15	2030	0.206	0.193	0.212	0.204	0.178	0.173	0.204	0.194	0.200	0.191
16	2031	0.214	0.200	0.220	0.212	0.184	0.179	0.211	0.201	0.207	0.198
17	2032	0.223	0.209	0.230	0.222	0.193	0.188	0.218	0.209	0.216	0.207
18	2033	0.227	0.213	0.234	0.226	0.196	0.191	0.228	0.218	0.221	0.212
19	2034	0.235	0.221	0.242	0.234	0.203	0.198	0.233	0.222	0.228	0.219
20	2035	0.242	0.227	0.249	0.241	0.209	0.204	0.240	0.230	0.235	0.226
21	2036	0.251	0.236	0.259	0.250	0.217	0.212	0.249	0.238	0.244	0.234
22	2037	0.260	0.245	0.269	0.260	0.226	0.221	0.258	0.247	0.253	0.243
23	2038	0.270	0.254	0.279	0.270	0.235	0.230	0.267	0.256	0.263	0.252
24	2039	0.280	0.264	0.290	0.281	0.244	0.239	0.276	0.265	0.272	0.262
25	2040	0.290	0.274	0.301	0.292	0.254	0.248	0.286	0.274	0.283	0.272

* Many variables can influence a customer's electric rate, which may be higher or lower than these examples

Attachment 6 - Schedule of Potential SREC Revenue for CFA Created for the Pennsylvania Commonwealth Finance Authority

Gabel Associates

October 19, 2015

Comparitive examples of potential annual SREC revenue to CFA assuming all projects are built in 2016

Low SRECS assumes SRECs remain at $15/MW

Medium SRECS assumes SRECSs climb to $25/MW by 2019

High SRECS assumes SRECS climb to $50/MW by 2019

At $0.81/Watt average rebate, program supports 37MW

At $1.00/Watt average rebate, program supports 30MW

At $1.25/Watt average rebate, program supports 24 MW

	Low SREC $15/MWh		Medium SREC (Climb to $25)			High SREC (Climb to $50)	
Year	**$1.00/Watt**	**$1.25/Watt**	**0.81/Watt**	**$1.00/Watt**	**$1.25/Watt**	**$1.00/Watt**	**$1.25/Watt**
2017	$540,000	$432,000	$746,667	$604,800	$483,840	$756,000	$604,800
2018	$537,300	$429,840	$875,600	$709,236	$567,390	$1,153,404	$922,728
2019	$534,615	$427,695	$1,029,631	$834,001	$667,205	$1,596,722	$1,277,385
2020	$531,945	$425,550	$1,094,537	$886,575	$709,250	$1,773,150	$1,418,500
2021	$529,275	$423,420	$1,089,043	$882,125	$705,700	$1,764,250	$1,411,400
2022	$526,635	$421,305	$1,083,611	$877,725	$702,175	$1,755,450	$1,404,350
2023	$523,995	$419,205	$1,078,179	$873,325	$698,675	$1,746,650	$1,397,350
2024	$521,370	$417,105	$1,072,778	$868,950	$695,175	$1,737,900	$1,390,350
2025	$518,775	$415,020	$1,067,438	$864,625	$691,700	$1,729,250	$1,383,400
2026	$516,180	$412,950	$1,062,099	$860,300	$688,250	$1,720,600	$1,376,500
2027	$513,600	$410,880	$1,056,790	$856,000	$684,800	$1,712,000	$1,369,600
2028	$511,035	$408,825	$1,051,512	$851,725	$681,375	$1,703,450	$1,362,750
2029	$508,470	$406,770	$1,046,235	$847,450	$677,950	$1,694,900	$1,355,900
2030	$505,935	$404,745	$1,041,019	$843,225	$674,575	$1,686,450	$1,349,150
2031	$503,400	$402,720	$1,035,802	$839,000	$671,200	$1,678,000	$1,342,400
2032	$500,880	$400,710	$1,030,617	$834,800	$667,850	$1,669,600	$1,335,700
2033	$498,375	$398,700	$1,025,463	$830,625	$664,500	$1,661,250	$1,329,000
2034	$495,900	$396,720	$1,020,370	$826,500	$661,200	$1,653,000	$1,322,400
2035	$493,410	$394,725	$1,015,247	$822,350	$657,875	$1,644,700	$1,315,750
2036	$490,950	$392,745	$1,010,185	$818,250	$654,575	$1,636,500	$1,309,150
2037	$488,490	$390,795	$1,005,123	$814,150	$651,325	$1,628,300	$1,302,650
2038	$486,045	$388,845	$1,000,093	$810,075	$648,075	$1,620,150	$1,296,150
2039	$483,615	$386,895	$995,093	$806,025	$644,825	$1,612,050	$1,289,650
2040	$481,200	$384,960	$990,123	$802,000	$641,600	$1,604,000	$1,283,200
2041	$478,800	$383,025	$985,185	$798,000	$638,375	$1,596,000	$1,276,750
Total	**$12,720,195**	**$10,176,150**	**$25,508,441**	**$20,661,837**	**$16,529,460**	**$40,533,726**	**$32,426,963**
NPV	**$8,927,676**	**$7,142,141**	**$17,734,694**	**$14,365,102**	**$11,492,082**	**$27,974,732**	**$22,379,788**