



# GUIDE TO IMPLEMENTING SOLAR PV FOR LOCAL GOVERNMENTS

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**SunShot**  
U.S. Department of Energy

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The Solar Outreach Partnership (SolarOPs) accelerates solar energy adoption on the local level by providing timely and actionable information to local governments. Funded by the U.S. Department of Energy (DOE) SunShot Initiative, SolarOPs achieves its goals through a mix of educational workshops, peer-to-peer sharing opportunities, research-based reports, and online resources.

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The Institute for Building Technology and Safety (IBTS) is a leading provider of Quality Assurance services to public and private sector clients for the past 35 years. As a non-profit organization, it is our goal to provide Quality Assurance services to our partners to ensure reliability, production and safety of installed systems, increase local jurisdiction responsiveness, and provide overall support to enhance the renewable energy industry. IBTS currently provides solar project owner's representation, feasibility studies, design review, and commissioning services to local and state clients.

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Guide to Implementing Solar PV for Local Governments is based upon work supported by the U.S. Department of Energy under Award Number DE-EE0003526. The U.S. Department of Energy (DOE) SunShot Initiative is a collaborative national effort to dramatically reduce the cost of solar energy before the end of the decade. The SunShot Solar Outreach Partnership (SolarOPs) is a U.S. DOE program providing outreach, training, and technical assistance to local governments to help them address key barriers to installing solar energy systems in their communities. The International City/County Management Association (ICMA), American Planning Association (APA), and National Association of Regional Councils (NARC), along with ICLEI-Local Governments for Sustainability and its partners, were competitively selected by the U.S. DOE to conduct outreach to local governments across the United States, enabling them to replicate successful solar practices and quickly expand local adoption of solar energy. For more information visit the SolarOPs website ([solaroutreach.org](http://solaroutreach.org)).

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## PREFACE

Implementing municipal solar PV and other renewable energy is an effective way to achieve a municipality's overall Energy Management goals and provide significant benefits for a community. This includes serving as a model to residents, businesses and neighboring towns and cities in environmental stewardship, enhancing economic development, and contributing to workforce development for renewable energy business in the new economy.

In addition to the benefits above, the economics of solar PV can stand on their own providing for significant long-term cost savings and an energy strategy not subject to fuel price volatility, at a time when many communities are required to become more efficient in managing their limited operating resources.

The purpose of this guide is to provide a resource for local government officials who have already decided on the benefits of solar PV and are looking to implement solar PV projects on municipal buildings and land. It will provide useful information in understanding this process, specific to city and county managers.

This guide provides municipalities with a general overview to make them aware of potential considerations and possible options available, as they seek to implement solar PV. It will provide valuable insight based on the experience of the contributors of this publication, as well as from the many sources of information used in preparing this document - published articles, books, presentations, federal and state agencies, and from other publicly available sources.

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## OVERVIEW

### Solar Basics

Solar Photovoltaic (solar PV) cells convert a portion of sunlight energy directly into electricity. When solar radiation in the form of photons penetrates a PV cell, it creates an electrical potential across the cell junction, exciting electrons and causing them to flow as a direct current (DC) through a closed circuit to a *load*, to which they impart their energy before returning through the circuit back to the cell to be re-energized.

PV cells are assembled and interconnected into a long string - typically 60 or 72 cells in series - and encapsulated into a weatherproof *PV module*. Modules are then mounted outdoors as an *array*, connected together in series to form strings of a particular voltage, and then strings connected in parallel combine to provide the desired total current. The voltage rating times the current rating of all the parallel strings is the total power rating for the array. All modules are tested and rated under strictly defined *Standard Test Conditions* (STC) to assure consistency between different manufacturers.

The direct current (DC) electricity generated by an array is usually converted by an Inverter to alternating current (AC) that can be consumed directly by AC loads, or exported to the electricity grid. PV system sizes vary widely, from small residential (a few kilowatts) to commercial (10-1000 kW), to large utility scale (1-100+ MW).

This guide focuses on the implementation of distributed generation (DG) solar PV projects that are located on municipal-owned buildings or land and connected to the utility grid. Distributed solar PV systems are typically connected to the electric grid through municipality's electric meter at the main



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electrical service panel (or subpanel), and fed by an array located on a building rooftop, carport or on a parcel of land with an existing or new meter service. Distributed solar PV systems are not necessarily small in scale, and in fact, can range anywhere from residential size to very large rooftop or ground-mounted systems.

## **Net Metering and Utility Interconnection**

Net metering allows a particular location to export excess solar electricity onto the utility grid when the facility is not using all that is produced. When energy consumption exceeds solar production, power is drawn from the grid. The utility then nets out this exchange at the end of the billing cycle and charges the municipality only for the net energy consumed (energy delivered less energy received). Utilities might also credit received energy against consumption from other meters owned under the same account. States and utility territories have several variations of this process, including price differentials, where the price of electricity may differ for power supplied to, and taken from the grid system, and also may include caps or other limitations. One of the first steps in implementing solar PV is to get this information from the utility provider, as it will be an important part of the financial analysis and feasibility study.

The great benefit of net metering is that during a high production time when the system is producing more than the facility is consuming, the excess energy is neither wasted nor required to be stored in expensive batteries, but instead is fed into the larger utility grid (spinning the utility meter backward) as a credit against consumption.

As of July of 2013, forty-three states, Washington D.C., and four U.S. territories have adopted net metering policies, and in three states there are voluntary utility net metering programs. Alabama, Mississippi, South Dakota and Tennessee have not implemented state or voluntary utility net metering policies.<sup>1</sup>

In addition to net metering policies, states and utility territories have varying policies, standards and limitations for solar PV interconnection to the utility grid. State standards primarily apply to investor-owned utilities. Forty-three states, Washington D.C., and Puerto Rico have adopted interconnection standards or guidelines. At the time of this document, Alabama, Arizona, Idaho, Mississippi, North Dakota, Oklahoma and Tennessee have not implemented these standards or guidelines.<sup>2</sup>

Detailed information on net metering and interconnection policies by state can be found on the internet at the Database of State Incentives for Renewables and Efficiency (DSIRE), maintained by North Carolina State University, at [www.DSIREUSA.org](http://www.DSIREUSA.org), and can be obtained through state energy agencies and local utilities.

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<sup>1</sup> Database of State Incentives for Renewables and Efficiency (DSIREUSA.org), North Carolina State University, <http://www.dsireusa.org/documents/summarymaps/index.cfm?ee=0&RE=0>. (accessed July 2013).

<sup>2</sup> DSIREUSA.org, North Carolina State University, <http://www.dsireusa.org/documents/summarymaps/index.cfm?ee=0&RE=0>. (accessed July 2013).



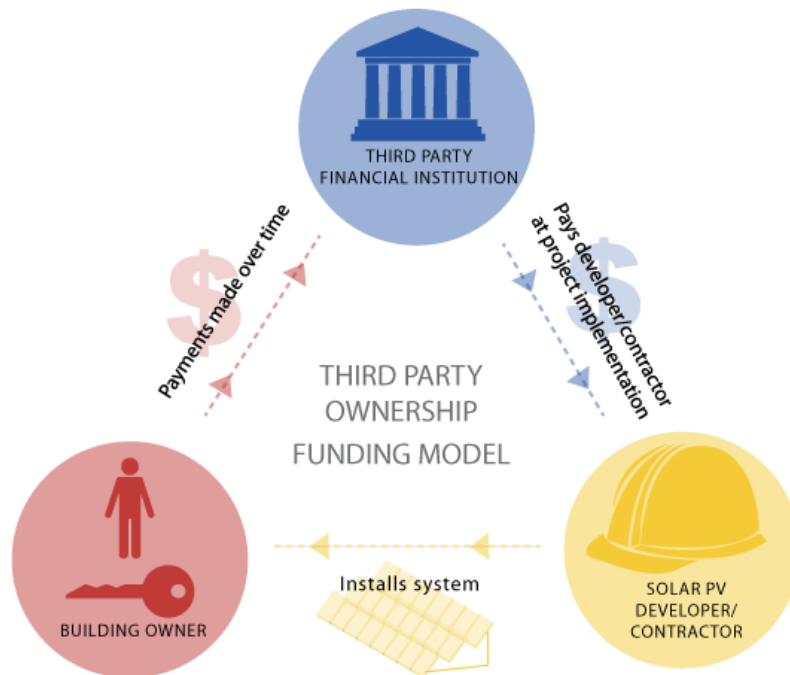
## Recent Trends

### Third Party Ownership (TPO)

Over recent years, one of the most popular methods of financing solar PV projects has been third-party ownership (TPO) models. TPO PV systems primarily employ two common structures, **Power Purchase Agreements (PPAs)** and **Operating Leases**.

**Power Purchase Agreements (PPAs)** - a developer builds, owns and maintains a solar PV system on a municipality's property, and sells electricity to the municipality for a fixed rate and term, typically at a lower price than the utility.

**Operating Leases** - a developer installs and owns the solar PV equipment on the municipality's property, and the municipality pays a fixed monthly fee for use of the equipment over a specified period of time. This is similar in many ways to an equipment rental agreement.



Third-party ownership has sparked significant growth in the solar marketplace because it allows a building or land owner to implement solar PV with little or no capital outlay and also allows for tax incentives to be monetized by a third party, who is often more capable of using these benefits. Third party use of tax benefits is particularly important for government offices that are not eligible to utilize these incentives.

## Price Trends and Project Scale

The solar PV industry typically classifies installations into three main categories – residential, non-residential (or commercial), and utility-scale projects. Utility-scale refers to projects selling power to the wholesale electricity market, connecting directly to the utility grid. Non-residential, refers to distributed generation (DG) projects that are not residential projects. Again DG, which is the focus of this guide, is connected on the customer side of the municipality’s electric meter at the main electrical service panel (or subpanel), and the power generated is used to replace consumption at a specific location or locations.

The median installed price for solar PV has declined significantly over recent years. In the tax-exempt sector between years 2008 and 2012, the median installed price for PV systems in the 5-10 kW range (about 20 to 40 solar panels) declined by almost 36% to \$5.40 per watt, and the median price for systems in the >100 kW range (>400 panels +/-) declined by almost 46% to \$5.10 per watt.<sup>3</sup> From Q3-2012 to Q3-2013 the national average system price for non-residential systems decreased another 6.1% year-over-year, however there are signs that price decreases are beginning to level off. It is important to note that installed prices may vary significantly from these median numbers, not only by geography, but also by project within a geography.<sup>4</sup>

Installed prices in the tax-exempt sector are reported at consistently higher rates than similar-sized projects in the residential and commercial sectors by about 5.5% to 15.7%. This is attributed to several factors including prevailing wage requirements, procurement processes, a higher instance of parking structure type arrays, additional permitting requirements and other factors.<sup>5</sup>

Increasing project scale may provide additional value for tax-exempt customers. In 2012, the median installed price for systems <10kW was 5.5% more expensive per watt than for systems >100kW. (In the commercial sector, this value of scale is greater, at 14%). With economies of scale, the fixed costs from solar PV development can be absorbed over more installed watts, and installers might realize volume discounts, lowering the overall price per watt for the project. In samples of all non-utility-scale systems, the median installed price per watt for systems greater than 1 Megawatt was 38% lower than for PV systems 2kW and under.<sup>6</sup> (1 mW = 1,000 kW = 1,000,000 watts).

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<sup>3</sup> Galen Barbose, Naïm Darghouth, Samantha Weaver, and Ryan Wiser, “Tracking the Sun VI: The Installed Price of Photovoltaics in the United States from 1998 to 2012,” Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory, LBNL-6350E (July 2013): 34. <http://emp.lbl.gov/sites/all/files/lbnl-6350e.pdf>. (accessed January 6, 2014).

<sup>4</sup> GTM Research and Solar Energy Industries Association (SEIA), “U.S. Solar Market Insight, Report Q3 2013, Executive Summary,” Greentech Media, Inc. and Solar Energy Industries Association, (2013): 14. <http://www.seia.org/research-resources/us-solar-market-insight>. (accessed January 6, 2014).

<sup>5</sup> Barbose, et al., “Tracking the Sun VI: The Installed Price of Photovoltaics in the United States from 1998 to 2012”: 33-34.

<sup>6</sup> Barbose, et al., “Tracking the Sun VI: The Installed Price of Photovoltaics in the United States from 1998 to 2012”: 23, 33-34.

While a 5.5% per watt price differential may seem relatively small, this economy of scale is important in project economics, where sometimes getting a project to pencil out may depend on lowering per watt installation costs by what seems like a small amount. A small reduction could make a big difference to the project owner, developer or financier.

For example, consider two hypothetical TPO solar PV projects at the same tax-exempt host location in Massachusetts, one a 10kW PV project, the other a 100kW PV project. At an installation cost of \$5.40 per watt, the 10kW system might have a 6.6% internal rate of return (IRR) and a 7-year payback. Using the same conditions and assumptions, the 100kW TPO project, having an installation cost of \$5.10 per watt, could provide an 8.4% IRR and a 6-year payback. While both projects are financially viable, one is more attractive from an investment standpoint. With financing and other development costs layered in, debt service coverage and other factors, a price differential of 5.5% per watt could be significantly important to a developer.

**Case Study: Using Project Scale**

Metropolitan Washington Council of Governments: [Metro DC Clean Energy Collaborative Procurement Initiative](#)

The main take-away from project scale is that while many projects are economically viable at all scales large or small, generally there are economies of scale that can be realized, and in some instances this might make a material difference to developers in overall project attractiveness and viability.

# FEASIBILITY STUDY

## Overview

The purpose of conducting a feasibility study for a solar PV project is to provide the municipality and its project partners and stakeholders with a general understanding of existing conditions, a review of potential risks, limitations and success factors, a financial assessment, and an outline of the requirements necessary to complete the project. An independent consultant typically conducts a feasibility study, as partners such as investors or other project stakeholders need assurance from an objective party that a municipality's project is sound. Feasibility research includes:

- Basis of Design and Intent
- Evaluating Electricity Consumption
- Reviewing Potential Location
- Staff and Funding Assessment

The study begins then broadly examines existing conditions, and assesses site conditions to determine if they are generally favorable for solar PV. Feasibility will also assess potential risks and limitations the project may encounter. In addition, as part of feasibility, project requirements including engineering (structural, electrical, geotechnical, environmental, or other), permitting, utility interconnection, technology, construction and general project timelines will all be reviewed. In addition, a general financial assessment is completed. Project costs and operating costs will not be known, but they will be roughly estimated and potential revenue sources and energy savings will be identified.

Once feasibility is complete, the municipality and its partners and stakeholders will have a broad understanding of the current status, site characteristics for solar PV, and risks and rewards to provide a general understanding of all that will be required to complete the solar project.

If the feasibility study leads the community to move forward with the project, the next steps will include site selections, conceptual designs and initiation of the permit and utility interconnection applications.

## Basis of Design and Intent

A feasibility study will typically begin with the *Basis of Design and Intent*, clearly documenting the municipality's overall goals, priorities, and what the municipality is trying to accomplish with the project. Documenting the *Basis of Design and Intent* is important for all phases of a project, as this will affect the decision-making process from initial design through operation, helping to ensure decisions are made in alignment with overall project goals. Some examples of goals and priorities include:

- Encourage community adoption of solar PV through a centrally located project focused on aesthetics
- Meet the municipality's overall renewable energy goals
- Increase power reliability and affordability due to increased energy costs

## Evaluating Electricity Consumption

Once the *Basis of Design and Intent* has been determined, the next step in a feasibility study is to begin collecting data on existing conditions. Because municipalities generally own or operate a portfolio of buildings, a good starting point is determining how much electricity is consumed, where it is consumed, and at what cost (price for electricity). Obtaining a recent electric utility bill for each meter will often provide much of the basic information needed. This is not as straightforward as it may seem though, as each utility has its own format and rate structure, and sometimes even variations of rate structures within its territory. A spreadsheet is helpful in compiling the baseline electricity data. Further details on your utility rate and structure are typically available on the utility's website or found online through OpenEI.org: <http://en.openei.org/wiki/Gateway:Utilities>. Alternatively, you may contact your utility representative directly and they should be able to provide this information.

A compilation of energy usage for the previous year or more is necessary to look at monthly variations and to determine a rough load profile for each location under consideration. Many utility bills will list the preceding 12 months of energy usage in kilowatt-hours (kWh). The utility bill may also list the peak power demand, measured in kW.

For basic assessments, collecting the kWh energy data by month for one year is sufficient to get a rough understanding of load profile. Some utilities may list only a graph of yearly usage, in which case previous bills from accounting files will be needed or the utility might also provide this information.

If a facility or load center uses significant amounts of energy and has high demand, such as a wastewater treatment plant or other power intensive function, it will likely make sense to get more detail than is provided with the monthly data from the utility. This can be completed through additional metering, also known as data logging, with measurements logged hourly (or more frequently) over a period of time to determine a more detailed usage profile.

In general, solar PV primarily offsets energy, measured in kilowatt-hours (kWh). To understand its effect on demand (kW), a detailed analysis is required. In a detailed feasibility study, utility rate structures for sites under consideration and detailed load profiles including energy and demand, and solar PV system size (also a function of available space) may all be considered together to help determine which of the government's facilities provide the optimum value for solar PV.

### **Sidebar: Energy Demand**

The concepts of **energy** and **demand** can be understood through a basic illustration: if you have a 100 watt light bulb, and the light is on for 10 hours, then the energy consumed is 100 watts x 10 hours, which equals 1,000 watt-hours or 1 kilowatt hour (kWh) of **energy**. While the light is turned on, regardless of duration, it requires 100 watts from the utility, which is the **demand**.

## Site Location

A municipality may have several property locations available for solar PV, and determining which locations are best involves many considerations. Problematic sites may increase installation costs or result in lower energy production. A municipality should consider added cost and complexity of one-site verses another, and weigh against the benefits. One basic consideration is whether the solar PV system is to be a **Rooftop** or **Ground-mount** solar PV system.

### Ground-mounted Solar PV

- Land areas that can add costs to a solar PV project might include wetland areas, solid waste landfills, brownfields, land with elevation changes, installations near an airport (glare study may be required), adverse soil conditions and other factors. While adding some costs, the benefits might also justify using such sites even with the added complexity, and sites should be considered and weighed against each other to find the optimal locations for the solar PV system.
- Obstructions of sunlight (solar resource) to the area should be considered, such as trees, adjacent buildings, towers, utility lines, wind turbines, and other potential obstructions that might cast shadows and significantly decrease solar production.
- Land use on lots adjacent to the solar array could change over time, and obstructions such as a new building or tower could emerge during the project's lifetime. Guarantee for continued solar access from adjacent properties should be considered by the municipality and might be addressed through a solar access easement agreement or other process. Some states have specific policies relating to solar access.



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### Rooftop Solar PV

- Orientation of roof; a pitched roof surface generally should face between  $-90^{\circ}$  and  $+90^{\circ}$  of *true south*, as the closer to true south, the higher the energy production. If a relatively flat roof is available that is structurally sound, the array tilt will most often be from  $5^{\circ}$  to  $20^{\circ}$ , using a pre-engineered mounting system.
- Obstructions of sunlight to the roof area such as a/c units, chimneys, vent stacks, flagpoles, adjacent trees, and buildings - even thin shadows from a small pipe or antenna - can cause underperformance of the PV system. Shading of any part of the array between the peak production hours of 9AM to 3PM (solar time) should be considered, particularly at winter

solstice, when the sun is lowest on the horizon. Shade mitigation technologies, such as micro-inverters and optimizers, which are installed on each module, may add costs, which then must be weighed against the added benefits.

- Slate or other special roofing material could make mounting the solar PV system more difficult and result in substantial additional costs.
- A very steep roof pitch or difficult to access building or rooftop may also increase installation costs.
- Total area available for solar PV should be considered along with the electric usage (or load) of the building. A large rooftop may be able to support a larger capacity of solar PV than is required to meet the electric load in the building.

Additionally, over the next 25 to 30 year life of a solar PV system, additional energy efficiencies may be realized (such as LED lighting or other energy saving upgrades). It is important not to oversize the array and pay for unused capacity. Conversely, a small rooftop on a building with high-energy usage might not provide enough area for solar PV to make any significant impact on the total energy usage in the building. The investment may still be worthwhile, but depending on goals, this may also be a consideration in site selection.



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### Roof or Structure Assessment

For roof-mounted systems, an additional layer of effort will be required to ensure the system will get the proper sunlight and that, structurally, the roof can support the solar PV system. If the roof is pitched, both the orientation and pitch (in degrees) are important factors affecting solar energy production. Average solar insolation (energy from the sun over time) is location dependent, and solar calculators or specialized software can be used to determine this data using typical meteorological year (TMY) weather data available in public databases. A list of available solar calculators is included in the Resources section at the end of this document.

Structural considerations are critical, as rooftop solar systems add weight to roofs, and when mechanically attached, affect wind uplift load. Solar PV mounting systems are mechanically attached to pitched roofs, and may be mechanically attached, ballasted, or both on relatively flat roofs. A review by a structural engineer is normally required to ensure the existing rooftop can handle the additional load or if structural upgrades may be needed.

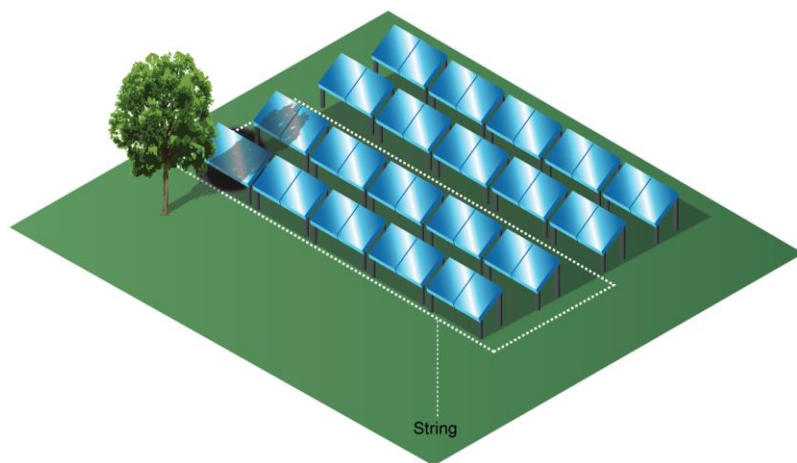
A rooftop solar array is expected to have a useful life of 25 to 30 years or more. A roof, whether asphalt, standing seam, metal seam, or other type of system, will not easily be replaced once solar PV is installed. Because of this, roof condition is a very important consideration in site evaluation. If the roof is older, it is advisable to install a new roof prior to installing solar PV. Additionally, with newer roofs, manufacturer warranties may likely include specific provisions for solar PV systems, requiring certain procedures and manufacturer approval to ensure the warranty is not voided.

### Shade Assessment

Solar access, which examines shade and obstructions to sunlight, can be measured using specialized tools such as the Solmetric Suneye ([www.solmetric.com](http://www.solmetric.com)) or Solar Pathfinder ([www.solarpathfinder.com](http://www.solarpathfinder.com)). Solar professionals are very familiar with these tools and use them to analyze shadows from trees, vent stacks, chimneys or other obstructions, which vary in length quite significantly depending on time of year. In general, shade on solar modules will have a significant negative impact on production output and in siting the array, and careful consideration must be taken to avoid shading during the peak solar window of 9AM to 3PM throughout the year.

#### Sidebar: Shading

For most systems (non-microinverters), a string of panels will only produce as much as the lowest producing panel. If one out of ten panels in a string is shaded, thus not producing, all other non-shaded panels can only produce as much as the shaded panel in the string. What seems to be a minor issue, may significantly affect the entire system. For example, in the figure to the right, the outlined string is being shaded by the tree. Even though only one panel is shaded, the energy production is reduced.



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### Site Conditions Which May Add Costs

Site conditions that may negatively impact costs or performance include electrical infrastructure issues, such as required upgrade of service panels or utility transformer, trenching requirements, and excessively long wire runs, among other factors. Special conditions, such as historic structures, brownfields, solid waste landfills, and other unique site characteristics, may add additional cost to projects with increased engineering and construction considerations.



## Financial Feasibility

As part of a *basic* feasibility study, a financial assessment will provide a rough picture of the landscape and help determine if some of the major drivers for a successful solar project are favorable. These drivers include a fine balance of several factors. For example, public policy by individual states has a significant impact (favorable or unfavorable) on solar project economics. Retail electricity prices might be low, lowering the value of energy savings, but the solar resource might be excellent and compensate for this through higher energy production. Each region and project site will have a unique mix of favorable and unfavorable factors for solar PV systems to pay for themselves within a reasonable amount of time. It is important not to jump to any conclusions on the financial feasibility without due process.

*Basic* financial feasibility only provides a rough picture of the financial landscape, and many important factors are not considered that would normally be included in a more detailed financial assessment conducted by a qualified financial professional as discussed further in the next section.

The following outline covers some of the factors to be considered in a *basic* financial feasibility:

- State and utility policies for interconnection to the electric grid
- State and utility net metering policies
- Retail cost of electricity
- Future regional projections for the retail cost of electricity (20 to 30 year projections)
- Solar resource (yearly insolation) that drives energy production
- Available incentives for solar PV projects for public entities
- State RPS standards and SREC market availability and strength
- Estimate of total project costs including feasibility, engineering and design, permits and fees, equipment, installation, commissioning, prepaid maintenance & extended warranties (subject to limits), and other additional project costs.
  - Costs for similar projects may differ significantly by location, including site characteristics such as roof pitch and condition, or soil condition, special considerations such as historic buildings, wetlands, etc., electrical infrastructure, urban versus rural, and many other factors
- Estimate of operating costs (25 to 30 years)
  - Operations and Maintenance (O&M)
  - Inverter replacement
  - Other costs

Assistance from a solar PV consultant or owner's engineer can present options using proven formulas and experience from similar projects. Additionally, financial due diligence can be an arduous task, probably best handled by a qualified consultant who is familiar with the requirements and procedures.

Other considerations in financial assessment may include:

- Revisiting energy efficiency in conjunction with PV, as less electric load equals fewer PV modules required to meet that load
- System size and load – with an expected useful life of 25 years, will there be building efficiency improvements over the next 25 years? Will other factors reduce or increase the future electrical load? It is important not to oversize the solar PV system and pay for unused capacity.
- Infrastructure upgrades – service panel upgrade, transformer upgrade, roof replacement, structural improvements required for the roof, and other considerations
- Weather and other considerations – seismic, wind (tornados, hurricanes), flood zone – all may increase construction and insurance costs

With energy usage data collected, financial feasibility will first examine the utility cost structure. In most cases, this is not a simple task. A typical utility bill may include several variable charges (rates x kilowatt-hours consumed) and fixed charges, such as flat fees, which do not need to be considered. Rates may be based on peak or off-peak periods known as time-of-use rates (TOU). Alternatively, the rate structure may be tiered, with the first tier kWhs (for example, the first 100 kWhs used in the month) at one price, and second and third tier prices becoming progressively lower or higher. In a tiered rate structure, solar energy can offset the last tier first (usually the lowest price), then the second, then the first. Often, there may also be a difference between summer and winter rates.

All of these details are important. In analysis, you should not necessarily assume the highest rate listed, as this could dramatically overstate financial benefits. For a rough quick estimate, one approach is to take a weighted average of usage and rates over a year. There are also software programs available (usually for a fee) that greatly simplify this process, containing most utility rate structures, and requiring inputs of monthly energy consumption (in kWh) for the year. Alternatively, a solar PV consultant may already have access to these programs and can readily complete the analysis.

As this baseline energy data is used to evaluate a long-term solar project, it is also useful to gather projected retail electricity costs for the next 20 or 30 years. This data is available by region on the U.S. Department of Energy, Energy Information Agency's (DOE EIA) website at [www.eia.gov/electricity/](http://www.eia.gov/electricity/).

With baseline costs known, the next step is to determine available incentives, renewable energy credits, grants, low-interest loans and other options available from federal, state, utility and other sources. This process has been greatly simplified thanks to North Carolina State University, which maintains a comprehensive database of such incentives and programs. This website can be accessed at [www.dsireusa.org](http://www.dsireusa.org). Once on the website, click on your state and review the list of incentives and resources. There is also a list of federal incentives on this site. In addition to the national database, state energy agencies and utilities often list renewable energy incentive programs on their websites.



### **Investment Tax Credit and Federal Accelerated Cost-Recovery System**

Two major incentives for solar PV projects are the Federal Business Energy Investment Tax Credit (ITC), and depreciation through the Federal Modified Accelerated Cost-Recovery System (MACRS). For a municipality, these major incentives are not available, and most solar projects are not financially viable without benefits from the tax credit and depreciation. However, with third party ownership structures, a developer owns and operates the solar PV array on the municipality's property, and then sells solar electricity to the municipality under a service contract. In this Power Purchase Agreement (PPA) model, a third party can monetize the tax credits and then share the benefit through lower energy prices to the municipality. There are also third party lease models, which in essence accomplish the same benefit.

### **Solar Renewable Energy Certificates (SRECs)**

Solar Renewable Energy Certificates (SRECs) are another important source of project revenue in many states. Based on renewable portfolio standards (RPS) adopted in these states, SRECs represent the green attributes of clean solar energy. In addition to the value of energy produced by solar, there is also the value of the green attributes, often measured in dollars per megawatt-hour (\$/MWH). Energy producers in certain states are required under RPS to include a certain percentage of renewable energy as part of the total portfolio mix of energy they produce. There are penalties associated with not meeting these requirements, and because of this, energy producers are willing to purchase SRECs from other sources to meet their requirements. Once sold however, you can no longer claim the environmental benefits of your solar PV array, as this would now belong to the purchaser of the credit. SREC prices vary in different states, some having little value, and others command values higher than the retail price of the electricity itself. Additional information on SRECs and current market prices in various states may be obtained through links provided by the U.S. Department of Energy, Energy Efficiency & Renewable Energy (EERE) website:

<http://apps3.eere.energy.gov/greenpower/markets/certificates.shtml?page=5>.

Once incentives, grants and other potential sources of financial benefit are identified, some estimates for cost can be obtained. These numbers will not be the actual costs, only a reasonable estimate. In technical feasibility, the available roof space or land area for the project will become known and the independent engineer, consultant or other team member will provide an estimate of approximate system size. From this point, market price for total installed cost (in actual dollars or in \$ per watt) can be determined by examining similar solar installations in the area or by other methods.

Some states maintain a public database listing completed solar projects by type, size, date, location and installed cost, and an average can be taken from this information to get a 'ballpark' estimate of installed cost. However, only recent project comparisons should be used. It is important to remember this will not be the actual cost, only an estimate. Many factors will determine the actual installed costs for a given project.

With the data collection completed, a rough financial model can be created using a basic solar calculator or modeling tool to provide estimated energy output and approximate value. One such tool is PV Watts Grid Data Calculator, Version 2, provided by the National Renewable Energy Laboratory (NREL) through their website: [www.nrel.gov/rredc/pvwatts/grid.html](http://www.nrel.gov/rredc/pvwatts/grid.html). Instructions and training on how to use the tool are provided on the website. There are other calculator tools available as well, and are included in the Resources section at the end of this document.

The screenshot shows the PV Watts Grid Data Calculator interface. At the top, there are logos for 'PV Watts', 'AC Energy & Cost Savings', and a yellow diamond warning icon that says 'Caution: For Interpreting the Results'. Below the logos is a search bar containing 'Sample PV Watts Report'. The main content is divided into two tables: 'Station Identification' and 'Results'.

Station Identification		Results			
City:	Austin	Month	Solar Radiation (kWh/m <sup>2</sup> /day)	AC Energy (kWh)	Energy Value (\$)
State:	Texas	1	4.32	396	33.66
Latitude:	30.30° N	2	4.96	403	34.26
Longitude:	97.70° W	3	5.47	488	41.48
Elevation:	189 m	4	5.52	464	39.44
PV System Specifications		5	5.54	472	40.12
DC Rating:	4.0 kW	6	5.93	483	41.05
DC to AC Derate Factor:	0.770	7	6.21	514	43.69
AC Rating:	3.1 kW	8	6.22	517	43.95
Array Type:	Fixed Tilt	9	5.77	477	40.55
Array Tilt:	30.3°	10	5.65	485	41.23
Array Azimuth:	180.0°	11	4.60	392	33.32
Energy Specifications		12	3.96	360	30.60
Cost of Electricity:	8.5 ¢/kWh	Year	5.35	5450	463.25

With basic modeling complete, outputs are then incorporated into a more complete 30-year cash flow spreadsheet that includes upfront costs, any rebates and incentives, grants, and SREC values (based on SREC price x energy production). SREC prices are fluid, and can rise and fall dramatically. Because of this, it is best not to forecast SREC values without floor price guarantees or a 3-year or 5-year advanced sale quote from a qualified SREC broker. In many cases, SREC revenue should not be overly relied upon without supporting reasons, due to the variability in market conditions. Be sure to include all estimated project expenses, including Operations and Maintenance, insurance and any other applicable operating costs. Additionally, a major component in the system, the inverter, will require replacement during the project life. The exact time is unknown and will depend on the particular inverter and its estimated life, but replacement sometime between year 15 and year 20 is a typical recommendation. It is important to include this replacement expense, and to be conservative with assumptions.

From a rough estimated cash flow spreadsheet, net present value (NPV), levelized cost of energy (LCOE) and other financial metrics can be determined. If the project does not appear profitable at first, further examination of incentives, grants or other sources of revenue that may improve the pro forma, and consultation with state and utility sources should be researched for more options. Additionally, there are several finance options discussed in the next section, including third party ownership structures, which may dramatically change the financial attractiveness of a municipal solar project.

#### **Sidebar: Detailed Financial Feasibility**

The process outlined above is only to provide an overview of financial considerations, and many important factors are not discussed that would normally be included in a detailed financial assessment. A **detailed financial analysis** from which financial decisions will be made should only be conducted by a qualified financial professional with experience in renewable energy projects. Complex financial modeling tools are required, which are linked to outputs from detailed energy simulation software. Developers and turnkey solar contractors may have this capability, however, an independent financial analysis is highly recommended.

At some point during an evolving process, it usually becomes evident whether a project does or does not make economic sense. To get to this point, it is important to be creative and not limit the scale or scope of the project, investigating all the various financing options, investigating grants, linking individual projects together to achieve economies of scale, and even working with neighboring communities to create joint RFPs. Whether small rooftop systems, or a large megawatt-scale solar power plant, there is more than one path to explore in producing a successful project.

### **Available Staff and Funding Assessment**

A municipality may have qualified personnel on staff who can perform feasibility studies or assist in portions of the feasibility process. A facilities engineer, finance or accounting staff, and other personnel may not have specific expertise in solar PV but with guidance from a solar PV consultant or independent owner's engineer, certain staff may be trained to assist in the development process for future projects.

Additional resources to be considered include an attorney experienced in the renewable energy field and familiar with municipal regulations and requirements, a tax attorney if certain third party finance structures are involved, and a qualified accountant familiar with solar tax credits and incentives as well as municipal requirements.

Financing a feasibility study can be accomplished through traditional local government funding avenues, but it is worth reviewing grants and other sources of capital that may be available through state agencies, utilities and other sources. Sources of capital may be listed on the DSIREUSA and OpenEI websites at: <http://www.dsireusa.org/> and [http://en.openei.org/wiki/State\\_Grant\\_Program](http://en.openei.org/wiki/State_Grant_Program).

## FINANCIAL OPTIONS

For many public entities, the upfront cost of implementing solar PV may be a substantial barrier to what otherwise might be a valuable community investment that protects the environment and achieves significant long-term financial savings. With many communities under significant budgetary constraints, project finance is a key mechanism that enables solar PV implementation.

Some of the financing mechanisms outlined are “work-around” structures to very complex tax regulations, which allow various parties to monetize tax-based incentives that are often critical to the economic viability of solar projects.

This section will explore some of the finance options available for solar energy projects, and will provide an overview of the potential benefits and challenges related to these options as they apply to local government.

### Financing Solar PV Projects

Financing solar PV projects can be achieved through a municipality’s direct ownership of the solar energy assets or through third-party ownership (TPO) by a developer such as an operating lease, Power Purchase Agreement (PPA) or sale/leaseback structure. PPAs have become widely accepted in many states; however, they are not permitted in all utility jurisdictions or in all states.<sup>7</sup>

In general, direct ownership of a solar PV system by public entities presents a greater financial challenge for a project, and for larger-size projects, the challenge becomes more significant. A project developer’s ability to monetize federal tax incentives and tax depreciation has been a major source of funding for private commercial solar projects throughout the U.S. For commercial solar projects, tax benefits may offset up to 50% or more of total project costs. However, as public entities, these tax-based incentives cannot be realized, at least not directly.

***There is no single formula for local governments to follow, as solar project economics are highly dependent upon financial variables that may differ quite significantly from one jurisdiction to another.***

On the other hand, traditional financing structures used by municipalities may provide project funds at much lower rates than that of private commercial entities. In general, though, even with the lower cost of capital, other benefits beyond energy savings are likely needed to develop a financially attractive project. These additional benefits might include state or private grants, rebates, SRECs or other sources of funds.

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<sup>7</sup> DSIREUSA.org, North Carolina State University. <http://www.dsireusa.org/documents/summarymaps/>. (accessed July 2013).

## Financial Incentives

Grants and incentives from federal, state, utility and other public and private sources may be available to help defray the costs of implementing solar PV on public buildings. As municipalities cannot realize tax-based incentives for renewable energy, these additional funding sources can be critical to solar project economics. Primary sources of grants for municipalities may include federal, state, utility and private sources and may include grants for special situations such as reclaimed land, water treatment facilities, rural locations with high-energy cost, or other specialized purposes.

Incentives may be either *performance based incentives* (PBI) as with SRECs, or *capacity based* as with rebates, and vary significantly by state and utility jurisdiction. The following are highlights of some grants and incentives that may be available to municipalities.

### USDA – High Energy Cost Grant Program

In FY2013, the USDA is making up to \$7.766 million available through a Notice of Funding Availability (NOFA). Eligibility requirements include communities with high energy costs (average residential energy costs exceeding 275% of the national average), and funds may be used for the implementation of new energy generation, transmission or distribution equipment or maintenance of existing equipment, including on-grid and off-grid renewable energy projects.<sup>8</sup>

### USDA – Rural Energy for America Program (REAP) Grants

REAP grant applications are accepted throughout the year, but are typically funded during a few specific periods during the year. This program offers both grants and guaranteed loans for commercial and agriculture entities in rural communities, with grants of up to 25% of eligible project costs, ranging from \$2,500 to \$500,000.<sup>9</sup> Additionally, DSIRE indicates REAP grants may also apply to Schools, Local Government, State Government, Tribal Government, Rural Electric Cooperative, Agricultural, Institutional, and Public Power Entities.<sup>10</sup> It is likely this would apply in the context of third party ownership structures in rural communities.

### REC Incentives

As discussed in the feasibility section, RECs vary in value quite significantly from one state to another. This is largely due to differences in state RPS policy, which set target goals for clean energy generation as a percentage of total energy generation. Currently, 37 states have an RPS policy.<sup>11</sup> The value of RECs or *solar carve-out certificates*, known as SRECs, is driven in part by the *alternative compliance penalty* (ACP) rate for not meeting renewable energy goals, as well as the progress of renewable energy generation capacity in relation to these goals. As policies vary from one state to another, and progress

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<sup>8</sup> U. S. Department of Agriculture, Rural Development Electric Programs, “Grants,” [http://www.rurdev.usda.gov/UEP\\_Our\\_grant\\_programs.html](http://www.rurdev.usda.gov/UEP_Our_grant_programs.html). (accessed August 2013).

<sup>9</sup> U. S. Department of Agriculture, Rural Development Electric Programs, “Grants,” [http://www.rurdev.usda.gov/UEP\\_Our\\_grant\\_programs.html](http://www.rurdev.usda.gov/UEP_Our_grant_programs.html). (accessed August 2013).

<sup>10</sup> DSIREUSA.org, North Carolina State University, “Federal Incentives/Policies for Renewables & Efficiency.” [http://www.dsireusa.org/incentives/incentive.cfm?Incentive\\_Code=US05E](http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US05E). (accessed July 2013).

<sup>11</sup> DSIREUSA.org, North Carolina State University, “Rules, Regulations & Policies for Renewable Energy.” <http://www.dsireusa.org/summarytables/rrpre.cfm>. (accessed July 2013).

toward meeting goals varies, so do the value of RECs. Further information on renewable energy certificates and the current prices for particular states can be found on the U.S. Department of Energy, Energy Efficiency and Renewable Energy (EERE) website.<sup>12</sup>

### **Renewable Energy Feed-In Tariffs (FIT)**

Renewable energy feed-in tariffs have been piloted in a few locations in the U.S., notably California, Florida, Oregon, Vermont, Washington, Wisconsin and Long Island, NY. This incentive has been successful in Europe and other parts of the world to provide incentive for rapid solar energy development. The premise is that a host site develops a solar PV system and sells power at an attractive rate directly into the utility grid. This may include the sale of RECs as well as electricity. The host site receives payment for energy produced, and as such, is a performance-based incentive (PBI). The stream of expected payments is helpful in obtaining investment for the project, offsetting financing costs over a specific contract period. The feed-in tariff structure is straightforward, and reduces risk for project investors, resulting in lower financing cost. However, sustaining feed-in tariffs on a large scale is difficult for utilities or state governments, and feed-in tariffs in the U.S. have not been consistent and are not nearly as widespread as they are in Europe.<sup>13</sup>

If a municipality owns property that is suitable for solar PV, it can benefit from a feed-in tariff incentive structure through either developing a project or simply leasing the land to a solar developer, who in turn takes advantage of the Feed-In Tariff incentive, sharing project profits with the municipality through lease payments. In this case, a municipality would issue a *Request for Qualifications* (RFQ) to gauge the interest of private developers.

### **Rebates**

Many states and utilities offer rebates for purchase of solar PV equipment. Availability, rules, eligibility and guidelines vary between states and within utility jurisdictions.

## **Solar Finance Options with Project Ownership**

Owner-funded solar projects are projects that are purchased, owned, maintained and operated by the local government entity. This can be achieved with funds from general obligation bonds, special tax-exempt bonds or funded through tax-exempt debt or lease structures, typically at below market interest rates.<sup>14</sup>

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<sup>12</sup> U.S. Department of Energy, Energy Efficiency & Renewable Energy (EERE), "Green Power Markets, Renewable Energy Certificates (RECs), REC Prices."

<http://apps3.eere.energy.gov/greenpower/markets/certificates.shtml?page=5>. (accessed August 2013).

<sup>13</sup> Toby Couture and Karlynn Cory, "State Clean Energy Policies Analysis (SCEPA) Project: An Analysis of Renewable Energy Feed-in Tariffs in the United States," National Renewable Energy Laboratory (NREL) Technical Report, NREL/TP-6A2-45551. (June 2009).

<sup>14</sup> U.S. Environmental Protection Agency (EPA) and National Renewable Energy Laboratory (NREL), "Best Practices for Siting Solar Photovoltaics on Municipal Solid Waste Landfills, Appendix C: Financing and Procurement Options." (February 2013): C1.



With ownership, municipalities own the rights to use or sell all energy production and renewable energy certificates (SRECs). Ownership of a solar PV system requires regular inspections, performance monitoring and maintenance, which could be handled by the municipality or instead provided through contract with a service provider. Additionally, as the system owner, the electric utility may require documentation of insurance and maintenance records as a condition of interconnection to their grid system. Performance risk, such as underperformance, system downtime, and maintenance risk resides with the municipality.

Public entities who own solar PV systems are not eligible to receive significant federal incentives provided through the tax code, and many projects might not be financially feasible without other significant incentives or grants.

### *Benefits*

Because the system is owned, the owner receives all of the benefits of solar PV, including reliable electricity production, stable and predictable electricity cost, and ownership of the rights to the environmental attributes evidenced through renewable energy certificates (SRECs). SRECs can be used to meet carbon emissions goals, or be sold to another party or utility that may use them for RPS or emissions compliance.

### *Challenges*

Though prices for solar PV systems have decreased dramatically over recent years, and over the long term solar PV offers great benefits, the upfront costs associated with installing solar PV are significant, especially for larger scale solar projects. Federal tax incentives and depreciation for solar PV may offset up to 50% or more of project costs, but municipalities are not able to realize these benefits and likely will need significant rebates, grants or other incentives to help make their projects financially viable.

### **Municipal Lease (Tax-Exempt Lease-Purchase)**

A municipal lease is available to some local governments (but not all) and carries a lower payment rate over that of other lease structures. This is because the lessor is not taxed at the federal level for the interest portion of the lease payment. This savings is reflected through lower lease payments. The lease term is typically structured through a series of one year terms that are renewed until there is little or no residual value left for the asset, then ownership of the solar assets are typically transferred to the lessee. Alternatively, ownership may be transferred to the municipality at the beginning of the lease term, with the lessor maintaining contractual security on the equipment.<sup>15</sup>

### *Benefits*

Lower lease payments and project ownership flexibility are the main advantages of this finance option. In addition, with non-appropriation and other specific language in the contract, lease obligations usually are not considered long-term debt, and are not considered a capital expense.

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<sup>15</sup> Association for Governmental Leasing & Finance, "Frequently Asked Questions About Tax-Exempt Municipal Leasing." <http://www.aglf.org/faq>. (accessed August 2013).

### Challenges

A municipal lease is issued by state, county or local government authorities or districts within, which cannot realize federal tax incentives and thus cannot pass these savings along through lower lease payments. Thus, the benefit of low tax-exempt interest payments may not be as attractive as the benefit of lower lease payments from private sources of capital, which are able to monetize tax credits. As with other ownership finance options, significant grants, rebates, or other incentives are likely required to make the solar project economically viable.

### Tax-Exempt Bonds

A municipality may finance renewable energy projects with tax-exempt bonds, which allow for low interest debt and ownership of the solar PV system. The municipality may, subject to various rules, use bond proceeds to contract services for the design, construction, operation and maintenance of the solar PV system with a private contractor.<sup>16</sup>

### Benefits

Low cost of capital with flexibility for longer terms at fixed interest rates are the primary benefits for this type of financing over traditional commercial debt, which typically has shorter terms and variable interest rates that are generally a few percentage points higher.

### Challenges

With ownership, a municipality would not receive any indirect benefits of renewable energy tax incentives or depreciation. As with other ownership structures, significant grants, rebates, or other incentives may likely be required to make the solar project financially attractive. Increasing debt obligations may be a sensitive issue in many communities; other alternatives, which could be classified as an operating expense, might be preferable.

### Revolving Loan Funds (RLF)

Several states have created *revolving loan funds* (RLF's) for municipalities as a means of providing low interest or even zero interest loans for renewable energy projects. As loans are repaid, the funds are replenished, which in turn allows more loans to be distributed. This concept is not limited to state or public entities. Large private non-profits have also created similar funds to provide loans for energy efficiency and renewable energy projects within their cost centers.

In a 2010 paper published by Latham and Watkins LLP, revolving loan programs available in 27 states were profiled. These RLFs provide low- or zero-interest loans to local governments to provide incentive for energy efficiency and renewable energy generation.<sup>17</sup>

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<sup>16</sup> John Wang, "Renewable Energy Projects: Tax-Exempt and Other Tax Advantaged Financing," Orrick, Herrington & Sutcliffe, LLP, (2012): 20-38.

<sup>17</sup> Michael J. Gergen, George D. Cannon, Jr., and G. Scott Binnings, "Incentives for Energy Efficiency and Renewable Energy Generation, State Revolving Loan Programs," Latham & Watkins, LLP. <http://www.cleanenergystates.org/assets/Uploads/Resources-post-8-16/staterevolvingloanprograms.pdf> . (accessed August 2013).

According to the National Association of State Energy Officials (NASEO), which maintains a database of RLF's for state energy programs, there are 66 funds available in 34 states, with more than \$925 million available. This database can be accessed on the NASEO website.<sup>18</sup>

### *Benefits*

State RLF's are replenished funds and an innovative way to support solar PV and other energy projects for local governments. Payment terms are typically structured to match project energy savings until the loan is repaid. As a source of low or even zero interest debt, RLF's help communities lower their borrowing costs, which in turn contributes to a solar project's overall economic viability.

### *Challenges*

Funds may be limited until they become replenished over time, and additional debt liability may be an issue for some communities. Energy savings should be equal to or greater than the debt payments. As with other ownership structures, indirect savings from tax-based incentives cannot be realized, and project economics may likely require additional incentives or grants to become financially feasible.

## **Solar Finance Options with Third Party Ownership**

As an alternative to financing solar projects through direct ownership models, non-ownership financing options may be more attractive to many local governments. With private third party ownership, tax incentives and tax depreciation for solar projects can be realized by the for-profit project owner, and savings then passed to municipalities through lower lease payments or through lower prices for energy.

Project scale is an important factor for third party investors, as fixed costs such as legal contracts, due diligence and other factors must be outweighed by the project's financial returns. As a general rule, the larger and more attractive the project, the more financing options become available, and the more negotiating leverage for the municipality. A project may consist of one site, a series of sites owned by a municipality, or even sites in more than one municipality.

The popularity of third party solar financing has grown tremendously over recent years. More and more communities are recognizing the potential to avoid large upfront costs and avoid performance and operating risks, while achieving significant energy savings as a result of shared benefit from tax credits. Third party finance structures include operating leases, sale/leaseback structures, partnership/flip agreements, power purchase agreements (PPAs), and hybrid financing structures. As not all structures are permitted in all states and jurisdictions, it is important to consult with appropriate state agencies, your utility and a qualified financial advisor familiar with local requirements for municipalities to determine which options are available for your location.

One further note, capturing tax benefits by third party financiers for use in municipal solar projects requires strict adherence to IRS regulations, as well as any state or other jurisdictional requirements. In

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<sup>18</sup> National Association of State Energy Officials (NASEO), "State Energy Financing Programs." <http://www.naseo.org/state-energy-financing-programs> . (accessed August 2013).

structuring third party agreements between taxable and non-taxable entities, it is essential that contracts meet these very specific requirements and limitations, which are beyond the scope of this guide. Because of this, it is recommended that contracts be carefully examined by an experienced attorney who understands the tax laws specific to renewable energy project finance, and understands the regulatory requirements for tax-exempt municipalities.

Third party owners may be a developer, an investor, or a special purpose entity such as an LLC comprised of stakeholders that may include the developer, the investor and others.

### *Benefits*

Third party ownership may allow local governments to implement solar PV projects with no upfront cost and no effect on their balance sheets. Projects are owned and operated by a private third party entity that is able to realize the savings from federal tax credits and accelerated depreciation and may share in this savings through lower lease payments or lower purchase price for electricity under a power purchase contract. Projects which otherwise may not be economically feasible, become more financially attractive due to a third party's ability to capture these tax benefits.

### *Challenges*

Though third party owners can take advantage of tax based incentives and depreciation, they typically have a high cost of capital, which offsets some of this benefit. This is particularly true for the tax equity investor who monetizes tax incentives and depreciation with expected return on investment often in double digits, reflecting a limited pool of tax equity supply as well as investor risk. There are still very important overall benefits to solar projects that take advantage of tax incentives, but those benefits are somewhat diminished by this higher cost of capital. The renewable energy industry is currently lobbying for revisions in the tax code that would allow more investors to participate in renewable energy projects. One such effort is for a Master Limited Partnership structure, which could potentially lower financing costs in some third party ownership models.

Other challenges may be presented by state policies and utility interconnection standards that have not ruled, or do not permit, private third parties to own solar PV systems and sell retail electric power to a host customer. These regulations and limitations vary by state and by jurisdictions within states.<sup>19</sup>

### **Operating Lease**

An operating lease allows a municipality to receive solar energy without ownership. A solar developer designs, builds and owns the solar equipment, then leases the use of this equipment to the public entity. This is similar to a rental agreement. The public entity receives use of the solar equipment to produce electricity and receive SRECs (if applicable) for the term of the lease, typically 7 years or longer, limited to under 75% of system life and up to 80% of the solar project's value, among other IRS requirements. At the end of the lease term, the public entity does not receive ownership, but may purchase the solar

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<sup>19</sup> DSIREUSA.org, North Carolina State University, "Solar Policy Information, 3<sup>rd</sup>-Party Solar PPA Policies," <http://www.dsireusa.org/documents/summarymaps/>. (accessed August 2013).

PV equipment at fair market value.<sup>20</sup> There are several tax rules that must be followed to qualify a solar lease as an operating lease. It is recommended that any lease contract be carefully reviewed by a qualified accountant and/or tax attorney.

### *Benefits*

With an operating lease, there are no upfront costs and payments are evenly distributed throughout the lease term. Because a private third party owns the solar PV equipment and meets IRS ownership requirements including *at-risk* rules, the lessor receives the federal tax incentive and depreciation and will monetize them. This benefit in turn will be shared with the municipality through lower lease payments. At present, lease payments are treated as an operating expense and do not affect the balance sheet, though there is a possibility that lease accounting standards may change in the near future.

### *Challenges*

The operating lease term must be limited to 75% of the solar PV system's estimated life and 80% of the solar project's value. Payments must be evenly spread over the term. At the end of the lease, ownership cannot be transferred unless sold at fair market value, which could be a substantial price. Further, the potential for significant accounting changes may eliminate one of the two primary benefits of operating leases. The Financial Accounting Standards Board (FASB) first indicated in 2010 a new lease accounting standard is being considered that may require operating leases to be capitalized, eliminating the "off-balance sheet" advantage.<sup>21</sup> In May 2013, FASB and the International Accounting Standards Board (IASB) issued revised joint proposals, and several joint roundtable meetings were held through October 2013 to solicit stakeholder input.<sup>22</sup> The FASB and IASB Boards plan to renew deliberations beginning in January 2014. In addition to accounting issues, while equipment risk resides with the developer as lessor, all energy production risk resides with the municipality.

### **Sale/Leaseback**

A sale/leaseback structure is a well-established structure allowing municipalities to design and build a solar PV project, then sell the project to a third party investor, who then leases back the solar PV assets to the municipality under an operating lease structure. Lease payments are treated similar to rental payments, as an operating expense. This allows the investor to monetize tax incentives and depreciation, and receive a cash flow return at an attractive overall interest rate. Benefits of the tax incentives and depreciation are shared with the municipality through lower lease payments. This same

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<sup>20</sup> Albert Thumann, P.E., C.E.M. and D. Paul Mehta, Ph.D., *Handbook of Energy Engineering*, 7<sup>th</sup> Edition, (Lilburn, GA, The Fairmont Press, Inc., 2013), 361.

<sup>21</sup> Kyle Meyer, CPA, Ph.D., Executive-in-Residence and Professor of Accounting, Rollins College, Crummer Graduate School of Business, "The Times They are A-Changing For Leasing Transactions," Financial Executives International (FEI), April 2013, [http://www.financialexecutives.org/KenticoCMS/Financial-Executive-Magazine/2013\\_04/Accounting-for-Leasing-Transactions--The-Times-The.aspx#axzz2XRKaPLQy](http://www.financialexecutives.org/KenticoCMS/Financial-Executive-Magazine/2013_04/Accounting-for-Leasing-Transactions--The-Times-The.aspx#axzz2XRKaPLQy). (accessed August 2013).

<sup>22</sup>The Wall Street Journal, U.S. Edition (online), July 2, 2013, "Press Release (Business Wire): July 2, 2013, 10:11 a.m. ET, Source: Financial Accounting Standards Board, FASB and IASB to Hold Joint Roundtable Meetings on Revised Leases Proposals," Business Wire (2013) and Dow Jones & Company, Inc. (2013).

structure has been used between investors and developers, with developers then selling the power to municipalities. As applied in this case, the municipality would be assuming the role of the developer.

### *Benefits*

In by-passing the developer and managing the engineering procurement and construction (EPC) process itself, a municipality, with help from an experienced independent consultant, might save money on construction finance costs, equipment purchases, developer fees and other related costs. The advantages of an operating lease structure also apply.

### *Challenges*

Developing a solar PV project of any scale requires very specialized knowledge. An experienced consultant should be retained to help guide a municipality through this process, assisting with design, project management, procurement, and construction oversight and commissioning functions. Specialized solar developers may have ongoing relationships with equipment suppliers and may be able to purchase equipment at a significantly lower cost than a one-time purchaser. Construction risk, which is significant, will be taken by the municipality. IRS regulations on ownership requirements for tax incentives limit the amount of time in which a solar PV system's ownership can be transferred after the construction process is completed. If a lease finance closing between the municipality and investor is delayed or canceled, this could severely impact the project economics and the municipality would bear this risk. Finally, as with the operating lease model, there is significant regulatory risk at this time regarding treatment of lease payments. While lease accounting standards are currently under review by FASB and IASB, there is no guarantee that operating lease payments will remain off balance sheet in the future.

### **Partnership Flip**

The partnership flip model (also known as the Minnesota flip model) was originally developed to finance wind energy projects, and has become a popular mechanism for financing large commercial solar projects. Using this finance structure, the municipality (host site), a private developer and an investor who can monetize tax incentives, become members of a special purpose entity such as an LLC. It is important that a municipality carefully review all legal requirements to determine whether they may be eligible to participate in this type of private-public partnership, and they should seek qualified counsel and consult with state and other jurisdictional authorities prior to considering this type of finance structure.

The municipality as a member of the LLC contributes use of land or rooftops, or other contribution, in exchange for a share in the long-term financial returns of the solar project. The municipality may also be the energy purchaser known as an *off-taker* in addition to being a member of the project LLC, but if also the energy off-taker, would purchase energy from the LLC under a separate contract with the special purpose entity.

In the LLC structure, the investor owns most of the project and receives most of project revenues until tax credits and depreciation are fully realized, usually 6 or 7 years, or sometimes longer until the investor has received their expected return. Investor ownership of the project is typically 95% for this

period. Once the investor has received the required rate of return, the ownership flips and the investor now owns 5%, and the remaining LLC partners then take over 95% ownership of the project from that point forward, hence the term flip. At this time, the investor's remaining interest in the project may be purchased by the other partners.<sup>23</sup>

### *Benefits*

If a municipality is capable of entering into a public-private partnership through a special purpose entity such as an LLC to develop a large solar project, the advantages may be significant. In addition to simply purchasing power from a third party at a below market rate as an off-taker, this structure allows the municipality to also participate in ownership and share in the long term profits of the project through partnering with the third party owner, in this case a special purpose entity comprised of the developer and investor. Taking part in the risks and upside rewards of the solar project may be beneficial economically and having some ownership may create additional support within a community.

### *Challenges*

The partnership flip structure and counter-party contracts are complex, and fixed project costs are high, so project scale must be large. There are significant questions as to whether many municipal entities could enter into such agreements, and questions on how the special purpose entity would need to be structured to accommodate this public-private partnership. Much depends on the regulatory authorities and laws governing municipalities, and much specialized legal and accounting due diligence is required. Contributions to the project from the tax-exempt municipality would likely need to be deducted from the project's cost basis for tax credits and depreciation. In a paper published in February 2013, jointly authored by the Environmental Protection Agency (EPA) and the National Renewable Energy Laboratory (NREL), third party flip agreements are discussed as an option for municipalities siting solar PV on municipal solid waste landfills.<sup>24</sup> Looking at the benefits of this structure, could the same goals of sharing in overall long-term project revenues be accomplished through more simple mechanisms, such as a separate lease contract for the municipally owned property, or reflected through a lower power purchase price?

### **Power Purchase Agreement, (PPA)**

*Power purchase agreements* (PPAs) have become widely accepted in many states as a means for public and non-profit entities to finance solar projects. With this finance structure, a private developer and financial investor with tax equity create a special purpose entity such as an LLC that designs, builds, owns and operates the solar project. The developer may also be the financier. A municipality provides the site(s) for the solar project under a long-term easement or lease to this entity, and then agrees to purchase the solar energy under long-term contract at an agreed upon rate that is typically less than the utility rate. The typical PPA term may be from 10 to 20 years or custom to the project, but will likely be

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<sup>23</sup> U.S. Environmental Protection Agency (EPA) and National Renewable Energy Laboratory (NREL), "Best Practices for Siting Solar Photovoltaics on Municipal Solid Waste Landfills, Appendix C: Financing and Procurement Options." (February 2013): C-1.

<sup>24</sup> The U.S. Environmental Protection Agency (EPA) and the National Renewable Energy Laboratory (NREL), "Best Practices for Siting Solar Photovoltaics on Municipal Solid Waste Landfills, Appendix C: Financing and Procurement Options." (February 2013): C-1.

at least 7 years, the period required for investors to safely monetize tax credits and depreciation. The power purchase rate may contain escalators that increase rates over time based on projections for utility price increases.

As of July 2013, twenty-two states plus Washington D.C. and Puerto Rico allow third party solar PPAs, six states disallow or restrict these agreements, and in the remaining states, solar PPA policies are unclear.<sup>25</sup>

### *Benefits*

Solar PPAs allow public entities to implement solar projects with little or no upfront cost. Third party owners assume system performance and maintenance risk, and municipalities may ensure certain levels of performance (energy supply) through contractual arrangements.

Also with a PPA, municipalities receive fixed, predictable pricing for electricity over a long period and may realize significant savings in energy expense over that time. The overall price is typically lower than ownership models, as third party owners are able to monetize and share the tax benefits through lower energy prices. Projected energy prices are just that, and decisions on long-term purchases do carry some risk, however there is also a non-monetary value in having predictable energy costs that can be safely budgeted, and not subject to unexpected price volatility.

In general, investors are concerned that off-takers make good on their long-term purchase agreements, and municipalities are attractive to investors as energy purchasers (off-takers). Municipalities have established credit ratings and will not potentially move somewhere else during the 20-year term, unlike some commercial off-takers. Because of this, good projects are likely to be funded.

### *Challenges*

Project scale is important, as the larger the project, the more attractive it becomes to investors. Smaller projects, such as a single small rooftop, may be financeable with a PPA, but with high fixed costs for the third party owner, terms and pricing would not likely be as favorable to the municipality.

Third party owners will have rights to the SRECs and most often will sell them to another party. Therefore, the municipality cannot claim the “green” attributes of the clean solar energy.

State and utility policies vary significantly, and PPA agreements are not permitted or policies are not well defined in 28 states.

Cost of capital from the tax equity investor and private commercial debt is higher and partially offsets the benefit of tax credits received in the solar project. As with other third party ownership models, tax equity investors typically receive a high premium for their function, with expected returns often at double-digit rates. This is due in part to there being relatively few tax equity investors for the large

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<sup>25</sup> DSIREUSA.org, North Carolina State University, “Solar Policy Information, 3<sup>rd</sup>-Party Solar PPA Policies,” <http://www.dsireusa.org/documents/summarymaps/>. (accessed August 2013).



number of projects (not just solar projects). Investors must also meet strict requirements concerning passive-loss and at-risk rules and other constraints required through tax law<sup>26</sup>, thus limiting the number of qualified investors capable of offsetting these tax credits. Even with this high cost of capital, overall savings will most often be significantly better than with ownership financing models.

### **Hybrid – Municipal Bond Power Purchase Agreement (Morris Model)**

In an effort to lower the cost of capital for third party owned municipal solar projects, a hybrid PPA model known as the Morris Model has been developed, named after Morris County, New Jersey, where this finance structure was first implemented.

This hybrid PPA takes advantage of a municipality's ability to access low-cost capital and incorporates this into a traditional PPA structure. The municipality, or a conduit to the municipality, issues taxable bonds to finance the development of the solar project. An RFP process is then used to select a developer, and a sale/lease-back model is employed whereby the municipality transfers project ownership to the developer in exchange for lease payments, using the capital lease structure (also known as a finance lease). The lease payments cover the cost of the municipality's taxable bond obligations and are secured through agreements, including a performance payment bond and a posted security. The municipality then enters into a long-term PPA agreement with the developer, receiving a low price for energy due to the realization of tax credits by the developer as well as the lower cost of debt financing, which lowers the loan payments of the developer.

#### *Benefits*

As with other third party agreements, there is little upfront expense for developing the solar project, and the municipality receives lower energy prices through the PPA due to the shared benefit of tax incentives and the lower cost of debt to the developer. The capital (or finance) lease payments from the developer cover the taxable bond obligations of the municipality. If the municipality uses a conduit to issue the taxable bonds, such as a county improvement authority or state authority, there may be no debt liability recorded on the municipality's balance sheet as this might be a guarantee obligation and not a direct obligation. Additionally, because the municipality is providing the third party developer with access to low-cost debt, they could be in a stronger negotiating position with contract terms and PPA pricing.<sup>27</sup>

#### *Challenges*

Due to the complexity of the structure, issuing taxable bonds, negotiating the sale/lease-back structure, and the PPA and Security agreements, transaction costs are high. The project must be at a scale that can absorb these fixed costs. Additionally, in order for the project economics to work, the municipality might need to have a strong credit rating (A-AAA). In providing low-cost capital to the developer, the

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<sup>26</sup> Paul Schwabe, "Passive Loss Rules and You," *Renewable Energy Project Finance*. National Renewable Energy Laboratory (NREL), February 6, 2012, <https://financere.nrel.gov/finance/content/passive-loss-rules-tax-equity-investors-renewable-energy-projects>. (accessed July 3, 2013).

<sup>27</sup> Claire Kreycik, "Financing solar PV at Government Sites with PPAs and Public Debt," National Renewable Energy Laboratory (NREL), (December 13, 2011): 1-5. <http://www.nrel.gov/docs/fy12osti/53622.pdf>. (accessed August 2013).

municipality takes financial risk. This risk can be mitigated with a performance and payment bond, and posted security valued at the net of what the developer owes at the time of default, less the PPA payments by the municipality.<sup>28</sup>

## **Other Options: Leasing Property for Solar**

### **Leasing Property for Solar**

Though not as financially beneficial as some third party ownership models, a municipality may decide to forgo energy savings and other value streams and simply lease land or rooftops to a solar developer, who would then sell the energy to another party, such as a utility. Though a lower value use of sites suitable for solar energy, depending on a municipality's goals, this option does provide some financial benefit with limited complexity, while also promoting solar development. Other than lease payments, no project benefits would be received by the municipality and an RFP would be issued with identified sites that have been determined feasible for solar development. Considerations should include lease and options payments, lease escalators, insurance, system removal and decommissioning at the end of the lease, among other issues.<sup>29</sup> Additional information on this topic can be found on the Solar Foundation website in a joint brief supported by industry groups and the U.S. Department of Energy, SunShot Initiative, at the following URL:

[http://thesolarfoundation.org/sites/thesolarfoundation.org/files/TSF\\_Leasing%20Fact%20Sheet.pdf](http://thesolarfoundation.org/sites/thesolarfoundation.org/files/TSF_Leasing%20Fact%20Sheet.pdf)

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<sup>28</sup> Kreycik, "Financing solar PV at Government Sites with PPAs and Public Debt," 1-5.

<sup>29</sup> The Solar Foundation, *Leasing Municipal and Private Property for Solar: Key Steps and Considerations*, [www.TheSolarFoundation.org](http://www.TheSolarFoundation.org), (March 30, 2012): 1-5. (accessed August 2013).

## Purchasing and Contract Models

Procuring services and equipment for solar PV systems can be approached in many ways. Procurement options depend on various factors, including scale of the project, ownership structure of the PV system, risk tolerance, and regulatory and jurisdictional requirements. There is no one correct answer for any particular project. However, certain concepts and key considerations do apply to most situations, and these characteristics require careful examination to help maximize the value for communities as they look to enjoy the benefits of clean solar energy. The applicability of options discussed in this section may not relate to a particular municipality or specific project due to local regulatory and jurisdictional requirements, and experienced legal counsel is strongly advised before making any specific decisions related to procurement or contract considerations.

Scale of a project is an important consideration in setting expectations for terms and conditions with prospective vendors. Smaller-scale projects are less attractive to developers and investors, options will be less, and negotiating leverage will be weaker with terms less favorable as project size decreases. Larger scale projects, such as multiple rooftops and large land parcels allow more room for negotiation.

Cost is an important factor, as lengthy contracts, performance risk and other risk allocations all add to fixed costs, which smaller projects simply cannot absorb. As a general rule, smaller projects will provide fewer options, make risk allocation less flexible, and if terms are too stringent, may cause more experienced developers to not be interested.

**Case Study: Purchasing Options**  
**Solarize Case Study**  
[Community-Based Collective Purchasing in West Linn, Lake Oswego, and Clackamas County, Oregon](#)

Project ownership and finance structures will affect leverage over which procurement and contract risk options are available to a municipality. If the owner is a third-party developer and financier, they most often require control over the processes for which they own risk, including equipment (construction risk including lead and delivery times, familiarity with installation procedures, and performance and maintenance risk), as well as engineering and contractor selection and Operations and Maintenance (O&M) contracts. If the municipality is the project owner, and the project is self-financed, then risk resides with the municipality and control over procurement and other processes would naturally be in their interest. An independent owners' engineer can assist the municipality with equipment specifications and other aspects of this process.

### **Design, Bid, Build (DBB) and Engineering, Procurement & Construction (EPC)**

Conventional projects in the public sector have used a *design, bid, build* (DBB) model, which provides a specific engineering design, including all project details, product specifications, quality and other information in the RFP for a vendor to submit a bid. RFPs using the DBB model shift risk in the bid to the developer, who submits a price for the full cost of procurement and construction. If the respondent neglects to include all of their costs in the bid, they bear all of the risk and associated cost.

However, within the solar industry, project RFPs typically follow an *engineering, procurement and construction* (EPC) model, especially with larger solar projects. In an article by Keene Matsuda (*Solar Industry* magazine, August 2012) the differences and implications are discussed in detail.<sup>30</sup>

In the EPC model, an RFP is issued requesting a contractor to develop all aspects of the project from engineering design, to procurement and construction. A municipality's RFP under the EPC model is geared toward the end product and usually includes project scope, and may provide partial (30%) engineering plans, include some specificity (e.g. no substitution for ...), or may have no specificity at all. The end design is left to the respondents, removing rigidity and allowing EPCs to develop the means to achieve the solicited end result. The competitive EPC response is anticipated to include all costs and the EPC is expected to bear all design and construction risks. However, the flexible structure of the EPC model may increase the municipality's risk for add-ons, change orders and other additional costs not included in a bid response. It is important for the RFP to clearly detail the project requirements and expectations.<sup>31</sup>

Suppose a municipality issued an RFP for a 750 kW solar PV system with no specifications. What type of solar modules would be provided by the lowest bidder: polycrystalline, monocrystalline, thin film? Higher efficiency modules may come at higher cost, but use less land or roof area. How are the modules rated for delivering the energy they claim? A foreign manufacturer may be about to withdraw from the U.S. market and is providing modules to developers (which cannot be supported over 30 years) at large price discounts. Are the module warranties backed by insurance or reserve? Inverters may be lowest cost, but their manufacturer may not provide timely support or extended warranties. Details such as general equipment characteristics, specific design quality features, and considerations for EPC wherewithal, system performance, reliability and O&M should be outlined, among many other important considerations. There are many factors to consider, but in general, the more specific the RFP is in outlining the basic design characteristics, the better. The EPC respondents to an RFP may then work within a clear framework to provide creative solutions leveraging their expertise.<sup>32</sup>

Because of the established EPC structure in the solar industry, it is strongly recommended that a municipality work closely with a third-party consultant or independent owner's engineer in structuring an RFP (and subsequent contract), to allow for both specificity and some creative flexibility and to avoid potential quality issues and cost overruns, while allowing room for innovative solutions.

## **Guaranteed Production**

For public entities that have selected a third-party ownership finance framework or other similar energy purchase arrangement, much of the risk of performance is mitigated, as a municipal energy off-taker only pays for what it receives. There are exceptions, such as take-or-pay clauses, where a municipality

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<sup>30</sup> Keene M. Matsuda, "Reduce EPC Risk to Increase Solar Project Development Success," *Solar Industry*, Volume 5, Number 7 (August 2012): 1-16.

<sup>31</sup> Matsuda, "Reduce EPC Risk to Increase Solar Project Development Success," 1, 13-16.

<sup>32</sup> Matsuda, "Reduce EPC Risk to Increase Solar Project Development Success," 13-14, 16.

must purchase all electricity produced by the solar project, regardless of whether energy is used or not, and system over-performance could become an issue. In addition, there is some opportunity risk in not receiving projected savings due to system under-performance. Overall, third-party ownership performance risk is primarily shifted to the developer, who must manage this risk with their EPC contractor. Regardless of which finance structure is used, a successful project requires all parties be in alignment in creating a solar project that performs well for everyone.

When a municipality owns a project or leases solar equipment, system performance and availability is critical to achieving expected returns. Because of this, O&M is very important, yet this often does not receive the attention deserved. Conceptually, funding a solar project is, in effect, pre-paying for electricity for many years in advance, and parties must strike a balance between mitigating production risk and adding project costs for these mitigations.

Finally, EPC contractors have traditionally accepted performance provisions for the first year or two. With longer terms, EPCs may not be as accepting and discussions may become more delicate. Project scale is an important factor in creating leverage for the municipality in negotiating performance guarantees, as is balancing these terms with project costs.

There are two fundamental methods of performance guarantees, the *energy guarantee* and the *capacity guarantee*. This next section will overview both approaches and review the advantages and challenges of each. Much of the content in this section is based on a journal article by Scott Canada “Approaches to EPC Performance Guarantees,” (SolarPro August/September 2012). This article is available online at: [www.SolarProfessional.com](http://www.SolarProfessional.com).<sup>33</sup>

## Energy Guarantee

In the early planning of a solar project, targets for production performance are determined. These targets are based on energy production modeling through software such as the *System Advisor Model* (SAM), (<https://sam.nrel.gov/>), or PVsyst, ([www.pvsyst.com/](http://www.pvsyst.com/)), which incorporate typical meteorological year (TMY) weather data from a nearby location such as an airport weather station.

When the project goes online, it includes a weather station that measures solar insolation (energy from the sun over time) using a pyranometer, along with module temperature and other conditions at the project location. Energy production data for the month, quarter or year is then adjusted for the actual weather conditions and production is assessed through a performance ratio.

### *Benefits*

Using one metric to determine performance of the entire solar PV system is an advantage of the energy guarantee. Additionally, the EPC contractor has incentive for good practices that are in alignment with

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<sup>33</sup> Scott Canada, “Approaches to EPC Performance Guarantees,” *SolarPro*, Issue 5.5, (August/September 2012). <http://solarprofessional.com/articles/finance-economics/approaches-to-epc-performance-guarantees>. (accessed August 2013).

the project owners' interests throughout the engineering, procurement and construction process, which should be reflected in performance and reliability over time.

### *Challenges*

The reliance on accurate performance modeling and accurate site measurements are subject to modeling and measurement errors, creating risk for the EPC. While weather stations generally are accurate, they are not always accurate, and sensors and other equipment are not 100% precise and may drift over time. EPCs may not agree to this methodology because of these issues, or may use these issues to avoid responsibility. Soiling is another factor that is not controllable by the EPC, especially if O&M is not part of a contract. Soiling refers to dust, ash, bird droppings and other degradation, and is variable dependent on rainfall in a given period, construction dust from a nearby site, or other issues which might be beyond the EPCs control. In desert climates, soiling may account for 2-6% production loss annually, with an even greater loss in shorter periods of time.<sup>34</sup>

## **Capacity Testing with Availability Guarantee**

Similar to the energy guarantee, early in the design process the owner and EPC agree on the sizing and production goals of the solar PV system. When the solar PV system is in operation, an established weather adjusted capacity test procedure is used to determine performance. This may be conducted on a quarterly basis or other time period as agreed. Test procedures and frequency would be clearly defined in the EPC contract. Modules may be cleaned prior to the test, eliminating the soiling accuracy issues, and testing equipment can be calibrated to avoid sensor issues, significantly lowering the testing margin of error.

System availability, (actual % uptime ÷ available uptime), which also affects energy production quite dramatically, is not captured in periodic capacity performance measurements, but can be addressed under contractual agreement with remedies for not meeting targets.

### *Benefits*

With periodic capacity testing, many of the uncontrolled variables and measurement risks of energy guarantees are avoided. Equipment sensor risk, soiling issues and other factors may allow an EPC to avoid responsibility for performance issues, but with periodic capacity testing, these variables are largely eliminated and true performance is clearer to all parties. Further, as the EPC does not take on risk for measurement variables not in their control, they can be more exact with their pricing and avoid hedging against costs for these risks.

### *Challenges*

A capacity guarantee alone does not account for reliability and system downtime. However, this may be handled through incorporating system availability targets and penalties into the contract.<sup>35</sup>

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<sup>34</sup> Canada, "Approaches to EPC Performance Guarantees." <http://solarprofessional.com/articles/finance-economics/approaches-to-epc-performance-guarantees>. (accessed August 2013).

<sup>35</sup> Canada, "Approaches to EPC Performance Guarantees." <http://solarprofessional.com/articles/finance-economics/approaches-to-epc-performance-guarantees>. (accessed August 2013).

## **Municipality as Developer and Municipality as Developer & EPC**

For financial or other specific reasons, a municipality may contemplate taking on the role of developer, or roles of both developer and EPC for a solar project. This should be carefully examined, as developing a solar project, large or small, involves many complexities and nuances and should not be considered without a highly experienced team, which may include a specialized consultant and an experienced independent owner's engineer.

Most municipalities have an existing relationship with an engineering firm and may desire to use this firm for services, even if they do not have specific experience with solar power systems. In such a case, it is recommended a consulting engineer with specialization in solar PV design be added to the engineering team. While professional engineers (PEs) and licensed electrical contractors are well trained in the realm of AC power, solar is a DC power system and is subject to complex DC electrical codes as well as years of continuous development of ever-evolving industry best practices. Some engineers and many electricians do not have experience with DC systems. Even well established engineering firms who do not have personnel with specific experience in solar PV are likely to miss some important considerations in the design, installation and system testing procedures.

### **Municipality as Developer**

If after careful consideration a municipality decides to take on the role of project developer, there are several important elements to consider in coordinating a successful project. The following is an overview of some of these elements and is not fully inclusive of the many critical considerations that will be required. Consultation with applicable state and county agencies and other resources available to a municipality for guidance in developing a solar project is strongly recommended.

The most important element in developing a solar project is to build a strong team. This team may include finance or accounting and legal professionals with experience in renewable energy project development and experience with local municipal regulations and requirements in process, contracts and financing structures, among other skillsets. This team should also include a specialized solar PV consultant and an experienced independent owner's engineer who specializes in solar PV electrical design.

A solar consultant, independent engineer or specialized attorney will be familiar with resources available in the industry, and will most likely know where to find qualified personnel who may be interested in taking part on the team. References and experience are very important, as is availability and a sense of trust. A strong team will help identify and mitigate risks inherent in project development, and help navigate the nuances associated with solar development in particular.

Scope of services should be clear with all parties, and compensation may be structured as hourly, hourly with budget not to exceed, or at a fixed rate for services. Contracts should include all provisions typical in a professional services agreement. Samples of these contracts are available through the American Institute of Architects (AIA) website ([www.aia.org/contractdocs](http://www.aia.org/contractdocs)) or through other sources, and contract

terms should be developed, reviewed and modified as needed by the municipality's attorney, and also reviewed by the municipality's insurance provider. Professional liability insurance should be required of all third party professionals, consultants and engineers on the team, as well as general liability insurance, with the municipality as named insured on these policies. Minimum levels of insurance and other specific contract provisions may be required by regulation, or determined through advice from legal counsel and the municipality's insurance provider.

Once the team is in place, feasibility can be performed and completed. If the project is attractive, a rough (approximately 30%) project design is then created for the RFP. The solar consultant, legal and finance team members, and the owner's engineer all contribute in creating the bid documents. It is important to provide specificity in the RFP as discussed earlier, while leaving some room for creative bid responses from the EPCs. RFP provisions may want to include line-item cost requirements for engineering, major components, balance of system components, installation, commissioning, O&M and administrative categories, to make bid submissions more transparent. RFPs can be distributed through traditional channels, and posted strategically through solar industry organizations with help from the solar consultant. If the project is attractive and the RFP announcement is widely and strategically distributed, this should ensure there is a strong response from qualified EPC firms.

In selecting EPC candidates for design and construction of a solar project, industry experience is essential. An industry certification such as the North American Board of Certified Energy Practitioners (NABCEP) *Certified PV Installer* designation (not to be confused with the entry level NABCEP *Certificate of Knowledge*), indicates a strong demonstration of skills and knowledge. Industry certification should not be considered alone, as many other factors are equally if not more important, including significant experience with similar projects, years in the industry, strong references from previous clients, financial ability to perform the services requested, and the ability to deliver on workmanship and performance guarantees if problems occur.

### **Municipality as Developer and EPC**

If the solar project is owned and financed by the municipality, in addition to taking on the developer role, the municipality may contemplate dividing and assuming the EPC role of engineering design, procurement and construction management functions. As with the developer role, a strong and experienced team is essential to manage these complicated processes and complete a successful solar PV project.

As self-design build projects by a municipality would add risk to investors without any control over the development process or quality of assets or construction, it is less likely this type of project could be financeable by third party owner-investors, and projects may have to be self-financed. This would then not allow municipalities to realize any benefit from tax-based incentives, including the 30% investment tax credit and accelerated depreciation which, as mentioned previously, may offset up to 50% or more of total project costs.



The engineering design plans in this case would more closely reflect the specificity required in the traditional design-bid-build (DBB) model. The project would be fully designed and components and installation requirements fully specified by the municipality, and contractors would bid on the construction portion only.

Permitting, including environmental if required, structural or building permits, electrical permits, and other permits and approvals required by authorities having jurisdictions, would be the responsibility of the municipality. Utility interconnection application and approvals and infrastructure upgrades would also be the responsibility of the municipality, as would all applications and requirements for rebates and other incentives or grants.

Procurement of equipment may also be challenging. EPC contractors have developed relationships with vendors and may receive volume discounts from distributors, and with scale, may purchase major components directly from manufacturers. One-time purchases from a municipality for a small project will not likely result in any savings, and might potentially cost more than the equipment provided through an EPC provider, even with the EPC's added profit margin. Further, in taking over the procurement role, logistics and coordination with the contractor may become an issue. Equipment delivery delays with idle workers or early equipment arrivals with assets sitting longer than necessary would bring additional costs to the municipality and add complexity to construction timelines, which could potentially create contractual liabilities with the contractor.

Also to be considered is the extensive administrative time associated with utility interconnection applications and approvals, and applying for and managing requirements of rebates, grants and other incentives. This can be quite significant, and even burdensome.

The municipality would take all project risks, including construction, O&M and performance risks (other than workmanship). The municipality may also opt for a contract with a third party for planned maintenance services.

A municipality's core competency is managing and improving services and creating opportunities for residents and businesses within their community. Solar project development and EPC services are specialized and complicated, as is the entire energy industry. Most often, it is best to let those who focus solely on these practices complete these tasks and to allocate project risks with those who are best able to mitigate and remedy issues. Inherent risks and complexities in solar project development, as well as incentive structures, expose the municipality to unnecessary risk and may likely increase project cost. Therefore, it is generally not recommended for municipalities to develop, engineer, procure and construct their own turnkey solar projects, procuring each process separately and managing construction.

## Contract Risk

Contract risks are part of any project, and it is important to clearly understand these risks and allocate them to the parties closest to the process and most able to manage and remedy them. In general, mitigating risk is very important, but depending on project scale, can also be overly burdensome, adding cost and complexity that may make a project unattractive to third party developers and investors. It is important to balance the relative attractiveness of solar projects to all parties by keeping overall project costs low and minimizing complexity, against the added costs and complexities of risk mitigation. In general, the larger the project, the more acceptable the risk mitigation and associated complexity for the parties. This section will examine contract risks, including contract structure, liability, and production expectations, as well as warranty considerations.

### Contract Structure

The most important action a municipality can employ for contract risk mitigation is to have the right vendors involved in the solar project. From equipment manufacturers, to the EPC contractor, installer and O&M provider, having the right project partners is the best means to reduce contract risk. To accomplish this, the municipality should carefully interview and score vendors, and eliminate potential partners who bring added risk. As mentioned throughout this guide, having an experienced solar PV consultant or independent owner's engineer on your side is strongly recommended, as they can assist in the selection process and help to identify potential issues in advance.

General considerations for project vendors include years in business, financial strength, and internal quality processes such as safety plans, ISO certifications (9001 / 14001), and other indicators that show sensitivity to risk and commitment to quality services. Financial strength is very important, as service providers must be capable of delivering and supporting their products and services over a long period of time.<sup>36</sup>

The contract between the project owner (which may be the municipality or developer) and the EPC contractor is of primary importance for risk management. The EPC contractor should be provided with complete site access to fully understand site conditions, and then assume all risk and responsibility for permits, utility interconnection and other technical aspects of the project.<sup>37</sup>

In the construction phase, milestones allow the owner to measure EPC progress against clearly defined goals. Typical milestones include: application for, and obtaining of, required permits; executed construction and equipment supply contracts; utility interconnection application and approvals;

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<sup>36</sup> Dave Williams, "Large-Scale PV Operations and Maintenance," *SolarPro*, Issue 3.4, (June/July 2010): 4. [http://solarprofessional.com/articles/operations-maintenance/large-scale-pv-operations-and-maintenance?v=disable\\_pagination](http://solarprofessional.com/articles/operations-maintenance/large-scale-pv-operations-and-maintenance?v=disable_pagination).

<sup>37</sup> Williams, "Large-Scale PV Operations and Maintenance," 4-5. [http://solarprofessional.com/articles/operations-maintenance/large-scale-pv-operations-and-maintenance?v=disable\\_pagination](http://solarprofessional.com/articles/operations-maintenance/large-scale-pv-operations-and-maintenance?v=disable_pagination).

equipment delivery to site; start of construction; interconnection of the solar PV system to the utility; and start of operations date.<sup>38</sup>

In addition, the EPC contractor should provide a workmanship guarantee for a minimum of one year and typically a maximum of three years. In Massachusetts, the solar rebate program has required a 5-year guarantee for workmanship by contractors. In other regions, EPC contractors may be uncomfortable with workmanship guarantees longer than two years. Finally, for larger scale projects, EPC contractors should provide performance guarantees, such as energy (performance ratio) or capacity guarantees, with additional provisions for system availability.<sup>39</sup>

## Liability

In allocating liability, there is no precise formula above what has been discussed in previous sections, as many variables affect who owns which liability and to what level, including project scale, finance and ownership structure, the ability of the partners to take on liabilities, and other considerations specific to the project. Certain aspects of liability will also be discussed subsequently in the “Production Expectations” and “Warranty Considerations” sections of this document.

With this in mind, there are key considerations in allocating risk and liability in partner contracts, including:

- Who is the party closest to a given risk, and most capable of managing that risk?
- Is that party able to bear the risk?
- Will that party accept a given risk, and how are you certain they have accepted that risk?<sup>40</sup>

On larger scale projects, a consultant or owners’ engineer can help a municipality develop a comprehensive risk strategy, reviewing what can go wrong, the probability, and the consequences. Then based on this matrix, they help determine which liabilities should be addressed along with cost effectiveness.<sup>41</sup>

Workmanship issues usually appear early on in operations, and can be addressed through contractual obligations from the installer.

Inverters, despite great technology advances in the last several years, are still the weakest link in a PV system and when down, the system production loss may have significant financial impact. Proper

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<sup>38</sup> Frank Shaw, Counsel, Skadden, Arps, Slate, Meagher & Flom, LLP., presentation: “Contract Structuring, Documentation and Risk Sharing,” Advanced Renewable Energy Project Finance & Analysis, Infocast, (San Francisco, CA, June 6-7, 2011), p. 6.

<sup>39</sup> Williams, “Large-Scale PV Operations and Maintenance,” 4-5. [http://solarprofessional.com/articles/operations-maintenance/large-scale-pv-operations-and-maintenance?v=disable\\_pagination](http://solarprofessional.com/articles/operations-maintenance/large-scale-pv-operations-and-maintenance?v=disable_pagination).

<sup>40</sup> Shaw, presentation: “Contract Structuring, Documentation and Risk Sharing,” 35.

<sup>41</sup> Williams, “Large-Scale PV Operations and Maintenance,” 3-4. [http://solarprofessional.com/articles/operations-maintenance/large-scale-pv-operations-and-maintenance?v=disable\\_pagination](http://solarprofessional.com/articles/operations-maintenance/large-scale-pv-operations-and-maintenance?v=disable_pagination).

electrical design may help alleviate high temperature related shutdowns (due to lower voltages), as well as the longevity of the inverter. Siting the inverter is also important. If located indoors, it should be located in a well-ventilated area and spaced away from other equipment, per manufacturer guidelines. If outdoors, the inverter should be protected from weather, well-ventilated, and preferably located in a shaded area.

Production monitors, which are relatively inexpensive, may not perform properly and affect production revenues. A redundant meter is recommended, and in the event of production monitor malfunction, a clear procedure should be identified in advance to capture an estimate of the production that was not recorded.

With performance guarantees, which allocate liability (risk) to an EPC contractor, it is essential that liability be limited in order to have a successful performance guarantee provision. Typically, performance liability is limited to a percentage of the EPC contract, placing a reasonable limit of exposure on the EPC contractor. Generally, EPC firms accept wrapping of liability for project completion, workmanship and management of equipment warranties, but ensuring future performance from their perspective is venturing into unknown and unclear risks. To work as partners, and gain a satisfactory level of commitment from the EPC, it is important to place some limit on this liability.<sup>42</sup> As previously discussed in the *Guaranteed Production* section of this document, clear performance guarantee rules and evaluation criteria, such as capacity-based guarantees and separate reliability (or uptime) provisions, also help in obtaining long-term commitments from EPCs.

## **Production Expectations**

Solar energy production is a primary driver of project economics and the basis for many decisions that will be made. Production is estimated using sophisticated software tools such as PVsyst or SAM. During feasibility, many projects rely on PV Watts ([www.nrel.gov/rredc/pvwatts/](http://www.nrel.gov/rredc/pvwatts/)) for initial high-level production analysis, and the PVsyst or SAM models are more often used for detailed feasibility and production estimates during the design phase. The historical TMY data used is typically from a nearby airport or other weather station. Adjustments by the engineer may be required for local climate conditions. Within a few miles, there can be significant differences in weather and solar irradiance. Examples of where *micro-climate* adjustments might be needed include coastline to inland locations, or mountainous regions where elevations and weather may change quite significantly within a short distance.

As discussed in an article authored by Mat Taylor and David Williams, (“PV Performance Guarantees: Proof of Performance & Guarantee Structures,” *SolarPro*, August/September 2011), production software models use historic climate data sets measured over several decades. Two issues arise with this however: 1) the data is historical and does not forecast or predict future energy production; and, 2) the

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<sup>42</sup> Mat Taylor and David Williams, “PV Performance Guarantees: Proof of Performance & Guarantee Structures,” *SolarPro*, Issue 4.5, (August/September 2011): 118.

data is collected over a long period of time, and the longer the window of time of energy forecast, the more accurate the simulation will be. Conversely, the shorter the window of production estimate, for example a year, or one month, the less accurate the projections will be, with daily and hourly projections becoming very inaccurate. The authors conclude that any performance guarantee tying energy production to simulations using these models is difficult, and may even be counterproductive.<sup>43</sup>

On small PV systems, the costs of implementation will likely not justify frequent capacity-based performance verifications or weather adjusted energy performance ratio verifications, and EPC firms will most likely not accept these requirements. In this case, an inexpensive utility-grade energy production meter and redundant meter are all that is needed.

However, on larger solar PV projects, clear and thoughtful performance verification methods are very important, and the costs of implementing production verification procedures are well worth the expense and will likely be required by project investors. Additionally, the performance risk allocated to an EPC must be clear and enforceable, and an EPC that accepts this risk must feel comfortable with the underlying process.

## Warranty Considerations

Equipment warranties help to ensure the solar PV system will perform as expected over a long period of time. Solar PV modules often carry a 5-year warranty for manufacturer defects, and a 20 or 25-year warranty on performance. Inverter manufacturers usually provide a 5-year, or sometimes 10-year warranty, with options to upgrade the warranty to 10, 15 or 20 years on larger models. Typically, inverter warranty upgrades require documentation of maintenance, and many inverter companies offer service contracts on their large capacity inverters in addition to warranty upgrades.

### Solar Modules

Module failures or underperforming modules can significantly affect a project's long-term energy production and financial performance. However, identifying a single module's underperformance is often difficult and requires a more granular-level of monitoring along with added cost. All crystalline solar modules have normal performance degradation over time, often about 2-3% in the first year, and about 0.5% per year thereafter.

Module production warranties typically come in two versions, a *step warranty* and a *linear warranty*. The step warranty usually guarantees 90% output in 10



*Sharp 240 watt Modules on Rooftop System*

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<sup>43</sup> Taylor and Williams, "PV Performance Guarantees: Proof of Performance & Guarantee Structures," 114.

years, 80% output in 20 years. This type of warranty exposes the project owner to up to 10% risk on performance from the moment the project goes into operation through year 10.

Many manufacturers have moved away from the step model under competitive industry pressures, and now offer a linear performance guarantee, often at 25 years. Under this type of warranty, in year one the module is typically guaranteed to perform at 97% of nominal rated power, and the performance guarantee decreases by about 0.7% per year, to 80% in year 25.<sup>44</sup>

Another important consideration is the “staying power” of the manufacturer should a warranty claim be required. 25 years is a very long time. Some questions to consider:

- Is the manufacturer diversified, or are they in a strong financial position?
- Is the warranty backed with a reserve or insurance?
- What would be the process for making a warranty claim, and how long would this typically take?

## Inverters

Though not entirely technically accurate, the inverter may be thought of as the one moving part in an almost perfect static system. The inverter, a piece of highly sophisticated electronic equipment, may most likely be the cause of an unplanned system shutdown, whether from simply a fuse, or from a more complicated issue requiring significant repair. As all energy produced in a grid-tie system must travel through the inverter, its reliable operation is very important. Unfortunately, not much data is available on inverter performance reliability (% uptime) or frequency of failures, as well as service response times.



*Advanced Energy PVP 260kW  
Inverter*

Most warranty programs are comparable among manufacturers, with a standard term of five (5) years on large inverters, and ten (10) years on smaller inverters. On larger inverters, warranty upgrades and service plans are typically available. The primary issues to consider in warranty coverage are responsiveness of the manufacturer to your location, and cost/benefits of extending coverage.

If a solar PV system is down due to an inverter malfunction, every lost minute equals lost revenue or savings, and response time is a critical consideration. The best means of managing this risk is finding an inverter manufacturer who can respond quickly to issues, and for larger projects, one who can provide a system availability guarantee with clear definitions.<sup>45</sup>

Warranty extensions can be expensive, and the longer the warranty term, the more the cost increases. It should be considered whether there is value in upgrading terms later in the lifecycle, as the inverter at

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<sup>44</sup> Williams, “Large-Scale PV Operations and Maintenance,” 5.

<sup>45</sup> Williams, “Large-Scale PV Operations and Maintenance,” 5.

some point will need replacement. For example, the cost differential from a 15-year warranty to a 20-year warranty is substantial, and 20 years is typically the expected life of an inverter, at which time it will need to be replaced. On the other hand, a financing agreement may coincide with a 20-year term, and the peace of mind with extended warranty coverage may well be worth the expense. In any case, careful cost/benefit analysis should be considered in making warranty extension decisions.

O&M considerations for inverters are quite important. Inverter technology can be somewhat complex, and is constantly changing, and an EPC contractor performing O&M may be highly qualified or may be qualified, but not trained in the particular version of the equipment. As an alternative to EPC responsibility for this aspect of O&M, inverter manufacturer service plans are offered to perform this function with field technicians specifically trained in the technology.<sup>46</sup> There might be benefits to this type of service plan. If a warranty claim is required, having a manufacturer's service agreement allows no question or potential for debate on whether the proper maintenance procedures were followed.

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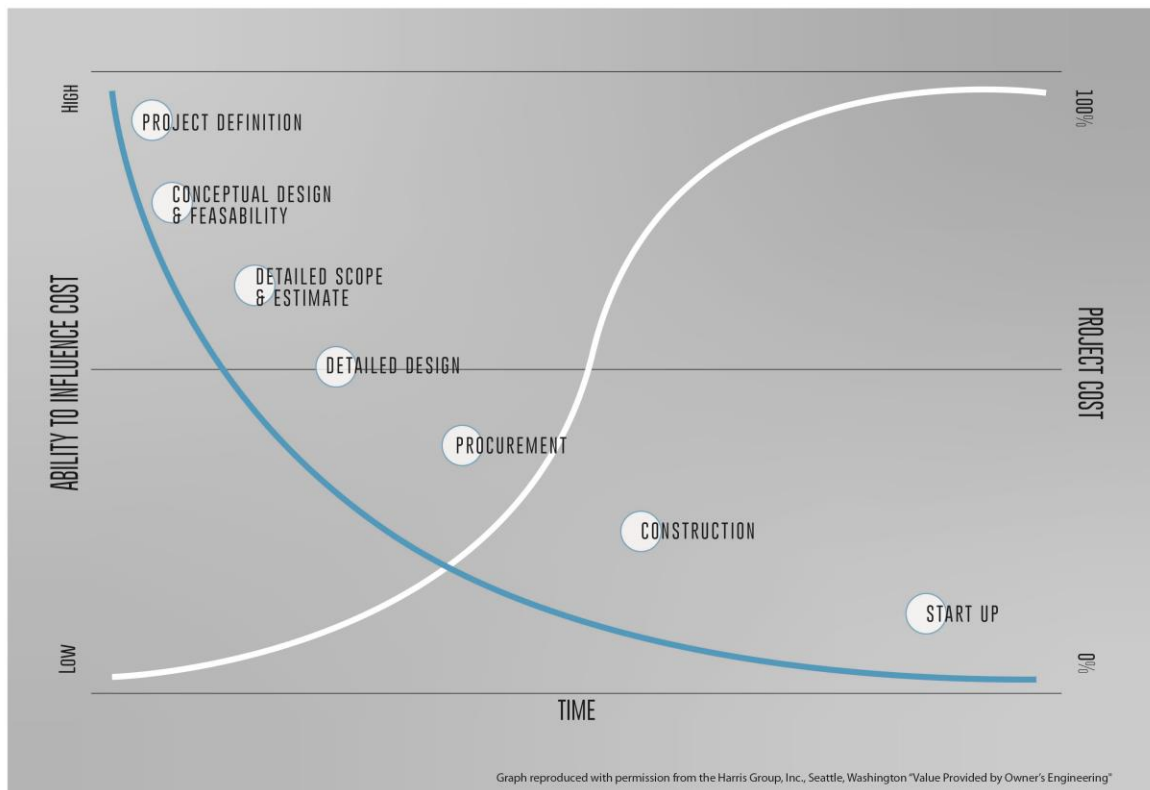
<sup>46</sup> Williams, "Large-Scale PV Operations and Maintenance," 5.

## SOLAR PV SYSTEM COMMISSIONING

The process of commissioning (Cx) solar PV systems has recently evolved into a comprehensive program, which typically includes full oversight and quality assurance of an entire project, from *Basis of Design* to *Functional Performance Testing* (FPT), and sometimes beyond (Retro-Cx and On-going Cx).

Commissioning is best directed by an independent owner's engineer, usually an experienced consultant who works for and represents the interests of the owner. The independent owner's engineer typically oversees the EPC's *commissioning agent* (CA) and plays an advisory role throughout the development of a project to assure a quality installation, and sometimes beyond, with ongoing commissioning services to ensure optimum long-term performance.

The cost for an independent owner's engineer to fully oversee and commission a PV project is typically only a small percent of the total project cost, depending of course on the specific application, scale and complexity of the installation. As illustrated in the graph below, it is much more economical to spend slightly more up front to have the project clearly defined and designed correctly, and to avoid the need for costly changes during procurement and construction.



Graph: reproduced with permission from the Harris Group Inc., Seattle, Washington<sup>47</sup>

<sup>47</sup> Harris Group Inc., "Value Provided by Owner's Engineering," 2.  
<http://epoverviews.com/oca/Owner's%20Engineering.pdf> (accessed September 2013).



## SOLAR PV OPERATIONS AND MAINTENANCE (O&M)

Despite some assertions that solar PV systems are essentially maintenance-free, this is not true, and they absolutely do require scheduled (and sometimes unscheduled) maintenance. The on-going operation, monitoring and maintenance of a solar PV generating system throughout its 20-30 year lifespan is critical to keeping the system running and achieving optimal performance.

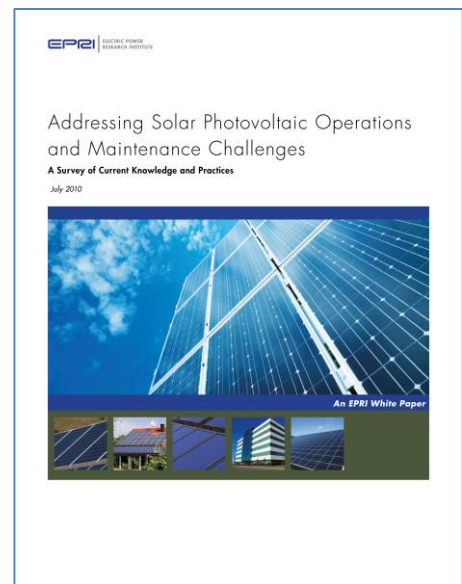
The O & M requirements and plan need to be at least roughly defined during the feasibility phase of the project, so they can be adequately budgeted and included in the energy production and financial models. Production models typically assume a system availability of at least 99% (of daylight hours), which equals about two days of total downtime during the year. This includes scheduled maintenance. Meeting uptime requirements can be difficult unless the system is properly designed and carefully operated, monitored and maintained.

Solar PV operating procedures and maintenance best practices are still evolving, and new tools are becoming available for improving the quality of maintenance inspections and testing. Monitoring systems continue to improve, providing detailed data on a system's operation and performance, with some systems even providing data at the individual module level.

As outlined in an Electric Power Research Institute (EPRI) report "Addressing Solar Photovoltaic Operations and Maintenance Challenges" *July 2010*, there are three major approaches to reduce costs, improve availability and increase productivity:

- Preventative maintenance (PM)
- Corrective or reactive maintenance
- Condition-based maintenance (CBM)

Depending on who is responsible for system maintenance, the value of productivity, accessibility to the site and many other factors, any one or even a combination of these approaches may be appropriate. Every system must be evaluated and cost-benefit trade-offs for the different approaches analyzed to determine how best to proceed.<sup>48</sup>



In 2010, EPRI gathered anecdotal data for direct O&M costs for both in-house and outsourced approaches from several installers of systems of 1 MW and less. They ranged from \$6/kW - \$27/kW of rated capacity, and from <1% to 5% of the "All In" cost of the complete project.<sup>49</sup>

<sup>48</sup> Nadav Enbar and Tom Key, "Addressing Solar Photovoltaic Operations and Maintenance Challenges, A Survey of Current Knowledge and Practices," Electric Power Research Institute (EPRI), (July 2010): 4-5.

<sup>49</sup> Enbar and Key, "Addressing Solar Photovoltaic Operations and Maintenance Challenges, A Survey of Current Knowledge and Practices," 8.

Scheduled comprehensive maintenance visits are usually required at least annually, sometimes semi-annually, or even quarterly – particularly at sites that often need modules cleaned, weeds pulled, or other frequent maintenance, to prevent shading and lost solar production. Inverters, despite being solid-state devices, have cooling systems with fans and filters that need periodic cleaning and occasional replacement. Close monitoring of the AC output vs. DC input of an inverter helps determine if there may be a problem. Inverter manufacturers typically offer a range of extended warranties on larger capacity models, which need to be assessed for cost and benefit.

More recently, new maintenance test procedures have been instituted due to the availability and advancement of testing equipment, including thermographic imaging of modules and individual string tests, including insulation resistance. Both of these tests can quickly point out faults and trouble spots in a PV array. String testing data can also be compared from year-to-year to give an indication of the average degradation of module power to determine if the modules are still producing within their warrantied power range.

Warranties for both workmanship and products are an essential and integral component to the O&M program. Workmanship warranties must clearly define what constitutes a required repair or replacement, whether it is critical or non-critical, who is responsible for equipment replacement, labor and shipping costs, and response timeliness.

Warranty coverage for modules and inverters usually specify very clear terms and conditions for proper installation, operation and maintenance. These instructions must be carefully followed for the warranty to remain in effect. The detailed requirements of all equipment warranties must be understood and followed during installation and final commissioning, to assure full coverage is maintained.

## RESOURCES

### SOLAR CALCULATORS / PROJECT ANALYSIS TOOLS:

**PV Watts Calculator** from the National Renewable Energy Laboratory (NREL):

<http://www.nrel.gov/rredc/pvwatts/>

“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.”

**Solar Energy Calculator**, Solar Energy International (SEI) and Cooler Planet

<http://www.solarenergy.org/solar-calculator>

Use this solar energy calculator to estimate the cost and size of a solar array in your area. “This calculator also gives rough estimates on how much carbon your current electricity usage contributes to greenhouse gas emissions.”

**RETScreen4** is a global clean energy project analysis tool provided by RETScreen International, Natural Resources, Canada.

<http://www.etscreen.net/ang/home.php>

“RETScreen 4 is an Excel-based clean energy project analysis software tool that helps decision makers quickly and inexpensively determine the technical and financial viability of potential renewable energy, energy efficiency and cogeneration projects.”

**System Advisor Model (SAM)** from the National Renewable Energy Laboratory (NREL):

<https://sam.nrel.gov/>

“SAM makes performance predictions and cost-of-energy estimates for grid-connected power projects based on installation and operating costs and system design parameters you specify as inputs to the model. Projects can be either on the customer side of the utility meter, buying and selling electricity at retail rates, or on the utility side of the meter, selling electricity at a price negotiated through a power purchase agreement (PPA).”

### OTHER RESOURCES:

#### **National Association of State Energy Officials (NASEO)**

Data on Key State Energy Activities: <http://www.naseo.org/state-energy-data>

State Energy Plans: <http://www.naseo.org/stateenergyplans>

State Energy Financing Programs <http://www.naseo.org/state-energy-financing-programs>

Interactive State Energy Data Map <http://www.naseo.org/map>

State and Territory Energy Offices <http://www.naseo.org/members-states>

## SunShot Initiative

U.S. Department of Energy (DOE), Energy Efficiency and Renewable Energy (EERE)

**Information Resources, Solar Energy Resource Center:** “articles, case studies, fact sheets, how-to guides, model rules and ordinances, presentations, sample government documents, technical reports, tools, and webinars.” <http://www1.eere.energy.gov/solar/sunshot/resources.html>

### **Power Purchase Agreement Checklist for State and Local Governments**

“This fact sheet addresses the financial, logistical, and legal questions relevant to implementing PPAs for PV installations.”

[http://www4.eere.energy.gov/solar/sunshot/resource\\_center/resources/power\\_purchase\\_agreement\\_checklist\\_state\\_and\\_local\\_governments](http://www4.eere.energy.gov/solar/sunshot/resource_center/resources/power_purchase_agreement_checklist_state_and_local_governments)

### **Request for Qualifications for Sacramento Landfill**

“This Request for Qualifications (RFQ) solicits experienced companies to design, permit, finance, build, and operate a solar photovoltaic farm (SPV Farm) on the City of Sacramento’s 28th Street Landfill. Respondents to this RFQ must demonstrate experience and capacity to design, permit, finance, build, and operate a SPV Farm that generates electricity that can be sold for electrical use through a power-purchase agreement. Submittals must be prepared and delivered in accordance with the requirements set forth in this document.”

[http://www4.eere.energy.gov/solar/sunshot/resource\\_center/resources/request\\_qualifications\\_sacramento\\_landfill](http://www4.eere.energy.gov/solar/sunshot/resource_center/resources/request_qualifications_sacramento_landfill)

### **Revised RFP Appendix E Knoxville Transit Station Array, March 2009**

“This request for proposal includes technical and general bid requirements.”

[http://www4.eere.energy.gov/solar/sunshot/resource\\_center/resources/revised\\_rfp\\_appendix\\_e\\_knoxville\\_transit\\_station\\_array](http://www4.eere.energy.gov/solar/sunshot/resource_center/resources/revised_rfp_appendix_e_knoxville_transit_station_array)

### **Tucson Request for Proposal for 1-5 MW PV PPA**

“The mission of Tucson Water, a Department of the City of Tucson (the City), is to ensure that its customers receive high quality water and excellent service in a cost efficient, safe and environmentally responsible manner. In the interest of furthering Tucson Waters mission, the City is seeking a Contractor to finance, design, build, commission, own, operate and maintain up to a 1 megawatt (MW) DCSTC photovoltaic (PV) system. The City also seeks an option for expanding the PV system up to a total of 5 MW DCSTC PV.”

[http://www4.eere.energy.gov/solar/sunshot/resource\\_center/resources/tucson\\_request\\_proposal\\_1\\_5\\_mw\\_pv\\_ppa](http://www4.eere.energy.gov/solar/sunshot/resource_center/resources/tucson_request_proposal_1_5_mw_pv_ppa)

## **U.S. General Services Administration**

“The Building Commissioning Guide.” United States General Services Administration (GSA), Public Buildings Service, Office of the Chief Architect. April 2005.

<http://www.wbdg.org/ccb/GSAMAN/buildingcommissioningguide.pdf>

### **Database of State Incentives for Renewables and Efficiency**

North Carolina State University, under NREL Subcontract No. XEU-0-99515-01.

“DSIRE is the most comprehensive source of information on incentives and policies that support renewables and energy efficiency in the United States. Established in 1995, DSIRE is currently operated by the N.C. Solar Center at N.C. State University, with support from the Interstate Renewable Energy Council, Inc. DSIRE is funded by the U.S. Department of Energy.”

<http://www.dsireusa.org/>

### **National Renewable Energy Laboratory (NREL)**

**NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.**

“At the National Renewable Energy Laboratory (NREL), we focus on creative answers to today's energy challenges. From fundamental science and energy analysis to validating new products for the commercial market, NREL researchers are dedicated to transforming the way the world uses energy.”

<http://www.nrel.gov/>

### **Solar Energy Industries Association (SEIA)**

Established in 1974, the Solar Energy Industries Association (SEIA) is the national trade association of the U.S. solar energy industry. Through advocacy and education, SEIA is building a strong solar industry to power America.

<http://www.seia.org/>

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