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Feasibility Study of Economics and Performance of Solar Photovoltaics at the Former St. Marks Refinery in St. Marks, Florida

A Study Prepared in Partnership with the Environmental Protection Agency for the RE-Powering America's Lands Initiative: Siting Renewable Energy on Potentially Contaminated Land and Mine Sites

Lars Lisell and Gail Mosey

Technical Report
NREL/TP-6A2-48853
September 2010

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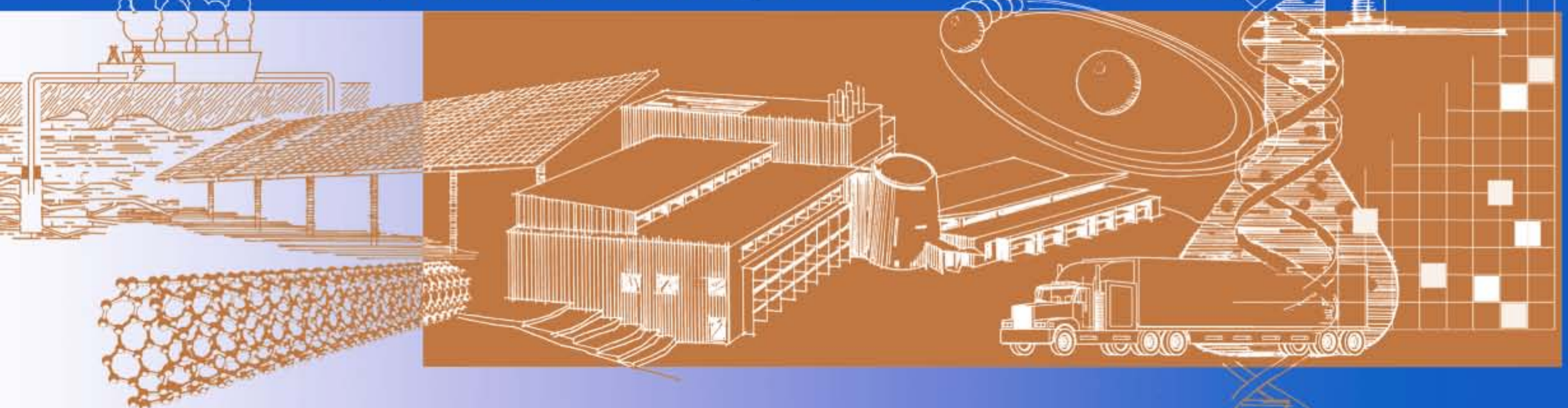

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Executive Summary

The City of St. Marks, Florida, received technical assistance from the National Renewable Energy Laboratory (NREL), under an interagency agreement funded by the Environmental Protection Agency (EPA) for a feasibility study to be conducted on a brownfield site located within the city limits. The purpose of this report is to assess the sites designated by the City of St. Marks for possible solar photovoltaic (PV) installation and estimate the cost, performance, and site impacts of three different PV options: crystalline silicon (fixed tilt), crystalline silicon (single-axis tracking), and thin film (fixed tilt). Each option represents a standalone system that can be sized to use an entire available site area. In addition, the report outlines financing options that could assist in the implementation of a system.

The City of St. Marks would like to explore the feasibility for installing ground-mounted PV. Two sites located at the former St. Marks Refinery were considered in this study, and both were found suitable to incorporate PV systems. The economics of the potential systems were analyzed using an electric rate of $0.08/kWh and incentives offered in the State of Florida and from the two accessible utilities, Progress Energy and the City of Tallahassee. Currently there are no incentives offered for commercial-size solar power systems in Wakulla County, Florida, or from the nearby utilities. The calculations reflect the solar potential if the total area is utilized from both of the sites that were visited. Table ES-1 summarizes the system performance and economics of a potential system that would use both available areas that were surveyed in St. Marks. Table ES-1 also summarizes job creation if the St. Marks location were used for PV.

Table ES-1. PV System Performance and Economics by System Type[a]

			Annual Cost Savings ($/year)		Payback Period (years)		
Array Tilt (Deg)	**PV System Size (kW)**	**Annual Output (kWh/year)**	**Annual O&M ($/year)**	**System Cost with Incentives ($)**	**With Incentive**	**Jobs [b] Created**	**Jobs [c] Sustained**
Crystalline Silicon (Fixed Tilt)							
30.4	3,050	4,007,700	$25,925	$10,675,000	36	115	0.3
Crystalline Silicon (Single-axis Tracking)							
0	2,450	3,770,550	$51,450	$10,290,000	41	111	0.6
Thin Film (Fixed Tilt)							
30.4	1,200	1,576,800	$8,976	$3,696,000	32	40	0.1

[a] Data assume a maximum usable area of 804,942 ft^2.
[b] Job-years created as a result of project capital investment including direct, indirect, and induced jobs.
[c] Jobs (direct, indirect, and induced) sustained as a result of operations and maintenance (O&M) of the system.

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1 Study Location

The City of St. Marks, Florida, is the former site of the St. Marks Refinery, which specialized in manufacturing and refining crude oil into jet fuel and asphalt. The facility closed in 2001, leaving the site vacant and contaminated. The remediation of the site started in 2004 with the removal of all infrastructure except for 10 above-ground storage tanks. It is anticipated that four of the tanks will be removed this spring, leaving six tanks that will need to be removed upon the implementation of a redevelopment plan. After the removal of infrastructure, the site was cleaned using in-situ and ex-situ methods, leaving the site available for commercial or industrial redevelopment with strict ground disturbance restrictions. At this time, no more remediation is planned for the site. The site is located on the main road into St. Marks near the river. The site has electrical service to the buildings and to the storage tanks. The site has been designated as a brownfield site by the Environmental Protection Agency (EPA). The property was recently turned over to the city of St. Marks at no cost by the St. Marks Refinery. The site is discussed in Section 3 of the report. An additional site, the "Recently Closed North Site," was included in the analysis due to the possibility that the site would become vacant in the near future. This site is a good candidate for other redevelopment but was included in the analysis due to the proximity to the main site.

2 PV Systems

Solar photovoltaics (PV) are semiconductor devices that convert sunlight directly into electricity. They do so without any moving parts and without generating any noise or pollution. They must be mounted in an unshaded location; rooftops, carports, and ground-mounted arrays are common mounting locations. PV systems work very well in St. Marks, Florida, where the average global horizontal annual solar resource is between 4.1–6.15 kWh/m^2/day. This number, however, is not the amount of energy that can be produced by a PV panel. The amount of energy produced by a panel depends on several factors. These factors include the type of collector, the tilt and azimuth of the collector, the temperature, and the level of sunlight and weather conditions. An inverter is required to convert the direct current (DC) to alternating current (AC) of the desired voltage compatible with building and utility power systems. The balance of the system consists of conductors/conduit, switches, disconnects, and fuses. Grid-connected PV systems feed power into the facility's electrical system and do not include batteries.

Figure 1 shows the major components of a grid-connected PV system and illustrates how these components are interconnected.

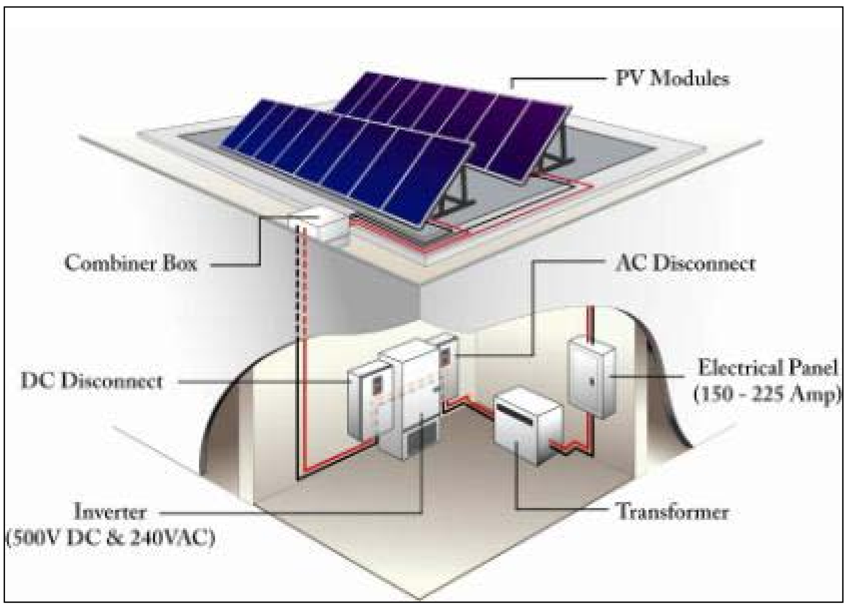

Figure 1. Major components of a grid-connected PV system

Credit: NREL

PV panels are made up of many individual cells that all produce a small amount of current and voltage. These individual cells are connected in series to produce a larger current. PV panels are very sensitive to shading. When shade falls on a panel, that portion of the panel is no longer able to collect the high-energy beam radiation from the sun. If an individual cell is shaded, it will act as a resistance to the whole series circuit, impeding current flow and dissipating power rather than producing it. By determining solar access—the unimpeded ability of sunlight to reach a solar collector—one can determine whether an area is appropriate for solar panels.

For this assessment, the National Renewable Energy Laboratory (NREL) team used a Solmetric™ solar path calculator to assess shading at a particular location by analyzing the sky view where the solar panel will be located. If a site is found to have good potential for a PV system, then the next step is to determine the size of that system, which highly depends on the average energy use of the on-site facilities. Providing more power than a site would use is generally not advisable due to the economics of most net-metering agreements. In the case of the assessed sites, all of the electricity generated at the sites would be sold to one of the nearby utilities because there is no electrical load. The system size would thus be determined by the amount of electricity the electric company would be willing to purchase or by how much land area is available. For the purposes of this report, the NREL assessment team assumed that the utilities would purchase any electricity that the site can generate. The systems will be broken down by site so the system size can be adjusted based on what the utility requests.

2.1 Types of PV Systems

Ground-mounted Systems

On a $/DC-Watt basis, ground-mounted PV systems are usually the lowest cost option to install. Several PV panel and mounting options are available, each having different benefits for different ground conditions. Table 1 outlines the energy density values that can be expected from each type of system.

Table 1. Energy Density by Panel and System

System Type	Fixed-tilt Energy Density (DC-Watts/ft^2)	Single-axis Tracking Energy Density (DC-Watts/ft^2)
Crystalline Silicon	4.0	3.3
Thin Film	1.7	1.4
Hybrid HE*	4.8	3.9

* Because hybrid high efficiency (HE) panels do not represent a significant portion of the commercial market, they were not included in the analysis. Installing panel types that do not hold a significant portion of the commercial market would not be feasible for a large-scale solar generation plant.

For the purposes of this analysis, all fixed-tilt systems were assumed to be mounted at latitude with a tilt of 30.4 degrees. To get the most out of the available ground area, considering whether the site layout can be improved to better incorporate a solar system is important. If unused structures, fences, or electrical poles can be removed, the unshaded area can be increased to incorporate more PV panels. When considering a ground-mounted system, an electrical tie-in location should be identified to determine how the energy will be fed back into the grid. For this report, only fixed-tilt ground-mounted systems and single-axis tracking systems were considered.

Fixed-tilt systems are installed at a specified tilt and are fixed at that tilt for the life of the system. Single-axis tracking systems have a fixed tilt on one axis and a variable tilt on the other axis. The system is designed to follow the sun in its path through the sky. This allows the solar radiation to strike the panel at an optimum angle for a larger part of the day than can be achieved with a fixed-tilt system. A single-axis tracking system can collect nearly 30% more electricity per capacity than can a fixed-tilt tracking system. The drawbacks include increased operation and maintenance (O&M) costs, less capacity per unit area (DC-Watt/ft^2), and greater installed cost ($/DC-Watt).

Roof-mounted Systems

In many cases, a roof is the best location for a PV system. Roof-mounted PV systems are usually more expensive than ground-mounted systems, but a roof is a convenient location because it is out of the way and usually unshaded. Large areas with minimal rooftop equipment are preferred, but equipment can sometimes be worked around if necessary. If a building has a sloped roof, a typical flush-mounted crystalline silicon panel can achieve power densities on the order of 11 DC-Watt/ft^2. For buildings with flat roofs, rack-mounted systems can achieve power densities on the order of 8 DC-Watt/ft^2 with a crystalline silicon panel.

Typically, PV systems are installed on roofs that either are less than five years old or have over 30 years left before replacement. Because no roof area is available on the sites studied, no roof-mounted analysis was conducted.

2.2 PV System Components

The PV system considered here has these components:

- PV arrays, which convert light energy to DC electricity
- Inverters, which convert DC to AC and provide important safety, monitoring, and control functions
- Various wiring, mounting hardware, and combiner boxes
- Monitoring equipment

PV Array

The primary component of a PV system, the PV array, converts sunlight to electrical energy; all other components simply condition or control energy use. Most PV arrays consist of interconnected PV modules that range in size from 50 peak DC-Watts to 300 peak DC-Watts. Peak watts are the rated output of PV modules at standard operating conditions of 25°C (77°F) and insolation of 1,000 watts/m^2. Because these standard operating conditions are nearly ideal, the actual output will be less under typical environmental conditions. PV modules are the most reliable components in any PV system. They have been engineered to withstand extreme temperatures, severe winds, and impacts. ASTM E1038-05[1] subjects modules to impacts from one-inch hail balls at terminal velocity (55 mph) at various parts of the module. PV modules have a life expectancy of 20–30 years, and manufacturers warranty them against excessive power degradation for 25 years. The array is usually the most expensive component of a PV system; it

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[1] ASTM International. "E1038-05 Standard Test Method for Determining Resistance of Photovoltaic Modules to Hail by Impact with Propelled Ice Balls," West Conshohocken, PA, 2005, DOI: 10.1520/E1038-05. http://www.astm.org/Standards/E1038.htm. Accessed August 2010.

accounts for approximately two-thirds of the cost of a grid-connected system. A large choice of PV manufacturers is available.[2]

Inverters

PV arrays provide DC power at a voltage that depends on the configuration of the array. This power is converted to AC at the required voltage and number of phases by the inverter. Inverters enable the operation of commonly used equipment such as appliances, computers, office equipment, and motors. Current inverter technology provides true sine wave power at a quality often better than that of the serving utility. The locations of both the inverter and the balance of the system equipment are important. Inverters are available that include most or all of the control systems required for operation, including some metering and data-logging capability. Inverters must provide several operational and safety functions for interconnection with the utility system. The Institute of Electrical and Electronic Engineers, Inc. (IEEE) maintains standard *"P929 Recommended Practice for Utility Interface of Photovoltaic (PV) Systems,"*[3] which allows manufacturers to write "Utility-Interactive" on the listing label if an inverter meets the requirements of frequency and voltage limits, power quality, and non-islanding inverter testing. Underwriters Laboratory maintains *"UL Standard 1741, Standard for Static Inverters and Charge Controllers for Use in Photovoltaic Power Systems,"*[4] which incorporates the testing required by IEEE 929 and includes design (type) testing and production testing. A large choice of inverter manufacturers is available.[5]

Operation and Maintenance (O&M)

The PV panels come with a 25-year performance warranty. The inverters, which come standard with a 5- or 10-year warranty (extended warranties available), would be expected to last 10–15 years. System performance should be verified on a vendor-provided Web site. Wire and rack connections should be checked. For this economic analysis, an annual O&M cost of 0.17% of the total installed cost is used based on O&M costs of other fixed-tilt grid-tied PV systems. For the case of single-axis tracking, an annual O&M cost of 0.35% of the total installed cost is used based on O&M costs of existing single-axis tracking systems.

2.3 PV Size and Performance

The PV arrays must be installed in unshaded locations on the ground or on building roofs that have an expected life of at least 25 years. The predicted array performance was found using PVWATTS, a performance calculator for grid-connected PV systems created by NREL's Renewable Resource Data Center.[6] The performance data was used to calculate the amount of

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[2] Go Solar California, a joint effort of the California Energy Commission and the California Public Utilities Commission, provides consumer information for solar energy systems. See http://www.gosolarcalifornia.org/equipment/pvmodule.php.

[3] IEEE. "ANSI/IEEE Std 929-1988 IEEE Recommended Practice for Utility Interface of Residential and Intermediate Photovoltaic (PV) Systems–Description." http://standards.ieee.org/reading/ieee/std_public/description/powergen/929-1988_desc.html. Accessed July 2010.

[4] UL 1741. "Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources." http://ulstandardsinfonet.ul.com/scopes/1741.html. Accessed July 2010.

[5] Go Solar California approves inverters.

[6] PVWatts. http://rredc.nrel.gov/solar/calculators/PVWATTS/version1/. Accessed July 2010.

revenue that could be expected each year. The project economics were based on this analysis, and the calculations can be found in Appendix A.

3 PV Site Locations

This section summarizes the findings of the NREL solar assessment site visit on January 28, 2010.

3.1 St. Marks Refinery

This site is environmentally contaminated and, according to the onsite staff, cannot be used again for any sort of residential development. There is the potential for industrial redevelopment, however, on parts of the site. The site has had extensive remediation resulting in a partial cap and water containment infrastructure. The site is a total of 55 acres, with the useful solar area a total of 17 acres, calculated by taking measurements of the site using Google Earth. There is a significant portion of the site that is covered in forest and wetland. In order for the full 17 acres to be usable, the eastern half of the site would need to be drained. At the time of the site visit there was water approximately 4 feet deep on the east end of the site. If none of the water from the site can be drained, only 50% of the 17 acres would be acceptable for a solar array, leaving only 8.5 acres available. See Figure 2 for an image of the submerged area. The State of Florida is currently unwilling to do any additional remediation on the site, but the site staff is investigating the feasibility of releasing the water. The water level on the site is controlled by a gate on the eastern berm, but the water cannot be lowered without proper authorization.

Figure 2. Submerged east portion of the site

Credit: Lars Lisell, NREL

There is currently some remaining manufacturing infrastructure on the site in the form of large chemical storage tanks and truck-filling stations. See Figure 3 for an image of the remaining infrastructure.

Figure 3. Large storage tanks

Credit: Lars Lisell, NREL

The site has plans to remove the four westernmost tanks and the filling stations during the summer of 2010. The remaining tanks will need to be removed as part of the implementation of the solar system. The buildings on the western side of the site are not included in the site area. The site has excellent sky exposure, with the only shading coming from the forested area on the east, some shading from the buildings on the west, and some shading in the northern areas due to the forest and the jagged property line. The site was well kept and mowed at the time of the site visit. The forest on the north and west sides is a mature forest with trees in the range of 50–70 feet tall. The site has electrical tie-ins at the building site on the west side of the site and also in the southwest corner of the site where the large storage tanks were connected to the grid. The connections in the southwest corner were high voltage connections that were formerly used for industrial equipment. Across the road from the site is a power plant that would possibly accept the power from the system. See Figure 4 for two of the possible electrical connection points.

Figure 4. Potential electrical connection points

Credit: Lars Lisell, NREL

This site needs to have a ballast-mounted system implemented on a portion of the site due to the cap that was installed during the remediation of the site. A ballast-mounted system is preferred in order to avoid any ground penetrations. Ballasted systems are placed on top of the ground and held in place by adding weight to the mounting frame. This is different than traditional mounting systems which require anchors to be put in the ground, potentially disturbing the cap. Some uncapped portions of the site would not require ballasted mounts. According to a site map that identifies the capped areas, 1.7 acres of the site would require ballasted mounts. This site map can be found in the Calculation Appendices in Figure A-1. This represents approximately 10% of the total available area.

*Proposed system location is shaded in gold in the figure.

Figure 5. St. Marks Refinery recommended PV system placement

Credit: Google Earth

Solar Access Measurements

The PV system placement and area calculation are based on solar access measurements that were taken on the site. This was accomplished by taking solar measurements around the perimeter of the site to determine if there were any obstructions that would shade out any portions of the site. The portions of the site that were found to be shaded for a significant portion of the year were eliminated from the usable site area. Two of the measurements are located in Figure 6 and Figure 7.

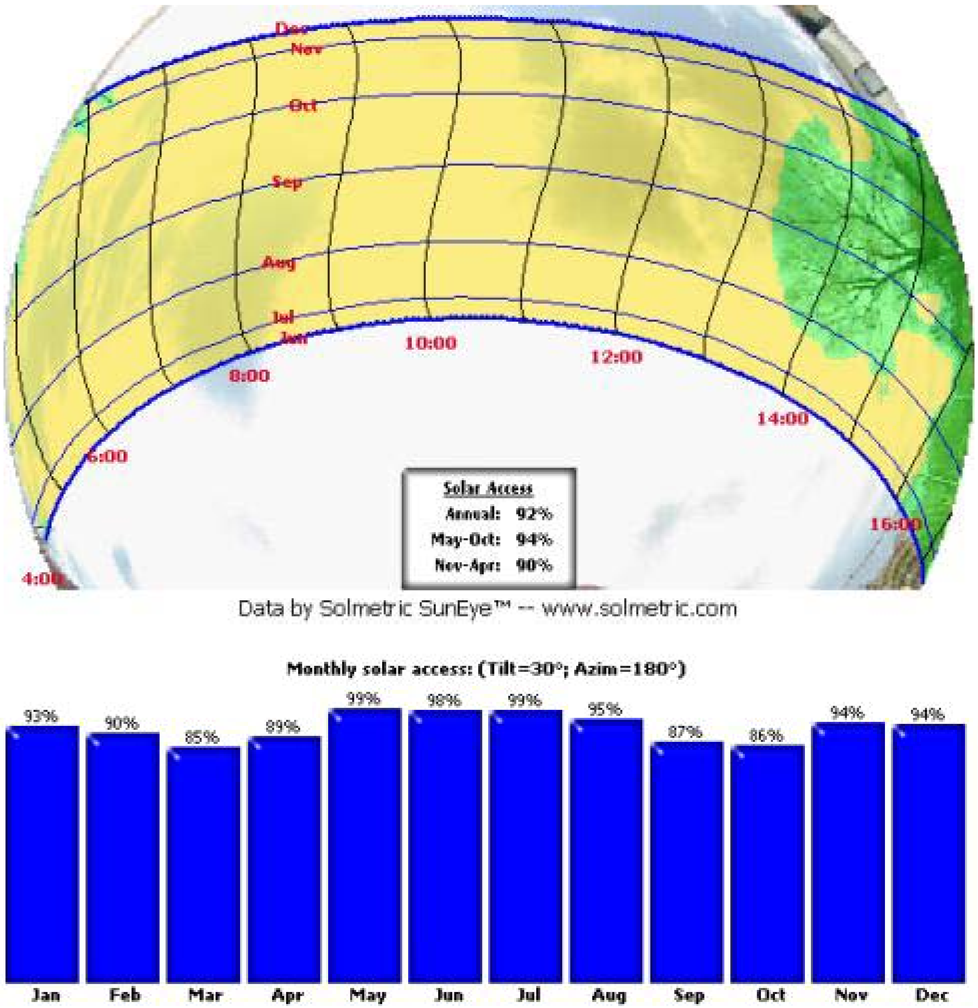

Figure 6. Solar measurement on the west border

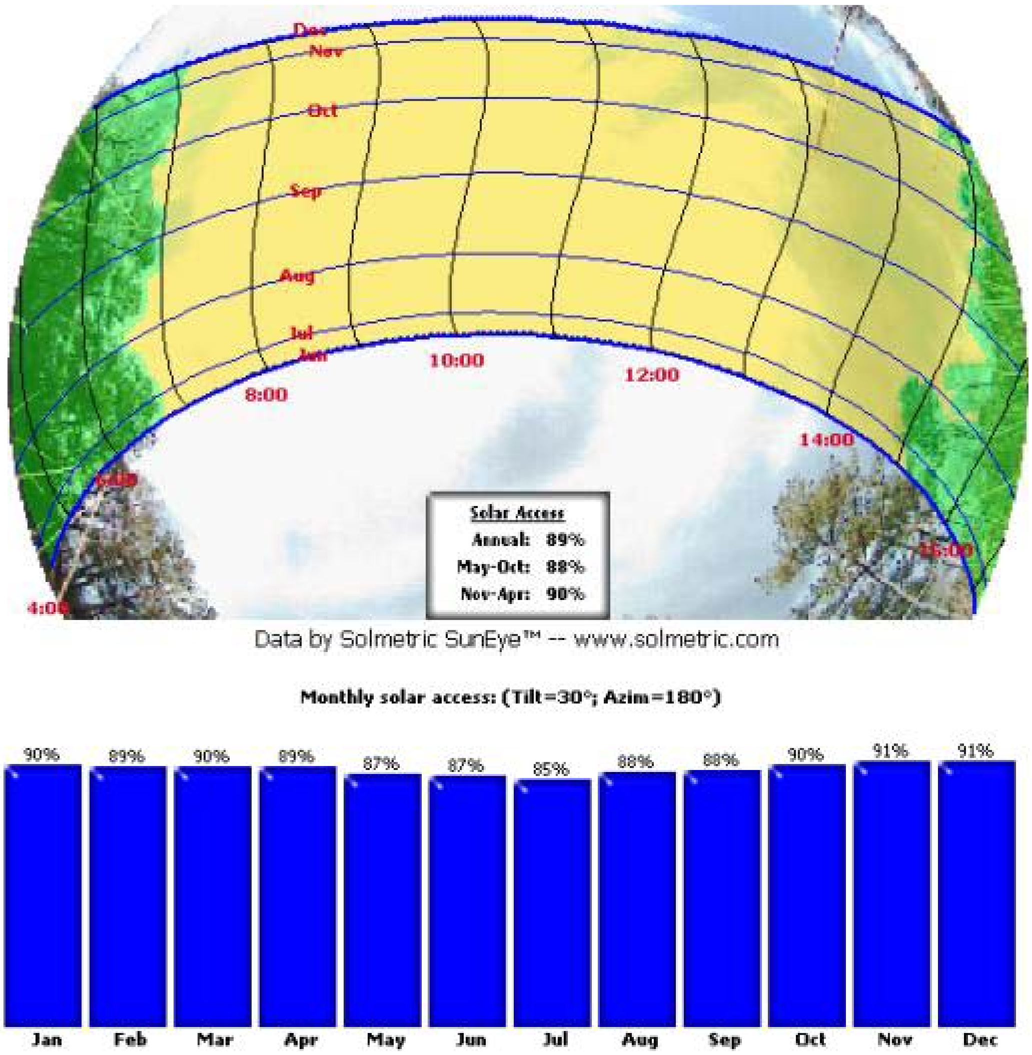

Figure 7. Solar measurement on the north border

Entire Site Options

Options for different system types that utilize the entire site are listed in Table 2 and assume that all of the water on the site will be drained. The three lines listed in the table are three different styles of solar systems that have different characteristics. Each of the lines is a standalone system that is sized to utilize the entire available site area. The site staff is in the process of having the water on the site tested to determine contamination levels. If the test results show that the water can be drained from the site, the majority of the site will have the potential to be used for a PV system. There is a water level adjustment gate in the northwest corner of the site that could be used to lower the water level. According to Florida state law, utilities are required to allow interconnection to their electrical grid for systems 2 MW and below. The total system size for the fixed-tilt crystalline silicon system that would utilize all available area at the St. Marks Refinery site may exceed this limit. This would require the utility to agree to exceed the 2 MW interconnection limit. In order to gain this approval, it would be beneficial to begin conversations with the utility early.

Once the shaded areas were removed from consideration, it was assumed that 90% of the remaining area would be usable for a PV system. This results in remaining usable area of 667,400 ft^2 (15.3 acres).

Table 2. Entire Site PV System Options

System Type	Potential System Size (kW)	Annual Energy Output (kWh)	Annual Cost Savings ($)	Annual O&M ($)	System Cost ($)
Crystalline Silicon—Fixed Tilt	2,500	3,285,000	262,800	30,600	8,650,000
Crystalline Silicon—Single-axis Tracking	2,000	3,078,000	246,240	63,000	8,300,000
Thin Film	1,000	1,314,000	105,120	11,220	2,980,000

Partial Site Options

Draining all the water on the site may not be possible, but draining a portion of the water may be an option. If the water level cannot be drained completely, it would be beneficial to lower the water level slightly, which would allow several acres on the west end of the containment pond to become dry and suitable for solar installation. This would still allow for a holding pond on the far east side of the site. This configuration could allow for the objectives of the PV system to be satisfied while at the same time making sure that contaminated water does not enter the St. Marks river. Figure 8 shows the area assuming partial water drainage, which would increase the usable area to 13 acres.

*Proposed system location is shaded in gold in the figure.

Figure 8. Partial site recommended PV system placement

Credit: Google Earth

See Table 3 for a summary of the different system types that could be implemented using the partially drained site.

Table 3. Partial Site PV System Options

System Type	Potential System Size (kW)	Annual Energy Output (kWh)	Annual Cost Savings ($)	Annual O&M ($)	System Cost ($)
Crystalline Silicon—Fixed Tilt	2,000	2,628,000	210,240	17,000	7,000,000
Crystalline Silicon—Single-axis Tracking	1,500	2,308,500	184,680	31,500	6,300,000
Thin Film	800	1,051,200	84,096	5,984	2,464,000

3.2 Recently Closed North Site

There is another site just north of the St. Marks Refinery site that will potentially be turned over to the City of St. Marks in the near future. This site has a significant amount of infrastructure currently on the site that is spaced out evenly across the site. Without the removal of this infrastructure, there is very little space available for a solar array. The site is surrounded by forest that ranges from 50–100 feet tall that shades a large strip of land around the edge of the site. The storage tanks in the middle of the site are also tall, shading out a large portion of the center of the site. The only unshaded area on the site is in the northwest corner. The onsite staff said that this site is not heavily contaminated and could potentially be redeveloped. Business redevelopment would be preferable over developing the site for a solar array, given the extensive infrastructure removal that would need to take place in order to prepare the site for solar. If all infrastructure was removed from the site, there would be 3.5 acres available for a solar array. This excludes the areas along the perimeter of the site that would be shaded by the surrounding forest. There is a potential electrical connection near the middle of the site, allowing for a convenient electrical tie-in.

*Proposed system location is shaded in gold in the figure.

Figure 9. Recommended PV system placement on recently closed north site

Credit: Google Earth

Once the shaded areas were removed from consideration, it was assumed that 90% of the remaining area would be usable for a PV system. This results in a remaining usable area of 137,565 ft^2 (3.2 acres).

Table 4. Recently Closed North Site System Options

System Type	Potential System Size (kW)	Annual Energy Output (kWh)	Annual Cost Savings ($)	Annual O&M ($)	System Cost ($)
Crystalline Silicon—Fixed Tilt	550	722,700	57,816	4,675	1,925,000
Crystalline Silicon—Single-axis Tracking	450	692,550	55,404	9,450	1,890,000
Thin Film	200	262,800	21,024	1,496	616,000

3.3 Summary of All Sites

Both sites that were visited were found suitable to incorporate PV systems. The economics of the potential systems were analyzed using an electric rate of $0.08/kWh and the 30% federal investment tax credit (ITC). Incentives that are offered in the State of Florida and from the two accessible utilities, Progress Energy and the City of Tallahassee, were also investigated. Currently there are no incentives offered for commercial-size solar power systems in Wakulla County, Florida, or from the nearby utilities. The only incentive that could potentially be captured is the 30% federal ITC. The calculations reflect the solar potential if the total area is utilized from both of the sites that were visited. The results are summarized in Table 5.

Table 5. St. Marks, Florida, Site Summary[a]

Array Tilt (Deg)	PV System Size (kW)	Annual Output (kWh/year)	Annual Cost Savings ($/year)	Annual O&M ($/year)	System Cost with Incentives ($)	Payback Period with Incentive (years)
Crystalline Silicon (Fixed Tilt)						
30.4	3,050	4,007,700	$320,616	$25,925	$10,575,000	36
Crystalline Silicon (Single-axis Tracking)						
0	2,450	3,770,550	$301,644	$51,450	$10,190,000	41
Thin Film (Fixed Tilt)						
30.4	1,200	1,576,800	$126,144	$8,976	$3,696,000	32

[a] Data assume a maximum usable area of 804,942 ft^2.

4 Economics and Performance

4.1 Assumptions and Input Data for Analysis

For this analysis, the following input data were used. It is assumed that the installed cost of fixed-tilt roof-mounted systems will be $6/W, and fixed-tilt ground-mounted systems will be $5/W. These prices include the PV array and the balance of system components for each system, including the inverter, electrical equipment, and installation. The economics of grid-tied PV depend on incentives, the cost of electricity, and the solar resource including panel tilt and orientation. For this analysis, it was assumed that the cost of electricity was $0.08/kWh.

A system DC to AC conversion of 77% was assumed. This includes losses in the inverter, wire losses, PV module losses, and losses due to temperature effects. Figure 10 summarizes average system installation costs for grid-tied U.S. PV systems in 2008; however, the costs have dropped significantly since 2008. PVWATTS was used to calculate energy performance.

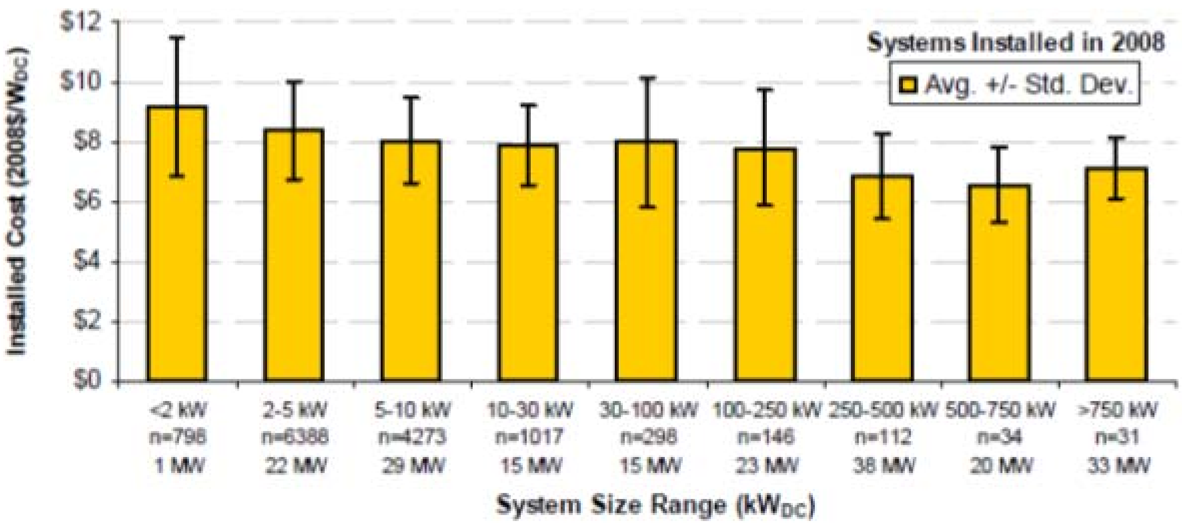

Figure 10. PV Costs[7]

It is assumed for this analysis that federal incentives are received. It is important to find state incentives or grants to make PV cost effective. A private, tax-paying entity that owns PV systems can qualify for a 30% federal business energy investment tax credit (ITC) and accelerated depreciation on the PV system, which are worth about 15%. The total potential tax benefits to the tax-paying entity are about 45% of the system cost. Because the city government does not pay taxes, private ownership of the PV system would be required to capture tax incentives.

[7] Wiser, R.; Barbose, G. ; Peterman, C. ; Darghouth, N. *Tracking the Sun II*. Environmental Energy Technology Division. Berkeley, CA : Lawrence Berkeley National Laboratory, 2009.

4.2 Incentives and Financing Opportunities

The Database for State Incentives for Renewable Energy (DSIRE) provides a summary of net metering, interconnection rules, and incentives available to Florida utility customers[8]. The power from this system could be sold to either Progress Energy or the City of Tallahassee.

Renewable energy systems, including commercial solar PV, are subject to interconnection rules promulgated at the state level. In Florida, the limit is currently set at 2 MW, but this may be negotiable, depending on how flexible the utility is. The utility would need to be contacted directly to determine what they are willing to do. Florida does not currently have a statewide Renewable Portfolio Standard (RPS).

There are currently no incentives offered by Wakulla County, Florida, or by the nearby utilities. Incentives greatly affect the economics of a system, and the current lack of incentives in Florida will have a large impact on the feasibility of a system at this site. The federal incentive can be captured if the system is owned by a tax-paying entity.

The system facilitator could potentially pursue an agreement with either the City of Tallahassee or Progress Energy that would negotiate a higher price for the electricity produced by the potential system. Any power that is produced by a solar PV system would be a great opportunity for utilities to get a jump on diversifying their energy mix with clean energy. It has been demonstrated across the country that people are willing to pay a premium for certified clean energy[9], and the utilities could potentially start a pilot program with energy from this site.

There are a couple of options for getting a solar PV system financed. At a site like St. Marks, when the land has been turned over to the city, securing financing is one of the most important parts of the process. A typical financing option is third party ownership; however, this type of agreement is prohibited in the State of Florida. Florida law specifically states that the entity that owns the system must use the power. This eliminates most of the options for a commercial size PV system. In order for the system to feed power to the power company, the power company needs to be the owner of the system. In this configuration, the land that the solar system is on would need to be leased to the utility for the duration of the system life. The city would retain the ownership of the land and lease it to the power company while the power company owns the system. Another option is to attract a business to the site in order to use the power that is generated on site. This would require the business to own the system, and there may be difficulties trying to set up this sort of configuration.

4.3 Job Creation

The implementation of this project would represent a large amount of money entering the clean energy industry of the United States. The Council of Economic Advisors (CEA) calculated the number of jobs created due to federal spending using economic models developed with real

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[8] DSIRE. http://www.dsireusa.org/incentives/index.cfm?re=1&ee=1&spv=0&st=0&srp=1&state=FL. Accessed July 2010.

[9] Xcel Energy's Windsource Program is a largely successful voluntary renewable energy purchase program. http://www.xcelenergy.com/Colorado/Residential/RenewableEnergy/Windsource_/Pages/WindSource.aspx. Accessed July 2010.

world data. CEA found that $92,000 in federal spending is equivalent to one job-year. This means that for every $92,000 of federal money that is spent, there is a job created that can be sustained for one year. See Table 6 for an estimate of job creation by system type if both sites studied at St. Marks were used for solar PV. This project represents a large amount of money that would create a significant number of jobs. A portion of these jobs, including the installation and system maintenance jobs, will be created within the community. The jobs created column refers to the number of job-years that would be created as a result of the one-time project capital investment. This means that the jobs will be created and sustained for one year. The jobs sustained column refers to the number of jobs that would be sustained as a result of the O&M of the system. These jobs will be sustained for the life of the system, due to the annual cost to keep the system operating.

Table 6. Estimated Job Creation by PV System Type

System Type	Jobs Created[a] (job years)	Jobs Sustained[b] (number of jobs)
Crystalline Silicon (Fixed Tilt)	115	0.3
Crystalline Silicon (Single-axis Tracking)	111	0.6
Thin Film (Fixed Tilt)	40	0.1

[a] Job-years created as a result of project capital investment including direct, indirect, and induced jobs.
[b] Jobs (direct, indirect, and induced) sustained as a result of operations and maintenance (O&M) of the system.

5 Conclusions and Recommendations

The sites considered for a solar PV system in this report are promising areas in which to implement a solar system. The availability of land that cannot be used for other purposes represents an area that minimizes the environmental impact of a solar generation plant and allows for the reuse of land that would otherwise make little to no contribution to productivity in the City of St. Marks. It is recommended that the site facilitator contact Progress Energy and the City of Tallahassee Utility to attempt to set up an agreement to sell the electricity generated at the site. According to the site production calculations, the most cost-effective system in terms of return on investment is the fixed-tilt thin film technology. The lower cost of the system combined with the cheap land available on the site makes a thin film system a good fit for this site. Thin film technology is a proven technology that can be successfully implemented with a traditional or ballasted-style mounting system. The other two system styles could also be implemented, but the increased cost of the crystalline silicon panels may extend the payback period. When the system goes out to bid, a design-build contract should be issued requesting the best performance (kWh/year) at the best price. The vendor should optimize system configuration including tilt. If the site can be modified by removing the storage tanks and lowering the water level, the feasibility of a PV system can be greatly improved. All payback calculations assumed a 30% federal tax credit would be captured for the system.

Installing solar facilities on contaminated land can reduce pressure on greenfields for installing these facilities. In addition, developing solar facilities on contaminated land can provide an economically viable reuse option for sites with significant cleanup costs or sites that local economic conditions prohibit traditional reuse. This is the case with St. Marks. The site has existing transmission capacity, roads, industrial zoning, and all other critical infrastructure in place for this renewable energy project. This site is an ideal candidate to help the United States further its goal of increasing clean energy use and reducing environmental impact.

Appendix A. Assumptions for Calculations

Table A-1. Total Site Usage Scenario[a]

Location	Array Tilt (deg)	Maximum Usable Area (ft^2)	Rounded PV System Size (kW)	Annual Output (kWh/year)	Annual Cost Savings ($/year)	Annual O&M ($/year)	System Cost with Incentives[b] ($)	Payback Period[c] (years)	System Cost without Incentives ($)
Crystalline Silicon (Fixed Tilt)									
St. Marks Refinery	30.4	667,377	2,500	3,285,000	$ 262,800	$21,250	$ 8,750,000	36	$ 12,500,000
Recently Closed Site	30.4	137,565	550	722,700	$ 57,816	$4,675	$ 1,925,000	36	$ 2,750,000
Crystalline Silicon (Single-axis Tracking)									
St. Marks Refinery	0	667,377	2,000	3,078,000	$ 246,240	$42,000	$ 8,400,000	41	$ 12,000,000
Recently Closed Site	0	137,565	450	692,550	$ 55,404	$9,450	$ 1,890,000	41	$ 1,890,000
Thin Film (Fixed Tilt)									
St. Marks Refinery	30.4	667,377	1,000	1,314,000	$ 105,120	$7,480	$ 3,080,000	32	$ 3,080,000
Recently Closed Site	30.4	137,565	200	262,800	$ 21,024	$1,496	$ 616,000	32	$ 616,000

[a] The calculations in this table were conducted with the assumption that all 17 acres of the site would be fully utilized.
[b] The incentives include the 30% federal tax credit.
[c] The payback period was calculated using the system cost with incentives.

Table A-2. Cost and System Assumptions

Name of Variable	Quantity of Variable	Unit of Variable
Cost of Site Electricity	0.08	$/kWh
Annual O&M (fixed)	0.17%	% of installed cost
Annual O&M (tracking)	0.35%	% of installed cost

System Type	Annual energy production kWh/kW	Installed Cost ($/W)	Energy Density (W/ft²)
Ground Fixed Tilt	1,314	$5.00	4.0
Ground Single-axis Tracking	1,539	$6.00	3.3
Thin Film Fixed Tilt	1,314	$4.40	1.7

Assumptions
1 acre = 43,560 ft²
1 MW = 1,000,000 W
Ground Utilization = 90% of available area
Incentives: Federal Tax Credit

Table A-3. Partially Drained Site Scenario[ab]

Location	Array Tilt (deg)	Maximum Usable Area (ft^2)	PV System Size (kW)	Annual Output (kWh/year)	Annual Cost Savings ($/year)	Annual O&M ($/year)	System Cost with Incentives ($)	Payback Period with Incentive (years)
Crystalline Silicon (Fixed Tilt)								
St. Marks Refinery	**30.4**	**500,040**	**2,000**	**2,628,000**	**$210,240**	**$17,000**	**$7,000,000**	**36**
Crystalline Silicon (Single-axis Tracking)								
St. Marks Refinery	**0**	**500,040**	**1,500**	**2,308,500**	**$184,680**	**$31,500**	**$6,300,000**	**41**
Thin Film (Fixed Tilt)								
St. Marks Refinery	**30.4**	**500,040**	**800**	**1,051,200**	**$84,096**	**$5,984**	**$2,464,000**	**32**

[a] The calculations address the PV system in the event that the site can only be partially drained. The calculations reflect the land required to facilitate a 2 MW crystalline silicon PV system. This system configuration would allow for a water holding area to prevent contaminated water runoff and allow for the rest of the site to be utilized by a solar system.
[b] The calculations assume that the 30% federal tax credit is secured.

The following image shows the elevation of the site, outlining the locations where the containment berms were installed and showing the location of the permanently capped areas. The areas with the permanent caps in place would need to implement a ballasted-style mounting system in order to avoid disturbing the cap that is in place.

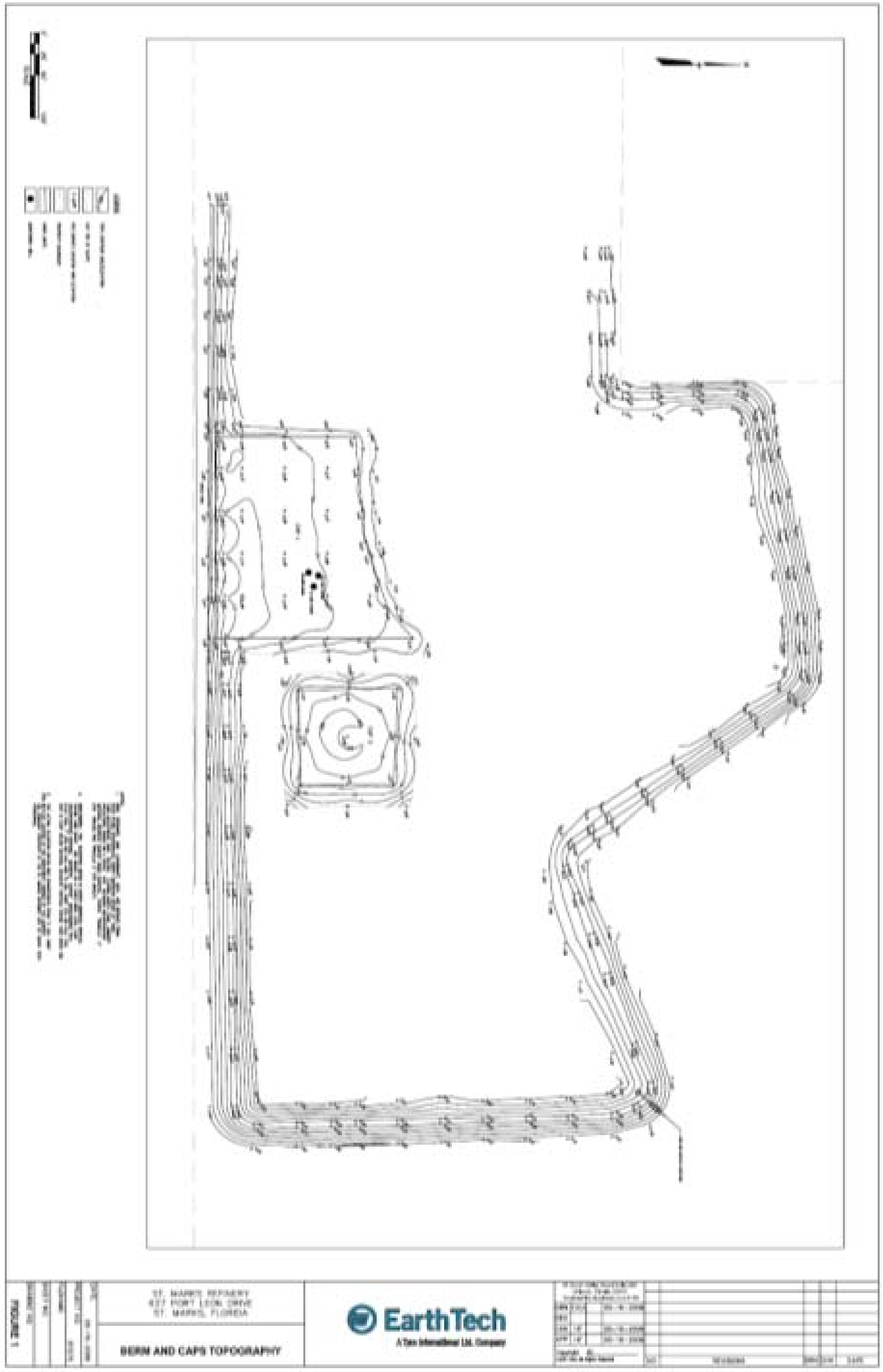

Figure A-1. Elevation of the site

Credit: EarthTech

Appendix B. Renewable Energy Incentives[a]

Table B-1. Brownfield Redevelopment and Renewable Energy Incentives and Financing Tools

Agency	Incentive Name	Incentive (I), Finance Tool (FT)	Public	Private	Funding Range
HUD	Brownfield Economic Development Initiative (BEDI) Competitive Grant Program	I	X	X[b]	$17.5 million appropriated in FY10. Award cap TBD as of 2/27/10
HUD	Section 108 Loan Guarantee Program	FT	X	X[b]	Up to five times public entity's latest approved Community Development Block Grants (CDBG) amount

[a] Must be used in conjunction with Section 108 loan guarantee commitment.
[b] Through re-loan from public entity.

Table B-2. Renewable Energy Development Incentives and Financing Tools Applicable to PV

Agency	Incentive Name	Incentive (I), Finance Tool (FT)	Public	Private	Funding Range
DOE	Loan Guarantee Program	FT	X	X	Not specified
DOE	Renewable Energy Production Incentive (REPI)	I	X		$0.021/kW
HUD	CDBG	I	X		Based on community needs formula
Treasury	1603 Renewable Energy Grant Program *option to Investment Tax Credit (ITC)	I		X	30% of the cost basis of the renewable energy project
Treasury	Business Energy ITC *option to 1603	I		X	30% of project expenditures
Treasury	Clean Renewable Energy Bonds (CREB)	FT	X		Varies
Treasury	Modified Accelerated Cost-Recovery System (MACRS)	FT		X	Various depreciation deductions
Treasury	Qualified Energy Conservation Bonds (QECB)	FT	X		Varies
USDA	Rural Energy for America Program (REAP) Grants	I	X	X	25% of project cost. Payment range $2,500–$500,000
USDA	REAP Loan Guarantees	FT	X	X	Up to 75% of project costs. Max $25M/Min $5K

Sources: DSIRE and Efficiency 2009; U.S. Department of Housing and Urban Development 2009

The programs included in Table B-3 are ongoing rebate and grant programs administered by state agencies or by third-party organizations on behalf of state governments. In addition to the programs highlighted in Table B-2, about 75 utilities in the United States offer PV rebates. In some states, such as Colorado and Arizona, solar rebates are available nearly statewide from utilities that must comply with state RPSs, but these are not shown in the table. Finally, programs that are purely performance-based, such as the State of Washington's production incentive and California's feed-in tariff, are not included in this table.

Table B-3. State Rebates for Commercial-sector PV Projects

State	Program Name	Incentive Amount	Renewable Energy Certificate (REC) Ownership	Funding Source
California	California Solar Initiative	Varies by sector and system size.	Remains with project owner	Rate-payer funded
California	CEC - New Solar Homes Partnership	Varies. Incentives are adjusted based on expected performance and will decline over time based on the total installed capacity.	Remains with system owner	Rate-payer funded
Connecticut	CCEF - On-Site Renewable DG Program	For for-profit owners: $3.00/W for first 100 kW, $2.00/W for next 100 kW. Not-for-profit system owners: $4.50/W for first 100 kW, $4.00/W for next 100 kW. Additional $0.10/W premium for buildings that meet LEED Silver certification. CCEF also compensates system owners based on the estimated present value of the system's RECs.	RECs transfer to CCEF for systems 50 kW-PTC and larger. CCEF compensates system owners based on estimated present value of the system's RECs over 15 years.	Connecticut Clean Energy Fund (public benefits fund)
Delaware	Green Energy Program Incentives	Delmarva: 25% of installed cost (35% for non-profits, government); DEC: 33.3% of installed cost; Minis: 33.3% of installed cost except 25% for Dover,	Remains with project owner	Green Energy Fund (Delmarva), DEC Renewable Resources Fund, Municipal Utility Green Energy Fund (public benefits funds)

State	Program Name	Incentive Amount	Renewable Energy Certificate (REC) Ownership	Funding Source
		Seaford; PV system cost may not exceed $12/W		
District of Columbia	Renewable Energy Incentive Program	$3/W DC for first 3 kW; $2/W DC for next 7 kW; $1/W DC for next 10 kW	Remains with system owner	Sustainable Energy Trust Fund (public benefits fund)
Illinois	DCEO - Solar and Wind Energy Rebate Program	Note (02/2010): Funding for FY 2010 has been fully allocated; no additional rebates are available. Residential and commercial: 30%; Non-profit and Public: 50%	Remains with customer/producer	Illinois Renewable Energy Resources Trust Fund (public benefits fund)
Maine	Solar and Wind Energy Rebate Program	$2/W AC	Remains with customer/producer	Funded by assessment of up to 0.005 cents/kWh on transmission and distribution utilities. Plus $500,000 per fiscal year (FY2009-2010 and FY2010-2011) for two years using Recovery Act funding.
Maryland	Mid-size Solar Energy Grant Program	$500/kW for first 20 kW DC; $250/kW for next 30 kW; $150/kW for next 50 kW	Remains with project owner	Recovery Act
Maryland	Solar Energy Grant Program	$1.25/W DC for first 2 kW; $0.75/W for next 6 kW; $0.25/W for next 12 kW	Remains with project owner	General Revenue Funds (appropriated annually); FY 2009 funds supplemented with RGGI proceeds
Massachusetts	CEC - Commonwealth Solar II Rebates	$1/W DC base; $0.10/W DC adder for MA components; $1.00/W DC adder for moderate home value or for moderate income	Remains with project owner	Massachusetts Renewable Energy Trust

State	Program Name	Incentive Amount	Renewable Energy Certificate (REC) Ownership	Funding Source
Massachusetts	CEC - Commonwealth Solar Stimulus	$1.50/W (DC) for first 25 kW; $1.00/W (DC) for > 25 kW to 100kW; $0.50/W (DC) for > 100 kW to 200 kW	Remains with project owner	Recovery Act
Nevada	NV Energy – Renewable Generations Rebate Program	(2010-2011 program year) Residential and small business: $2.30/W AC; Public Facilities/Schools: $5.00/W AC	NV Energy	Rate-payer funded
New Jersey	New Jersey Customer-sited Renewable Energy Rebates	Standard residential: $1.55/W DC; Residential with energy efficiency: $1.75/W DC; Residential new construction: varies by efficiency, $1.00–$1.75/W DC; Standard non-residential: $0.90/W DC; Non-residential with efficiency: $1.00/W DC	Remains with project owner	New Jersey Societal Benefits Charge (public benefits fund)
New Jersey	Renewable Energy Manufacturing Incentives (for End-Use PV Installations)	Varies by equipment type, sector, and system size. Ranges from $0.05–$0.55/W DC.	Not applicable	New Jersey Societal Benefits Charge (public benefits fund)
New York	NYSERDA - PV Incentive Program	Residential (first 5 kW): $1.75/W DC; Non-residential (first 50 kW): $1.75/W DC; Non-profit, government, schools: (first 25 kW): $1.75/W DC; Bonus incentive: $0.50/W for Energy Star homes and BIPV systems	First 3 years: NYSERDA, thereafter customer/generator	RPS surcharge
Ohio	ODOD - Advanced	$3.50 per DC-Watt, may be reduced by	Not specified	Ohio Advanced Energy Fund

State	Program Name	Incentive Amount	Renewable Energy Certificate (REC) Ownership	Funding Source
	Energy Program Grants - Non-residential Renewable Energy Incentive	shading		
Oregon	Energy Trust - Solar Electric Buy-down Program	Residential: $1.50/W DC for Pacific Power; $1.75/W DC for PGE; Residential, third party: $1/W DC for Pacific Power; $1.25/W DC for PGE; Commercial: $1/W - $0.50/W for Pacific Power; $1.25/W - $0.75/W for PGE; Non-profit/government: $1.25/W - $0.75/W for Pacific Power; $1.50/W - $1/W for PGE	Residential: RECs for first 5 years owned by customer/producer; Non-residential: RECs for first 5 years owned by consumer/producer, Energy Trust owns RECs for years 6–20	Energy Trust of Oregon (public benefits fund)
Pennsylvania	Pennsylvania Sunshine Solar Rebate Program	Residential: $2.25/W DC; Commercial: $1.25/W DC for first 10 kW, $1.00/W DC for next 90 kW, $0.75/W DC for next 100 kW; Low-income: 35% of installed costs	Not specified, but net metering customers generally retain title to RECs	Pennsylvania Energy Independence Fund (state bonds)
Puerto Rico	Puerto Rico - State Energy Program - Sun Energy Rebate Program	Solar PV: Residential and commercial $4/W DC; Solar PV: Governmental $8/W DC	Not addressed	Recovery Act State Energy; Program funds
Tennessee	Tennessee Clean Energy Technology Grant	40% of installed cost	Not specified	State of Tennessee Economic and Community Development Energy Division
Vermont	Vermont Small-Scale Renewable	Individuals/businesses: $1.75/W DC; Multi-family, low-income:	Not addressed	Utility settlement funds and the Vermont Clean

State	Program Name	Incentive Amount	Renewable Energy Certificate (REC) Ownership	Funding Source
	Energy Incentive Program	$3.50/W DC		Energy Development Fund
Wisconsin	Focus on Energy - Renewable Energy Cash-Back Rewards	Residential/business: $1.00/kWh/1-yr.; Non-profit/government: $1.50/kWh/1-yr.; (Estimated 1-yr. production using PVWATTS). Efficiency First participants: add $0.25/kWh/1-yr.	Not addressed	Focus on Energy Program

Source: DSIRE 2010

Note: The information provided in this table presents an overview of state incentives, but it should not be used as the only source of information when making purchasing decisions, investment decisions, tax decisions, or other binding agreements. For more information about individual programs listed above, visit the DSIRE Web site at http://www.dsireusa.org/.

Table B-4. State Tax Credits for Commercial-sector PV Projects

State	Program Name	Eligible Recipients	Incentive Amount	Third-party Owner Eligible	Non-profit/ Government Eligible
Arizona	Non-residential Solar & Wind Tax Credit (Corporate)	Any non-residential installation is eligible, including those for non-profits and governments. Individuals, corporations, and S corporations and partnerships may claim the credit. Third-party financiers/installers/mfrs. of eligible system may claim the credit.	10%	Yes	Yes
Georgia	Clean Energy Tax Credit (Corporate)	Any GA taxpayer who has constructed, purchased, or leased renewable energy property and placed it in service.	35%	Yes	Not specified
Hawaii	Solar and Wind Energy Credit (Corporate)	Hawaii taxpayer that files a corporate net income tax return or franchise tax return. Credit may be claimed for every eligible renewable energy technology system that is installed and placed in service. Third-party taxpaying entities may claim the credit if they install and own a system on a commercial taxpayer's building or on a non-profit or government building. Multiple owners of a single system may take a single tax credit. The credit is apportioned between the owners in proportion to their	35%	Yes	Yes

State	Program Name	Eligible Recipients	Incentive Amount	Third-party Owner Eligible	Non-profit/ Government Eligible
		contribution to the system's cost.			
Iowa	Renewable Energy Production Tax Credits (Corporate)	Producers or purchasers of renewable energy from qualified facilities. Installations must be at least 51% owned by a state resident or other qualifying owner and placed in service on or after July 1, 2005, and before January 1, 2012. Electricity must be sold to an unrelated person to qualify for the tax credit.	$0.015/kWh for 10 years after energy production begins.	Yes, credits may be claimed by system owner or by purchaser of electricity. System owners must meet certain eligibility criteria.	Schools and cooperative associations are eligible owners. Credits may be transferred or sold one time.
Kentucky	Renewable Energy Tax Credit (Corporate)	Any installation on a dwelling unit or on property that is owned and used by the taxpayer as commercial property	$3/DC-Watt	Not specified	Not specified
Kentucky	Tax Credit for Renewable Energy Facilities	Companies that build or renovate facilities that utilize renewable energy	100% Kentucky income tax or limited liability entity tax	Not specified	Not specified
Louisiana	Tax Credit for Solar and Wind Energy Systems on Residential Property (Corporate)	A taxpayer who purchases and installs an eligible system or who purchases a new home with such a system already in place	50%	No	No
Maryland	Clean Energy Production Tax Credit (Corporate)	All individuals and corporations that sell electricity produced by a qualified facility to an unrelated person. Net metering arrangements qualify.	$0.0085/kWh for 5 years after facility is placed in service.	Not specified	No

State	Program Name	Eligible Recipients	Incentive Amount	Third-party Owner Eligible	Non-profit/ Government Eligible
Montana	Alternative Energy Investment Tax Credit (Corporate)	A corporation, partnership, or small business corporation that makes a minimum investment of $5,000	35%	No	No
New Mexico	Advanced Energy Tax Credit (Corporate)	Any taxpayer	6%	No	No
New Mexico	Renewable Energy Production Tax Credit (Corporate)	A taxpayer who holds title to a qualified energy generator that first produced electricity on or before January 1, 2018, or a taxpayer who leases property upon which a qualified energy generator operates from a county or municipality under authority of an industrial revenue bond and if the qualified energy generator first produced electricity on or before January 1, 2018.	Varies annually over 10 years; $0.027/kWh average	Not specified	Not specified
New Mexico	Solar Market Development Tax Credit	Residents and non-corporate businesses, including agricultural enterprises	10% of purchase and installation costs	No	No
North Carolina	Renewable Energy Tax Credit (Corporate)	Any NC taxpayer who has constructed, purchased, or leased renewable energy property and placed it in service.	35% (distributed 7% per year for 5 years for non-residential installations)	Yes. For leasing, a taxpayer may take credit for property that the taxpayer leases if written verification is received from the owner that states	No

State	Program Name	Eligible Recipients	Incentive Amount	Third-party Owner Eligible	Non-profit/ Government Eligible
				that owner will not take credit for renewable energy installation.	
North Dakota	Renewable Energy Tax Credit	Corporate taxpayers filing a North Dakota income tax return. System must be installed on a building or on property owned or leased by the taxpayer in North Dakota.	15% (distributed 3% per year for 5 years)	A pass-through entity that installs the system at a property it owns or leases is considered the taxpayer. The credit amount allowed is determined at the pass-through entity level and must be passed through proportionally to corporate partners, shareholders, or members.	No
Oklahoma	Zero-emission Facilities Production Tax Credit	Any non-residential taxpayer who sells electricity to an unrelated person. Any nontaxable entities, including agencies of the State of Oklahoma, may transfer their credit to a taxpayer.	$0.0050/kWh for first 10 years of operation	Yes	Yes, nontaxable entities, including agencies of the State of Oklahoma or political subdivisions thereof, can take advantage of the tax credit by transferring it to a taxable entity.

State	Program Name	Eligible Recipients	Incentive Amount	Third-party Owner Eligible	Non-profit/ Government Eligible
Oregon	Business Energy Tax Credit	Trade, business, or rental property owners who pay taxes for a business site in Oregon are eligible for the tax credit. The business, its partners, or its shareholders may use the credit. A project owner also can be an Oregon non-profit organization, tribe, or public entity that partners with an Oregon business or resident who has an Oregon tax liability. This can be done using the pass-through option.	50% (distributed 10% per year for 5 years)	Yes	A project owner can be a non-profit, tribe, or public entity that partners with a business or resident to take advantage of the pass-through option. The pass-through option allows a project owner to transfer the 35% Business Energy Tax Credit project eligibility to a pass-through partner for a lump-sum cash payment. The pass-through option rate for 5-year Business Energy Tax Credits effective October 1, 2003, is 25.5%. The pass-through option rate for 1-year Business Energy Tax Credits (those with eligible costs of $20,000 or less) effective October 1, 2003, is 30.5%.
Puerto Rico	Puerto Rico - Solar Tax Credit (Corporate)	Any Puerto Rican taxpayer who has acquired, assembled, and installed eligible solar electric equipment.	75% during FY 2007-2008 and 2008-2009; 50% during FY 2009-	Not specified	Potentially; the tax credit may be transferred, sold, or otherwise given to "any other person."

State	Program Name	Eligible Recipients	Incentive Amount	Third-party Owner Eligible	Non-profit/ Government Eligible
			2010 and FY 2010-2011; 25% starting FY 2011-2012		
Rhode Island	Residential Renewable Energy Tax Credit (Corporate)	Rhode Island taxpayer who (1) owns, rents, or is the contract buyer of the dwelling(s) served by the system. The dwelling or dwellings must be in the main or secondary residence of the person who applies for the tax credit, or of a tenant; (2) owns, or is the contract buyer of the system and pays all or part of the cost of the system; or (3) is the contractor that owns the dwelling for speculative sale in which the system is installed	25%	Yes. Credit is available to RI taxpayers who are the contract buyers of eligible systems and pay all or part of the cost of the system.	No
South Carolina	Solar Energy and Small Hydropower Tax Credit (Corporate)	Taxpayers who purchase and install an eligible system in or on a facility owned by the taxpayer	25% for 2010; was 30% in 2009	No	No
Utah	Renewable Energy Systems Tax Credit (Corporate)	Any company that owns a qualified system	Residential: 25%; Commercial: 10%	No	No

State	Program Name	Eligible Recipients	Incentive Amount	Third-party Owner Eligible	Non-profit/ Government Eligible
Vermont	Business Tax Credit for Solar (Corporate)	Corporations that pay corporate income tax in Vermont that do not receive grants/funding from CEDF.	30% of expenditures (for systems placed into service on or before 12/31/2010).	Not specified	No

Source: DSIRE 2010

Note: The information provided in this table presents an overview of state incentives, but it should not be used as the only source of information when making purchasing decisions, investment decisions, tax decisions, or other binding agreements. For more information about individual programs listed above, visit the DSIRE Web site at http://www.dsireusa.org/.

Table B-5. U.S. Department of Energy Brightfields Program Grants

Award Year	Award Amount	Project	Project Description	Project Status
2000	$30,000	Brockton, MA: Brownfields to Brightfields Project	"This project involved attracting a photovoltaic system manufacturer to a Brockton Brownfield and building a solar array on a second site. Anticipation: This array will bring into productive use up to 27 acres of idle property and the array could also generate up to 6 MW of electricity. To create sufficient local demand to attract the manufacturer, other potential sites for photovoltaic applications will be surveyed."	425 kW facility commercially operated since September 27, 2006. Expanded by 35 kW to 460 kW in July 2007. Grid-connected selling 100% of output into New England Power Pool
	$50,000	Atlantic City, NJ: Cityscape Solar-Powered Bed and Breakfast on an Urban Brownfield.	"Involves the construction of a solar-powered bed and breakfast on an urban Brownfield site in Atlantic City, New Jersey, as part of an overall neighborhood redevelopment plan with a sustainability theme. The project will showcase the use of photovoltaics in supplying renewable energy and also contain sustainable features such as recycled building materials and Energy Star appliances and will be located in the "Cityscape Neighborhood," an area designed to promote renewable energy, sustainable building materials, and concepts of New Urbanism."	Project canceled
	$50,000	Hanford, WA: Brightfield Project	"This project will ultimately be the largest photovoltaic installation of its kind and will bring the Brightfield concept to one of the worst Super Fund sites in the nation. The funding provided will cover a portion of the pilot phase of the project, involving 40 kW. Later phases will use a wind/solar green energy blending strategy to finance development up to 1 MW or larger. This solar array will act as a nucleation site around which Energy Northwest intends to grow a renewable energy industrial park."	38.7 kW system installed in May 2002
2004	$65,400	Cedar Rapids, IA: Bohemian Commercial Historic District Solar Development	"The Iowa Department of Natural Resources (IDNR) will partner with the City of Cedar Rapids, the Iowa Renewable Energy Association, Alliant Energy, and Thorland Company to install a 7200 Watt solar array in Cedar Rapids on a multiuse converted former warehouse building in a	7.2 kW installed

	Program	designated Brownfields redevelopment area." The IDNR has established partnerships with the City of Cedar Rapids, Alliant Energy, the Iowa Renewable Energy Association, and the building owner to increase the economic and environmental viability of a redeveloped Brownfield area and expand the value and viability of solar projects."	
$59,400	Brockton, MA: Solar Energy Park: Deploying a Solar Array on a Brownfield	"The City of Brockton will build New England's largest solar array at a remediated 27 acre Brownfield site in fall 2004. The 500 kW solar PV array—or "Brightfield"—will be installed in an urban park setting with interpretive displays. The Brightfield could include as many as 6,720 solar panels connected in strings that span the site. The Brightfield will grow incrementally to 1 MW with expansions financed through positive annual cash flow generated by the sale of renewable energy certificates (RECs) and electricity."	425 kW facility commercially operated since September 27, 2006. Expanded by 35 kW to 460 kW in July 2007. Grid-connected selling 100% of output into New England Power Pool.
$125,000	Raleigh, NC: Brightfield Technology Demonstration at NCSU	"Carolina Green Energy, LLC proposes to partner with the North Carolina Solar Center to design and install a 30-kW grid-tied PV system. As part of its continued efforts to bolster support for renewable energy, the Solar Center will incorporate the "Brownfield to Brightfield" project at Lot 86 into its ongoing education and outreach programs."	75.6 kW PV generation project operational since October 2007.

Source: U.S. Department of Energy State Energy Program 2006

Note: According to EPA, the term brightfields refers to "the conversion of contaminated sites into usable land by bringing pollution-free solar energy and high-tech solar manufacturing jobs to these sites, including the placement of photovoltaic arrays that can reduce cleanup costs, building integrated solar energy systems as part of redevelopment, and solar manufacturing plants on brownfields." For more information, see: http://epa.gov/brownfields/partners/brightfd.htm

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Feasibility Study of Economics and Performance of Solar Photovoltaics in St. Marks, Florida: A Study Prepared in Partnership with the Environmental Protection Agency for the RE-Powering America's Lands Initiative: Siting Renewable Energy on Potentially Contaminated Land and Mine Sites

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14. ABSTRACT *(Maximum 200 Words)*
This report presents the results of an assessment of the technical and economic feasibility of deploying a photovoltaics (PV) system on a brownfield site in St. Marks, Florida. The site was assessed for possible PV installations. The cost, performance, and site impacts of different PV options were estimated. The economics of the potential systems were analyzed using an electric rate of $0.08/kWh and incentives offered in the State of Florida and from the two accessible utilities, Progress Energy and the City of Tallahassee. According to the site production calculations, the most cost-effective system in terms of return on investment is the fixed-tilt thin-film technology. The report recommends financing options that could assist in the implementation of such a system.

15. SUBJECT TERMS
feasibility study; solar photovoltaics; PV system; ground-mounted PV; St. Marks; brownfields; cost; performance; site impacts; financial incentives; financing options

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