United States Environmental Protection Agency

Solar Screening Study for the Camden Avenue Site in Flint, MI

A Solar Screening Study Prepared by the Environmental Protection Agency, Region 5 for Siting Renewable Energy on Contaminated Lands

Team Consisting of:
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This report is to be used for screening purposes only.

Additional evaluations will need to be conducted to fully characterize the feasibility and economics of the Camden Avenue Site. Third party solar developers and local utility companies may have technical and financial interests to pursue potential solar renewable energy projects and perform additional solar assessments to determine if projects are economically viable.

This study does not assess the environmental conditions at the site.

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I. Executive Summary

An analysis of solar photovoltaics was performed for the Camden Avenue Site in Flint, Michigan. A system of approximately 1.31 MW could be implemented on the site, offering a positive redevelopment option that could power the equivalent of approximately 150 homes[1]. It was determined that the cost of electricity from a solar photovoltaic (PV) system could be less than the cost of electricity purchased from the utility given the assumptions in Table 1 and if the electricity is sold "behind-the-meter" to an industrial site that is located adjacent to the site.

Table 1. Camden Avenue Site Photovoltaic System Simulation Results

Simulation Results	Fixed-Tilt System
DC System Size	1.31 MW
Installed PV System Cost	$2.20/Wdc
Average Cost of Electricity Purchased from Utility	10.71 ¢/kWh
Cost of Electricity Generated by the PV System	7.00 ¢/kWh

The annual energy output, annual energy value, and various economic results are listed in Table 2 along with the annual emissions reductions. One scenario is presented where the electricity is sold to a neighboring business for 10.71 ¢/kWh. As shown, the economics for the case where the electricity is sold to a neighboring business for 10.71 ¢/kWh is a financially viable case.

Table 2. Camden Avenue Site Photovoltaic System Detailed Simulation Results

Site	PV System Size (MW)	Annual Energy Output (kWh/year)	Annual Energy Value ($/year)	Estimated Initial Cost with 30% ITC ($)	Cost of Electricity (¢/kWh)	Cost of Electricity Generated by PV (¢/kWh)	Simple Payback (years)	Annual CO_2e Emissions Reductions (metric tons/year)
Camden Avenue Land Bank Owned Area Assuming 10.71 ¢/kWh	1.31	1,607,551	$172,169	$2,019,967	10.71	7.0	11.7	1,188

There is a multitude of ways which a project could be developed including: public private partnership, power purchase agreement, enhanced use lease, on site off-taker, or community solar. The next steps to move the site forward include:

- Compile all information available on the site and assemble a master repository for the information, including Phase 1 Environmental Site Assessments (ESA) assessments, ownership documents, historical uses, etc. A list of pre-construction activities that must be completed is listed in Appendix A.
- Apply for funding to clean up site either partially or fully.
- Identify the off-taker for the power. This could be the adjacent businesses, members of the community, the tenants of a potential redevelopment, or the utility.
- Finalize the project implementation pathway, and assemble the stakeholders.
- Engage the utility and offer full transparency into project plans, technology sizes, and partner organizations.

The development is an opportunity to re-invigorate the neighboring community with job opportunities, waste removal, and blight reduction. Brownfield sites such as this site offer unique

[1] Assuming average American home uses 11,000 kWh/yr.

redevelopment prospects, and developing renewables on the site is an opportunity to leverage synergies between the industrial nature of the site's former use (e.g., electrical infrastructure, level topography, limited alternative use) and site preparation required for clean power systems. By implementing RE on this site, there is potential to help the community divest itself of traditional fossil energy sources.

II. Background

A driving force in the creation of the Imagine Flint Master Plan for a Sustainable Flint, Flint's first master plan since 1960, sustainability and adapting to change are two key guiding principles laid out by the City and its residents. These two principals have set the stage for how Flint envisions itself becoming a 21st Century Sustainable Community, by virtue of using the abundance of vacant land that exist throughout the city and repurposing it into active uses that benefit the adjacent neighborhoods, businesses and ultimately residents of Flint.

The City's place based land use plan was built using data, citizen input, and analysis that resulted in an approach that identifies areas of high vacancy and publicly held land, and strives to implement the green economy through the permission of green uses occurring by-right. This land use plan and updated zoning code, has the potential to reshape and redefine Flint as a leading urban city ready to tackle blight and abandonment through the means of innovative and sustainable uses.

The City, in partnership with the Genesee County Land Bank Authority, feels the time is perfect to explore the options of urban solar.

The Camden Avenue Site (2701 Camden Avenue, Flint, Michigan 48507) is a 7.87-acre site located approximately one mile to the south of downtown Flint, Michigan. The site was formerly an industrial site and the structures have been razed. The concrete foundations and deteriorating asphalt remain. The land was deeded to the Genesee County Land Bank in 2014 after the land went through tax foreclosure.

Through the RE-Powering America's Lands initiative, a desktop analysis of the Camden Avenue Site was screened for solar development potential. A team of local stakeholders including the City of Flint Planning Division, Genesee County Land Bank, TRC Environmental Services, the Environmental Protection Agency (EPA) Headquarters and the National Renewable Energy Laboratory (NREL), began discussions regarding the site in January of 2016.

Brownfield sites typically have limited redevelopment potential and solar PV installations can be a viable reuse. Blighted properties often are particularly well-suited for solar development because they are often:

- Located near critical infrastructure including electric transmission lines and roads;
- Located near areas with high energy demand (e.g., large population bases);
- Have minimal grade (0-2 percent) which allows for optimal siting of solar photovoltaic (PV) structures;
- Offered at lower land costs when compared to open space; and may be adequately zoned for renewable energy;
- May have environmental conditions that are not well suited for commercial or residential redevelopment;
- Can provide job opportunities in urban and rural communities;
- Able to accommodate net metered or utility scale projects; and
- May reduce the environmental impacts of energy systems (e.g., reduce greenhouse gas emissions).

Each solar PV system represents a standalone system that can be sized to use an entire available site area. The viability of implementing a solar PV system on a site is highly impacted by the available area for an array, solar resource, distance to transmission lines, distance to major roads, favorable economic conditions, and community support.

This solar screening report provides critical information to assist the Camden Avenue Site officials in determining the site's potential for solar PV electricity generation. In addition, the report will outline various financial incentives (Section VI - Incentives) that could assist in financing the implementation of a solar PV system. Incentives for solar PV are currently not offered by the local utility company Consumers Energy.[2]

Solar arrays will provide the following benefits over conventional fossil energy sources:

- PV systems are gentle on the environment, in contrast with electricity generated by fossil fuels, PV-generated electricity creates no noise, and air or water pollution,
- Provides long-term stabilization of electrical costs,
- When combined with a battery backup system, a PV unit can provide power when utility power is not available,
- Additional federal and state tax credits may apply.

Net metering is allowed in Michigan, which greatly simplifies the interconnection process and makes the revenue from the system fluctuate less. Net metering for non-residential solar PV generation systems are allowed for systems less than 150 kW in size. In a conventional net metering situation, a customer-sited renewable energy system is connected to the utility grid through a customer's utility meter. This is known as "behind-the-meter generation." At any given moment, if the site is using more electricity than the system is producing, all the electricity produced by the system is used on-site and the site's electricity needs are supplemented from the grid. If the site is using less electricity than the system is producing, the excess electricity is exported to the grid and the customer receives a credit. This is typically recorded as negative use and is commonly referred to as the "meter spinning backwards." At the end of the billing cycle, the grid-supplied electricity and the credits for any exported electricity are reconciled, and any surplus credits can be carried forward to the next billing cycle. The specifics of net metering are dependent on the customer's service classification.

It is highly recommended that the Camden Avenue Site stakeholders consult with the electric distribution company, Consumers Energy, to discuss the potential solar project and net metering opportunities.

If the Flint Solar Project Team decides to further pursue the installation of solar PV technology, then Consumers Energy should be consulted early in the planning stages so that the municipality can be alerted of any potential transmission interconnection issues that might exist or equipment upgrades needed to facilitate the solar project.

While financing the Flint Solar Project is beyond the scope of this report, the Project Team should consider finding a private developer interested in investing and building the solar energy farm. The developer will need an entity interested in purchasing the electricity and willing to sign a Power Purchase Agreement (PPA).
To learn more about PPA structures, please go to the following PPA Checklist for State and local Governments:

http://www.nrel.gov/docs/fy10osti/46668.pdf

[2] https://www.consumersenergy.com/content.aspx?id=1478

III. PV Ground Mount Systems

The solar array has to be secured and oriented optimally to maximize system output. The structure holding the modules is referred to as the mounting system. For ground mount systems, the mounting system can be either directly anchored into the ground (via driven piers or concrete footers) or ballasted on the surface without ground penetration. Mounting systems must withstand local wind loads, which range from 90–120 mph range for most areas or 130 mph or more for areas with hurricane potential. Depending on the region, snow and ice loads must also be a design consideration for the mounting system.

Typical ground-mounted systems can be categorized as fixed-tilt or tracking. Fixed-tilt mounting structures consist of panels installed at a set angle, typically based on site latitude and wind conditions, to increase exposure to solar radiation throughout the year. Fixed-tilt systems are used at many contaminated sites. Fixed-tilt systems have lower maintenance costs but generate less energy (kWh) per unit power (kW) of capacity than tracking systems.

Tracking systems rotate the PV modules so they follow the sun as it moves across the sky. This increases energy output but also increases maintenance and equipment costs slightly. Single-axis tracking, in which PV is rotated on a single axis, can increase energy output up to 25% or more.

The selection of mounting type is dependent on many factors including installation size, electricity rates, government incentives, land constraints, soil conditions, alignment and latitude requirements, and local weather. The mounting system design will also need to meet applicable local building code requirements with respect to snow, wind, and seismic zones. Selection of mounting types should also consider frost protection needs especially in cold regions. Contaminated land applications may raise additional design considerations due to site conditions, including differential settlement. Selection of the mounting system is also heavily dependent on anchoring or foundation selection.

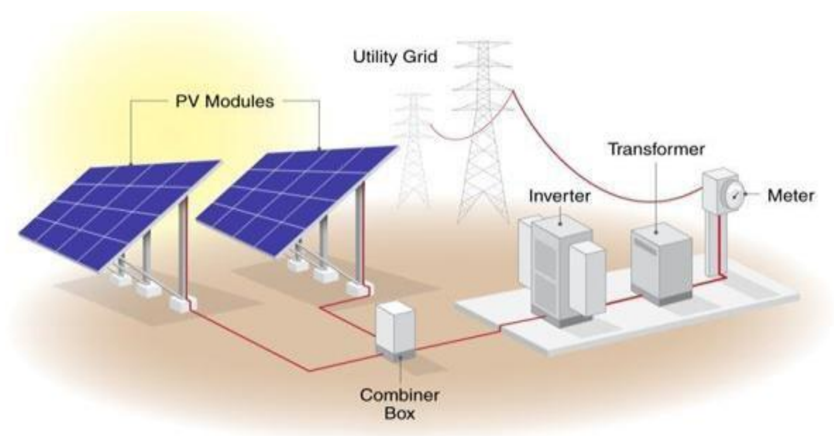

Figure 1. Ground Mount PV Array
Source: NREL

Major System Components

A typical PV system is made up of several key components including:

- PV modules
- Inverter
- Balance-of-system components - includes mounting racks, hardware for the panels, and

wiring for electrical connections. Electrical connections, including wiring, disconnect switches, fuses, and breakers are required to meet electrical code (e.g., NEC Article 690) for both safety and equipment protection.

In most traditional applications, wiring from the arrays to inverters and inverters to point of interconnection is generally run as direct burial through trenches. On contaminated site applications, this wiring may be required to run through above-ground conduits due to restrictions with cap penetration or other concerns. Therefore, developers should consider noting any such restrictions, if applicable, in requests for proposals in order to improve overall bid accuracy. Similarly, it is recommended that PV system vendors reflect these costs in the quote when costing out the overall system. See Appendix C for additional information on PV Systems Overview and Appendix D for a Glossary of Terms.

A number of brownfield sites that are municipally owned and operated have expressed interest in potential revenue flows from PV systems. In some cases, revenue can be generated by the use of PV on a contaminated site pending actual site conditions, financial incentives, economic conditions, and support from the utility companies.

IV. Camden Avenue Site PV System/Siting Considerations

The Camden Avenue Site is located approximately one mile to the south of Downtown Flint, Michigan. Flint, Michigan has a favorable solar resource of 4.18 kWh/m^2/day on average over the course of a year. Solar PV in Flint is capable of generating power in all months of the year. The following resource maps shows how the solar resource differs across the United States.

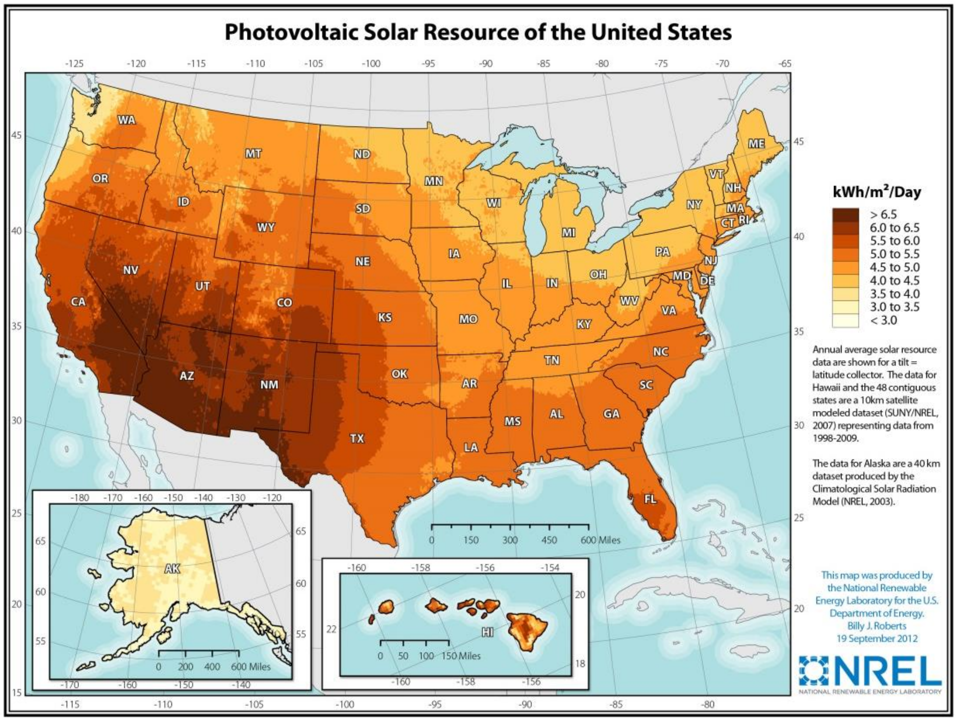

Figure 2: Solar Resource Map USA[3]
Source: NREL

Figure 3 shows an aerial view of the Camden Avenue Site. As shown, the site is flat with one large area that can potentially be used for PV.

[3] http://www.nrel.gov/gis/solar.html

Figure 3. Current Potential Areas for PV at Camden Avenue Site
Source: Google Earth

Useable Site Acreage

The current total feasible area for PV at the Camden Avenue Site is approximately 7.87 acres. In general, the available site area will impact the potential PV system size and the cost of PV systems. The economics of the PV system will also vary according to the entities developing solar PV at the site (municipally funded system or a power purchase agreement funded system).

Typically, a minimum of 2 useable acres of the site area is recommended to site PV systems. Useable acreage is typically characterized as "flat to gently sloping", southern exposures that are free from obstructions and get full sun for at least a 6-hour period each day. Overall, the center area at the Camden Avenue Site can be considered open and flat.

Ownership

We need something here about the land bank and ownership and the willingness to sell it. Take from the email from the Land Bank about the pricing.

Transmission/Utility Resources

Electrical transmission lines run along to the southeast of the site by approximately 1.5 miles. As indicated earlier, if the Camden Avenue Site officials decide to pursue PV solar generation on the site, a high level preliminary interconnection transmission study from Consumers Energy is highly recommended early in the process. The interconnection study will allow Consumers Energy to determine the feasibility of interconnecting to the electric grid, assess potential electrical upgrades, and estimate the potential costs. All technical pertinent information about the proposed solar PV system should be provided to Consumers Energy in accordance with the application requirements.

In general, the distance from the proposed solar PV system to the point of interconnection with electrical transmission should be within a ½ mile distance in order to yield more viable economic conditions. The following aerial image shows the locations of the nearest utility substations. The Hemphill Substation is located approximately 1.5 miles from the Camden Avenue Site and is a 120 kV substation.

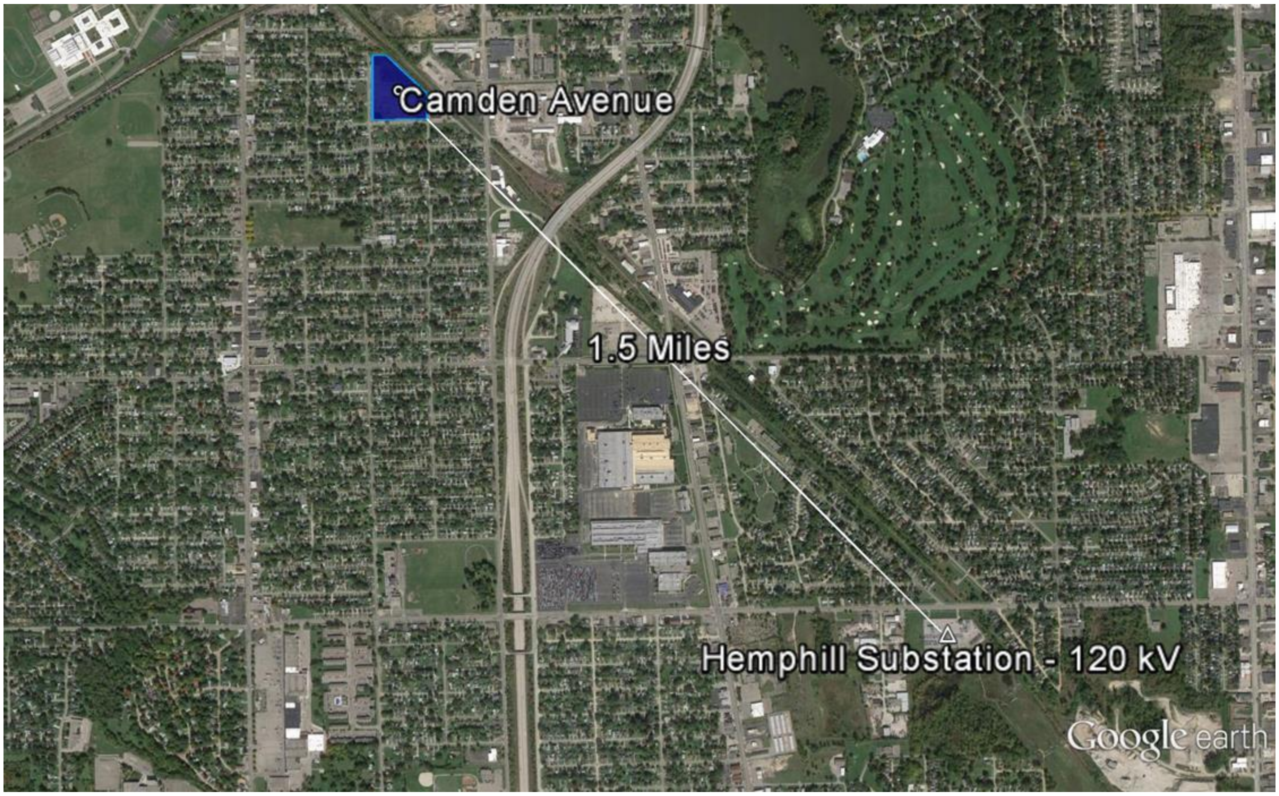

Figure 4. Nearby Utility Substation
(Photo Credit: Google Earth)

V. Solar Assessment

PV modules are very sensitive to shading. When shaded (either partially or fully shaded), the panel is unable to optimally collect the high-energy beam radiation from the sun. PV modules 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. If an individual cell is shaded, it acts as resistance to the whole series circuit, impeding current flow and dissipating power rather than producing it. By finding the solar access, it can be determined if the area is appropriate for solar power generation.

It is recommended that the team perform a shading analysis on the site, to ensure that the panels can operate free of shading in order to maximize the production from the system. Any areas that have substantial shading should be removed from the available area. An annual solar availability of 90% or higher is recommended for siting PV to assure that there is minimal shading of the PV panels throughout the year. Areas that have neighboring structures that cause the annual solar availability to drop below 90% should not be considered for PV.

The following key and site related information was collected to aid in the solar assessment for the Camden Avenue Site.

Table 3. Camden Avenue Site Information

Brownfield/Site Name	Camden Ave (not currently listed as a Brownfield[1])
Physical Address	2701 Camden Ave, Flint, Michigan 48507 (pid: 4119176010)
Property Operator/Owner (private/public)	Genesee County Land Bank
Local Town Official Contacts (phone number/emails)	Douglas K. Weiland, Executive Director, Genesee County Land Bank 452 S. Saginaw St., 2nd Floor, Flint, MI 48503 (810) 257-3088 ext. 521, dweiland@thelandbank.org
Other relevant contacts	Heidi Phaneuf, Community Resource Planner, Genesee county Land Bank (810) 257-3088 ext. 524, hphaneuf@thelandbank.org Kevin Schronce, Planner III, City of Flint (810) 766-7426 ext.3028, kschronce@cityofflint.com
Site Physical Characteristics:	
Property Size (total)	7.87
Potential Usable for Solar PV	7.87
Known Contamination?	None. Address was not found on any MDEQ database that indicates or documents environmental impacts. Address found on the MDEQ Waste Data System Database (WDS): ALLEN STORAGE & MOVING WDS ID: 427765 / Site ID: MIG000056333 The WDS database lists the address as not a receiver of waste and as inactive. (WDS tracks regulated waste disposal from facilities including, hazardous and liquid industrial waste, and does not indicate if a release occurred.)
Has there been a site assessment performed (Phase I or Phase II)	Address was not listed in any MDEQ databases that indicated a Phase I and/or II were performed.
Physical Conditions - surface area, terrain conditions/soil erosion?	Surface area is generally flat, primarily consisting of concrete and deteriorated asphalt surfaces. The majority of the site (approx. 5 acres) consists of the concrete, which was the floor of a former industrial building. No significant soil erosion was observed. [2] Subsurface is indicated as loam in the SSURGO. [2] Building Demolished due to a fire between 2012 & 2014
Known Shading Concerns (existing trees/buildings/structures)	None observed. Adjacent SE property building is single-story. [2]
Any available site maps, including topographical maps?	1999-2015 Google Earth aerials and 1975 USGS topo (in project file) Site Map

Utility Information:	
Utility Company serving the Area (contacts)	Consumers Energy (based on Consumers Energy Service map https://www.consumersenergy.com/content.aspx?id=2021) Consumers Energy – Kevin Keane: kevin.keane@cmsenergy.com, (810)760-3447
Distance to major highways (provide highway information)	Within 0.5-mile NE of Interstate 475[2] The site is roughly 4,400' from I-475 entrance ramp (@ Hemphill Road)
Distance to Electrical Transmission Lines Closer distance will minimize interconnection cost.	Overhead electrical lines are located directly to the north and west of the site. There appears to be a cell tower within 50' of the site. Electrical transmission lines are adjacent to the NE property boundary[2]
Location of the Substations	None positively identified[2]
Identified off-taker?	No manufacturing facilities identified within 1 mile. There is a small industrial corridor located directly east of the proposed site. The businesses are smaller in nature, and further site analysis is needed on their use. Potential non-manufacturing facilities identified include[2]: • Shively Brothers, Inc. (too supply and maintenance) located 0.25 mile SE • Dry Ice (dry ice and ice cream distributer/retailer) located 0.4 mile SE • City of Flint Department of Public Works is located approximately 0.5 mile N • Southwestern Academy (school) is located 0.75 mile WNW • Diplomat Specialty Pharmacy (large prescription call and filling center) is located approximately 1 mile • International Academy of Flint, a charter school is 2000 ft away.
Other	
Any previous solar or interconnection studies done at the site?	
Nearest critical Infrastructures from the site? (Hospitals, police stations, school/shelters, fire house, waste treatment plants, water treatment facilities, municipal facilities, cell towers, or others).	Site is within 1,000' of the Genesee County Road Commission. Site is within 2,000' of the International Academy of Flint (k-12 charter school). Site is seems to be within 50' of a cell tower, but further analysis is needed.
Are there any neighboring industries or businesses that could be an off-taker of the power generated by solar?	
Community vision for reuse and development at the site? Is there municipality support?	Yes, this is a Community Open Space land use district which would permit commercial solar collection as a Special Use.
Can the Loading Bearing Capacity of the LF accommodate the additional loading of a Solar PV system?	
Any on-going remediation at the site	No [1]
Any existing site liens/bankruptcy status?	2014 tax foreclosure, deeded to the Land Bank 12-22-2014. Quiet title judgement was completed on the property 8-25-2015 by Genesee County Land Bank. Title insurance can be obtained for the property. (see attached deed and quiet title judgement)

PV Watts Site Identification

The predicted array performance was found using PVWatts[4] for the Camden Avenue Site. NREL's PVWatts™ calculator determines the energy production and cost savings of grid-connected photovoltaic (PV) energy systems throughout the world. It allows homeowners, installers, manufacturers, and researchers to easily develop estimates of the performance of hypothetical PV installations. The PVWatts calculator works by creating hour-by-hour performance simulations that provide estimated monthly and annual energy production in kilowatts and energy value. Users can select a location and choose to use default values or their own system parameters for size, electric cost, array type, tilt angle, and azimuth angle.

The PVWatts Grid Data Calculator is another NREL tool which was utilized to calculate estimates of kWh and MWh energy performance for the system based on the number of acres available. Table 4 below shows the identification information, PV system specifications, and energy specifications for the site.

Table 4. PVWatts Site Identification Information and Specifications

Location and Station Identification	
Requested Location	2701 Camden Avenue, Flint, MI 48507
Weather Data Source	(TMY2) FLINT, MI 3.8 miles
Latitude	42.97° N
Longitude	83.73° W
PV System Specifications *(Commercial)*	
DC System Size	1310 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	20°
Array Azimuth	180°
System Losses	14%
Inverter Efficiency	96%
DC to AC Size Ratio	1.1
Initial Economic Comparison	
Average Cost of Electricity Purchased from Utility	0.1071 $/kWh
Initial Cost	2.20 $/Wdc

[4] http://pvwatts.nrel.gov/pvwatts.php

Cost of Electricity Generated by System	0.07 $/kWh
Selected Incentives	
Investment Tax Credit (ITC)	Commercial Renewable Energy Tax Credit Percent of Cost: 30%

Table 5 shows the performance results for a 1310 kW, 20-degree fixed tilt PV system at the Camden Avenue Site as calculated by PVWatts.

Table 5. Camden Avenue Site PVWatts Results

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Energy Value ($)[5]
January	2.19	79,848	8,552
February	3.27	105,578	11,307
March	4.04	139,822	14,975
April	5.08	163,815	17,545
May	5.90	190,744	20,429
June	6.20	189,700	20,317
July	5.98	183,995	19,706
August	5.55	173,468	18,578
September	4.64	143,240	15,341
October	3.41	112,011	11,996
November	2.11	70,107	7,508
December	1.54	55,222	5,914
Annual	4.16	1,607,550	$ 172,168

Cautions for Interpreting the Results - Weather Variability

The monthly and yearly energy production are modeled using the photovoltaic system selected parameters and weather data that are typical or representative of long-term averages. Because

[5] **Energy Value** - is the value of the electricity generated by the grid-connected photovoltaic system, assuming that the electricity service provider values all of the electricity at the average cost of electricity purchased from the System. The energy value is the product of the total electricity generated in each month (kWh) and the average cost of electricity purchased from utility ($/kWh). It does not represent a situation where the electricity customer buys electricity at one price and sells it at a different (typically lower) price, or where electricity prices vary with time (time-of-use pricing) or consumption (tiered rates)

weather patterns vary from year to year, the values in the tables are better indicators of long-term performance than of performance for a specific month or year.

Photovoltaic system performance is largely proportional to the amount of solar radiation received, which may vary from the long-term average by ±30% for monthly values and ±10% for annual values.

VI. Forecasted Economics and Performance

The PV system includes the solar modules and inverter and other system parts known as the solar balance-of-system components, which include:

- Mounting racks and hardware for the panels and
- Wiring for electrical connections.

The forecasted economics for the solar PV system include the PV array and the balance of system (BOS) components (including the inverter and electrical equipment) costs, as well as the installation cost. The system costs also include estimated federal incentives and a national-average labor rate, but do not include land cost.

In general, the economics of grid-tied PV system will also depend on available financial incentives, the cost of electricity, the solar resource, and panel tilt and orientation. The cost of a PV system will also depend on the system size and other factors such as geographic location, mounting structure, type of PV module, etc. For this analysis, the installed cost of the fixed- tilt ballasted system is assumed to be $2.20/Wdc.

Table 6 provides a summary of the economic comparisons from PVWatts outlining the average cost of electricity generation serving the area, the initial system costs $/Wdc, and the projected costs of electricity generated by the proposed solar PV systems. The installed PV system cost of $2.20/Wdc includes the installation of the PV panels and the balance of system (e.g., racks, inverters, wiring, hardware, etc.). This cost does not include additional costs that could be incurred preparing or redeveloping the site for PV (e.g., grading, removing structures, addressing contaminations issues, etc.). The PVWatts results show the cost for solar PV electricity generation is lower than the average electrical utility generation but higher than the electricity buyback rate.

Table 6. PV Watts Initial Economic Comparison

Simulation Results	Fixed-Tilt System
Installed PV System Cost	$2.20/Wdc
Average Cost of Electricity Purchased from Utility	10.71 ¢/kWh
Cost of Electricity Generated by the PV System	7.00 ¢/kWh

An estimate for the proposed PV systems based on the usable site area for solar generation, the system size, and the initial system costs assuming the Federal Investment Tax Credit (ITC) is obtained is outlined in Table 7.

Table 7. Estimated PV System Sizes and Costs

Mounting System Type	Estimated Acres/MW	Estimated System Size	Estimated System Cost with ITC
Fixed-Tilt	6.0 acres/MW	1.31 MW	$2,882,000

VII. Incentives

The economics of grid-tied PV depends on financial incentives, available federal tax credit, the regional cost of electricity, the solar resource, panel tilt, and orientation. Table 8 provides possible financial incentives to assist with financing a proposed solar PV system. The local utility Consumers Energy currently does not provide incentives for installing PV systems.

Table 8. Summary of Applicable Incentives

1. Federal and State Investment Tax Credit*	System owners may qualify up to 30% federal tax credits. Must be a taxable entity to qualify for these, or partner with a taxable entity.
2. Modified Accelerated Cost Recovery System (MACRS)	MACRS depreciation is also considered another important financial incentive. The MACRS is a method of depreciation in which a business' investments in certain tangible property are recovered, for tax purposes, over a specified time period through annual deductions. Qualifying solar energy equipment is eligible for a cost recovery period of five years. More information about MARCS is available here:
3. Other Incentives	For other applicable incentives, go to the following website: www.dsireusa.org

*Note: The Federal Tax Credit is currently available through December 31, 2019.

VIII. Conclusions and Recommendations

An analysis of solar photovoltaics was performed for the Camden Avenue Site in Flint, Michigan. The Camden Avenue Site appears to have somewhat favorable site conditions to support solar PV generation and economic viable reuse, especially since the site has nearby businesses that could potentially use the electricity generated from PV, transmission lines, accessible roads, somewhat flat and open area, and minimal shading issues.

A system of approximately 1.31 MW could be implemented on the site, offering a positive redevelopment option that could power the equivalent of approximately 150 homes[6]. It was determined that the cost of electricity from a solar photovoltaic (PV) system could be less than the cost of electricity purchased from the utility given the assumptions in Table 9 and if the electricity is sold "behind-the-meter" to an industrial site that is located adjacent to the site.

Table 9. Camden Avenue Site Photovoltaic System Simulation Results

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DC System Size	1.31 MW
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Average Cost of Electricity Purchased from Utility	10.71 ¢/kWh
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The annual energy output, annual energy value, and various economic results are listed in Table 10 along with the annual emissions reductions. One scenario is presented where the electricity is sold to a neighboring business for 10.71 ¢/kWh. As shown, the economics for the case where the electricity is sold to a neighboring business for 10.71 ¢/kWh is a financially viable case.

Table 10. Camden Avenue Site Photovoltaic System Detailed Simulation Results

Site	PV System Size (MW)	Annual Energy Output (kWh/year)	Annual Energy Value (\$/year)	Estimated Initial Cost with 30% ITC (\$)	Cost of Electricity (¢/kWh)	Cost of Electricity Generated by PV (¢/kWh)	Simple Payback (years)	Annual CO_2e Emissions Reductions (metric tons/year)
Camden Avenue Land Bank Owned Area Assuming 10.71 ¢/kWh	1.31	1,607,551	\$172,169	\$2,019,967	10.71	7.0	11.7	1,188

EPA supports the potential of solar PV generation at the Camden Avenue Site. Other possible benefits from solar generation at the site include competitively priced electricity from the project, revenues via land lease payments from a solar developer, and reduced operation and maintenance responsibilities and costs.

The Camden Avenue Site was chosen as a favorable site because:

- The available are for PV is relatively large (7.87 acres)
- The projected solar site has only one owner (Genesee County Land Bank) who has expressed significant interest in solar energy
- Renewable energy development is one of the highest uses for this space
- The project already has buy in from local stakeholders who are engaged and enthusiast

[6] Assuming average American home uses 11,000 kWh/yr.

about installing PV on the Camden Avenue Site

- Possible offtakers are identified and conveniently located. One is an interested vegetable distributor with high energy needs adjacent to the site
- There is no serious contamination on the site
- There are few shading obstructions
- Solar development fits with the City's Master Plan land use in this area of Flint.

By choosing an implementation mechanism and clean up pathway, this could become a showcase for the state and the country of a creative reuse of an underutilized parcel.

IX. Recommended Next Steps

This solar screening study provides the PV system sizes based on the proposed usable area. However, the actual system installation will need to factor the availability of funds and the amount of power that can be sold. There are a number of ways the parcel could be developed with renewables.

- The city could develop the site using bonds.
- A third-party partnership could be used to develop a power purchase agreement (PPA). In exchange for access to a site through a lease arrangement, third-party developers can finance, develop, own, and operate the solar projects utilizing their own expertise and sources of financing.
- Interested offtakers could partner together to build a "Community Solar" system where the site is leased from the owners and split the benefits of the system and take advantage of economies of scale.
- The site could be leased to a solar developer in exchange for lease payments.
- Site stakeholders could reach out to the utility to offer the site as a solar development location in exchange for lease payments.
- The solar system could be sized to meet the electrical demands of the site.

Public private partnerships are favorable ways to structure site development, due to the ability of private partners being able to take advantage of the tax benefits that cannot be captured by municipalities (or other entities that do not pay corporate income taxes). Once the system is installed, the third-party developer can sell the electricity to the site host or local utility via a PPA – a contract to sell electricity at negotiated rate for a fixed period of time. The term of the PPA typically varies from 20 to 25 years. The following steps should be taken in order to develop a project on this site:

- Compile all information available on the site and assemble a master repository for the information, including Phase 1 ESAs, ownership documents, historical uses, etc. A list of pre-construction activities that must be completed is listed in Appendix A.
- Apply for funding to clean up site either partially or fully.
- Identify the off-taker for the power. This could be the site, adjacent businesses, members of the community, the tenants of a potential redevelopment, or the utility.
- Finalize the project implementation pathway, and assemble the stakeholders.
- Engage the utility and offer full transparency into project plans, technology sizes, and partner organizations.
- Identify a developer who will build the project and/or finance the system.

By following these steps, in this order, many of the pitfalls and project roadblocks may be avoided. The actual mechanics of a development, as well as the amount of money changing hands may be much different than the scenarios investigated here, but the underlying economics of building a system appear to be workable.

Additional evaluations will need to be conducted to fully characterize the feasibility and economics of the Camden Avenue Site for PV installation. Third party solar developers and local utility companies may have technical and financial interests to pursue potential solar renewable energy projects and perform additional solar assessments to determine if projects are economically viable.

This study does not assess the environmental conditions at the site.

Appendix A: Pre-Construction Development Activities

Camden Avenue Site – Pre-Construction Activities

The activities discussed below are critical to making decisions concerning the feasibility of redeveloping the land into a solar power generating (SPG) station, including technical and financial aspects of a project.

Environmental Due Diligence – completion of environmental due diligence to support property assemblage, ownership transfer, and identification of factors that could potentially impact development activities is imperative for successful completion of this project. Conducting due diligence will provide a broad, comprehensive understanding of actual site conditions and will be needed to inform subsequent decisions impacting the development of the site as a solar power generating (SPG) station. The following recommended tasks should be evaluated on a area-by-area basis relative to the availability of existing technical data.

Requisite components of environmental due diligence include (with order of magnitude pricing estimates):

1. Phase I Environmental Site Assessment (ESA) – Estimated Price Range: $10,000 – 20,000, depending upon actual parcels selected for project. A Phase I ESA, including DEQ file review of existing information, should be conducted inclusive of all parcels being considered for assemblage to support this project. A preliminary feasibility study (e.g., quickly determining which parcels are not suitable for solar or likely have a high cost associated with redevelopment) of the individual parcels prior to the Phase I ESA could assist in quickly eliminating parcels that are unlikely to be usable by the development, which will assist with focusing the Phase I ESA and subsequent activities and controlling costs. In accordance with ASTM standards, a Phase I ESA report should be no older than 6 months at the time of transfer of ownership and/or beginning of operations at the site, whichever comes first. Phase I ESAs that are between six and 12 months in age may be updated.
2. Phase II ESA – Estimated Price Range: $50,000 – $100,000. Adequate site investigation of proposed development parcels needs to be conducted to support obtaining liability protection for property acquisitions/operation and to preliminarily identify environmental health & safety concerns that will impact the redevelopment and construction process. Results of the Phase II ESA would be the basis for preparing a Baseline Environmental Assessment. It should be noted that existing analytical data may be appropriate for use to qualify certain target parcels as 'facilities'. Efforts should be made to evaluate this data in advance of conducting any field activities to assist with cost control and efficient use of funding.
3. Baseline Environmental Assessment (BEA) – Estimated Price Range: $10,000 – $20,000, depending upon the actual number of parcels and/or entities involved. Preparation of BEAs to support obtaining liability protection for property transfer of ownership and/or operation will be necessary.
4. Documentation of Due Care Compliance (DDCC) – Estimated Price Range: $15,000 – $25,000. At a minimum, preparation of DDCCs for the developer to cover the construction (e.g., residuals management plan) and post-construction (e.g., SPG station operation and maintenance) phases of the projects should be prepared. These documents will describe the required property management methods in regards to handling any

contamination that may be present and exposed during the construction phase. It is assumed that one DDCC for each phase can be prepared to cover all relevant parcels included in the project.

Geotechnical Analysis – in addition to environmental due diligence, it will be necessary to evaluate the subsurface geotechnical conditions within appropriate sections of the target parcels prior to making final decisions regarding the parcels to be assembled for project use. Grubbing and clearing of vegetation (e.g., removing trees to remove or reduce shading effects) should also be considered as part of a geotechnical analysis.

Based on currently known and assumed geotechnical and environmental conditions, for purposes of this summary it is assumed that the SPG will use a ballasted ground mount panel racking approach.

5. Geotechnical engineering evaluation – Estimated Price Range: $25,000 – $50,000. A geotechnical engineering evaluation of construction soil stability needs to determine best and most cost-effective path forward to managing building debris, subgrade voids, and other subsurface debris challenges. This analysis should be conducted on a parcel-by-parcel basis to determine subsurface conditions, evaluate existing information and determine what additional geotechnical data is needed for design of solar racking foundations and installation methods.
6. Geotechnical investigation – Estimated Price Range: $50,000 – $100,000. Based on above evaluation findings, the SPG developer will likely need to conduct a site-specific, parcel-by-parcel, geotechnical investigation to determine the actual soil constructability conditions. This investigation would include collection of soil samples for specific laboratory testing of soil characteristics. This information will be used to design solar racking system foundations.

Public engagement – engaging with the site, adjacent and surrounding property owners, as well as other public entities, will be an important part of successful development of the project. Gaining public support is key to a smooth and efficient permitting process, as well as the long term good will of the project. An open and transparent process in which the community participates is also key to meeting some of the metrics involved with Environmental Justice concerns for this area.

7. Public Outreach Program – Estimated Price Range: $25,000 – 50,000, depending upon number of meetings and venues selected. Design and host open house meetings within the neighborhood to present proposed redevelopment plans. Includes preparation of site drawings, venue and refreshments.

As previously indicated, the above price ranges are only preliminary order of magnitude estimates based on current information and past experience on similar projects. As this project proceeds, the estimates for these tasks should be refined to provide better understanding of Capital Expenditure needs, as well as an examination of on-going Operations & Maintenance (O&M).

It is strongly recommended that the environmental due diligence and geotechnical activities for all potential parcels for this project be completed prior to the assemblage/transfer of parcels and final planning and permitting of the project. Conducting these activities will provide significant data necessary to make decisions concerning the actual parcels that are adequately positioned for inclusion in the SPG station at a reasonable price for pre-construction and construction activities.

Additional Considerations

In addition to the above due diligence and planning work tasks, it is recommended that the following items and activities be explored to provide additional insight into the technical and financial challenges to developing solar power at the site.

- Environmental justice implications – evaluate impacts/opportunities on the surrounding community associated with land use as a SPG facility.
- Electrical interconnect study – an electrical interconnection study with the local utility (i.e., Consumers Energy) will be required.
- Electrical line corridor - determine the necessary permitting and engineering activities to install the electrical interconnection line from the SPG facility to the approved substation, such as right of way permits for utility easement and pole mount or subsurface installation of line.
- Identify land zoning requirements - special land use permits or rezoning may be required to redevelop the selected parcels as a SPG facility.
- Stormwater management – evaluate the integrity of the adjacent municipal stormwater infrastructure to verify adequacy to manage run off from the proposed SPG facility.
- Explore availability of incentives for environmental and/or geotechnical Brownfield activities – identify the brownfield redevelopment authority (BRA) with jurisdiction, verify site is in a Core Community, explore the potential availability of brownfield assessment funding, and evaluate the support.

Appendix B: Re-Powering America's Land – Background and Resources

Through the Re-Powering America's Lands Initiative, the U.S. EPA promotes the reuse of potentially contaminated properties, landfills, and mining sites for renewable energy generation. This initiative identifies the renewable energy potential of these sites and provides useful resources for communities, developers, industry, state and local governments or anyone interested in reusing these sites for renewable energy development. The various Re-Powering America Initiative resources are summarized below and can be found at http://www.epa.gov/oswercpa.

- Mapping and Screening Tools - Under the Mapping and Screening tools, EPA's Re-Powering America's Land team screened more than 66,000 potentially contaminated sites and MSW landfills covering nearly 33 million acres across the United States for suitability to site renewable energy generation facilities, including utility-scale solar. Maps depicting the locations of these EPA tracked sites and their potential for supporting renewable energy generation can be found at www.epa.gov/oswercpa/mapping_tool.htm. These maps enable users to view screening results for various renewable energy technologies at each site.
- Technical Assistance and Support - As part of the Re-Powering America's Land Initiative, the EPA and the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) are evaluating the feasibility of developing renewable energy production on Superfund, brownfields, and former landfills or mining sites. This project pairs EPA's expertise on contaminated sites with the renewable energy expertise of NREL.
- A list of feasibility studies for renewable energy production for various technologies including solar can be found at www.epa.gov/oswercpa/rd_tech_assist.htm.
- Redevelopment Tools and Resources – Under the Redevelopment Tools and
- Resources, EPA and NREL created the joint publication, "Best Practices for Siting Solar PV on Municipal Solid Waste Landfills" to provide assistance in addressing common technical challenges of siting PV on MSW landfills (such as impacts to landfill settlement differentials and the PV solar performance, impacts to other landfill systems, understanding landfill cap integrity/characteristics, and understanding landfill post closure requirements for solar PV design considerations) and provide other useful information for solar developers, landfill owners, and federal, state, and local government entities. Other documents for stakeholders to consider are "EPA RE Powering Finance Fact Sheet, "Handbook on Siting Renewable Energy Projects while Addressing Environmental Issues" and "Revised Bona Fide Prospective Purchaser (BFPP) Provisions Enforcement Guidance for Tenants"
- Fact Sheets and Success Stories - The Re-Powering Team highlighted numerous successful stories and fact sheets of Renewable Energy projects implemented throughout the United States. The Re-Powering America Team also maintains a list of completed renewable energy installations on contaminated sites and landfills. To date, the Re-Powering Initiative has identified 135 renewable energy installations on 128 contaminated lands, landfills, and mine sites, with a cumulative installed capacity over 773 megawatts (MW) and consistent growth in total installations since the inception of the Re-Powering Initiative.

Appendix C: PV Systems Overview

Solar PV technology converts energy from solar radiation directly into electricity. Solar PV cells are the electricity-generating component of a solar energy system. When sunlight (photons) strikes a PV cell, an electric current is produced by stimulating electrons (negative charges) in a layer in the cell designed to give up electrons easily. The existing electric field in the solar cell pulls these electrons to another layer. By connecting the cell to an external load, this current (movement of charges) can then be used to power the load, e.g., light bulb.

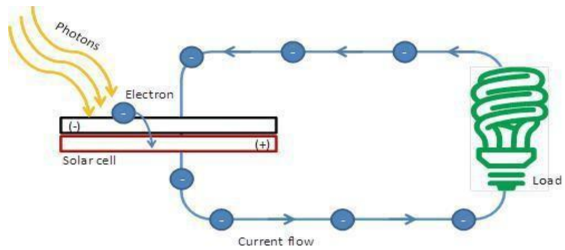

Figure C-1. Generation of Electricity from a PV Cell
Source: NREL

PV cells are assembled into a PV panel or module. PV modules are then connected to create an array. The modules are connected in series and then in parallel as needed to reach the specific voltage and current requirements for the array. The direct current (DC) electricity generated by the array is then converted by an inverter to useable alternating current (AC) that can be consumed by adjoining buildings and facilities or exported to the electricity grid. PV system size varies from small residential (2-10 kilowatts (kW), commercial (100-500 kW), to large utility scale (10+ megawatts (MW)). Central distribution plants are also currently being built in the 100 MW+ scale. Electricity from utility-scale systems is commonly sold back to the electricity grid.

PV Module

Module technologies are differentiated by the type of PV material used, resulting in a range of conversion efficiencies from light energy to electrical energy. The module efficiency is a measure of the percentage of solar energy converted into electricity. Two common PV technologies that have been widely used for commercial- and utility-scale projects are crystalline silicon and thin film.

Crystalline Silicon

Traditional solar cells are made from silicon. Silicon is quite abundant and nontoxic. It builds on a strong industry on both supply (silicon industry) and product side. This technology has been demonstrated for a consistent and high efficiency over 30 years in the field. The performance degradation, a reduction in power generation due to long-term exposure, is under 1% per year. Silicon modules have a lifespan in the 25-30-year range but can keep producing energy beyond this range.

Typical overall efficiency of silicon solar panels is between 12% and 18%. However, some manufacturers of mono-crystalline panels claim an overall efficiency nearing 20%. This range of efficiencies represents significant variation among the crystalline silicon technologies available. The technology is generally divided into mono- and multi-crystalline technologies, which indicates the presence of grain-boundaries (i.e., multiple crystals) in the cell materials and is controlled by raw material selection and manufacturing technique. Crystalline silicon panels are widely used based on deployments worldwide.

Thin Film

Thin-film PV cells are made from amorphous silicon (a-Si) or non-silicon materials such as cadmium telluride (CdTe). Thin-film cells use layers of semiconductor materials only a few micrometers thick. Due to the unique nature of thin films, some thin-film cells are constructed into flexible modules, enabling such applications as solar energy covers for landfills such as a geomembrane system. Other thin film modules are assembled into rigid constructions that can be used in fixed tilt or, in some cases, tracking system configurations.

The efficiency of thin-film solar cells is generally lower than for crystalline cells. Current overall efficiency of a thin-film panel is between 6% and 8% for a-Si and 11-12% for CdTe. Figure 4 shows thin-film solar panels. Industry standard warranties of both crystalline and thin film PV panels typically guarantee system performance of 80% of the rated power output for 25 years. After 25 years, they will continue producing electricity at a lower performance level.

Inverters

Inverters convert DC electricity from the PV array into AC and can connect seamlessly to the electricity grid. Inverter efficiencies can be as high as 98.5%. Inverters also sense the utility power frequency and synchronize the PV-produced power to that frequency. When utility power is not present, the inverter will stop producing AC power to prevent "islanding" or putting power into the grid while utility workers are trying to fix what they assume is a de-energized distribution system.

This safety feature is built into all grid-connected inverters in the market. Electricity produced from the system may be fed to a step-up transformer to increase the voltage to match the grid. There are two primary types of inverters for grid-connected systems: string and micro inverters. Each type has strengths and weakness and may be recommended for different types of installations.

String inverters are most common and typically range in size from 1.5 kW to 1,000 kW. These inverters tend to be cheaper on a capacity basis, as well as have high efficiency and lower O&M costs. String inverters offer various sizes and capacities to handle a large range of voltage output. For larger systems, string inverters are combined in parallel to produce a single point of interconnection with the grid. Warranties typically run between 5 and 10 years with 10 years being the current industry standard. On larger units, extended warranties up to 20 years are possible. Given that the expected life of the PV panels is 25-30 years, an operator can expect to replace a string inverter at least one time during the life of the PV system.

Micro-inverters are dedicated to the conversion of a single PV module's power output. The AC output from each module is connected in parallel to create the array. This technology is relatively new to the market and in limited use in larger systems due to potential increase in O&M associated with significantly increasing the number of inverters in a given array.

Current micro-inverters range in size between 175 W and 380 W. These inverters can be the most expensive option per watt of capacity. Warranties range from 10 to 20 years. Small projects with irregular modules and shading issues typically benefit from micro inverters.

With string inverters, small amounts of shading on a solar panel will significantly affect the entire array production. Instead, it impacts only that shaded panel if micro-inverters are used. Figure C-2 shows a string inverter.

Figure C-2. String Inverter
Source: NREL PIX 07985

Mounting Systems

The array has to be secured and oriented optimally to maximize system output. The structure holding the modules is referred to as the mounting system.

Wiring for Electrical Connections:

Electrical connections, including wiring, disconnect switches, fuses, and breakers are required to meet electrical code (e.g., NEC Article 690) for both safety and equipment protection.

In most traditional applications, wiring from (i) the arrays to inverters and (ii) inverters to point of interconnection is generally run as direct burial through trenches. In contaminated site applications, this wiring may be required to run through above-ground conduits due to restrictions with cap penetration or other concerns. Therefore, developers should consider noting any such restrictions, if applicable, in requests for proposals in order to improve overall bid accuracy. Similarly, it is recommended that PV system vendors reflect these costs in the quote when costing out the overall system.

PV System Monitoring

Monitoring PV systems can be essential for reliable functioning and maximum yield of a system. It can be as simple as reading values such as produced AC power, daily kilowatt-hours, and cumulative kilowatt-hours locally on an LCD display on the inverter. For more sophisticated monitoring and control purposes, environmental data such as module temperature, ambient temperature, solar radiation, and wind speed can be collected.

Appendix D: Glossary of Terms

Glossary of Terms	
PV	Photovoltaic Energy
AC	Alternating Current – which can be transmitted over power lines
DC	Direct Current - which cannot be transmitted over power lines
Ballast	A footing on which a Solar Panel can be placed which will not penetrate the soil cap
Inverter	A machine which takes in Direct Current and converts it to Alternating Current which can then be transmitted to an electrical sub for transmission to a utility company
Energy Density	The number of solar arrays which can be placed in a specific area and is the packing factor – fixed axis panels take up less space, single axis panels take up more space.
kW or kWh	Kilowatt or Kilowatt Hours
MW or MWh	Mega Watt or Mega Watt Hours
ITC	Investment Tax Credits
O&M	Operations and Maintenance
Payback Period	Number of years until the project is paid for
PPA	Power Purchase Agreement - legal contract between an electricity provider and a purchaser that defines all commercial terms for the sale of electricity