Solar Energy Systems for Small Commercial Businesses

Guide to Assessing, Investigating, and Contracting

Prepared for:
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Adapted from *Renewable Energy and Schools: A step-by-step guide for evaluating, acquiring, installing, promoting and using renewable energy systems in K-12 schools*; Minnesota Renewable Energy Society (L. Cina, B. Ross, R. Lundberg, J. Dontje, C. Tarr); published by Minnesota Department of Commerce, Minnesota Pollution Control Agency. Edited by Brian Ross, CR Planning, Inc.

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Small commercial businesses in Minnesota frequently have both interest in and opportunity to invest in solar energy. But most small businesses are unfamiliar with the specific opportunities and risks associated with making a solar energy investment. This document describes the basic process for businesses to assess opportunities and barriers to making solar energy investments and how to move forward with installing a solar energy system. The document outlines the following steps:

Step 1. Understand your options

Step 2. Assess of your solar resource

Step 3. Assess your building

Step 4. Bidding and installing your solar energy system

Solar Energy Systems Guide for Small Business

This guide to assessing, investigating, and contracting for solar energy systems for small commercial businesses is adapted from *Renewable Energy and Schools: A step-by-step guide for evaluating, acquiring, installing, promoting, and using renewable energy systems in K-12 schools.* The original document is published by the State of Minnesota Department of Commerce, Division of Energy Resources.

This guide frames the issues that small businesses should consider prior to making a solar energy investment. However, this guide does not address all possible issues, and many businesses will encounter situations that are not covered. Moreover, the solar energy market is rapidly changing. Costs, technologies, and financial arrangement will continue to evolve and create new opportunities for businesses to consider.

Step 1: Understand your options

Two elements of installing a solar energy system are particularly important for businesses to understand:

1) the various solar technologies and the associated benefits, and;
2) financial issues and options associated with a long-lived "infrastructural" investment such as solar energy that differs from other types of investments that businesses routinely make.

Technology

Solar energy systems come in two general types; solar photovoltaic and solar thermal. Solar photovoltaic produces electricity, solar thermal produces heat in the form of either hot water or hot air. Choosing the type of solar energy production that makes the most sense depends first on the way the business uses energy, and to some extent on characteristics of the solar resource at the business's location.

Moreover, within each general type of solar technology (electric and thermal), businesses will have technology choices to consider. Understanding that these choices and options exist will help the business when conducting assessments and evaluating vendors.

A. Electric technologies

A solar electric system captures the sun's energy with photovoltaic panels. Electricity is produced in the form of direct electrical current (DC). Since most electrical appliances use alternating electrical current (AC), typical solar electric systems include an inverter to convert DC power to AC power. DC electric power can stored in batteries, but batteries are expensive, require maintenance, and the storage process uses energy, leaving less production for business operations. Since businesses will also be connected to utility power, this guide focuses on "grid-tied" systems. Grid-tied solar energy systems feed power onto the utility grid when the system produces more power than the facility needs, and draws power from the grid when the solar electric system cannot meet the business's full demand.

The grid-tied approach makes solar electric systems very scalable. If financial resources are limited, or if the business wants a demonstration system, a small system can be connected even to a large building. But if resources and space allow, larger systems can be built. Systems can even be large enough to produce sufficient power that the facility becomes a net exporter of energy (although this can create additional concerns and design issues).

Solar electric systems are commonly placed on building roofs because that space is not usually used for other purposes and because there are usually fewer problems with shading. But solar electric systems can also be ground mounted on frames or poles. In some cases, photovoltaic panels can be integrated into the architectural features of a building like the roof, walls or awnings.

B. *Thermal technologies*

Solar thermal systems are very efficient at converting solar energy into low temperature thermal energy. They use glass panels or tubes that capture the sun's heat in much the same way your car windows capture the sun's energy even on winter days. That heat can be carried away from the panels by water, antifreeze or by air.

Unfortunately, businesses may find it difficult to effectively use low-temperature thermal energy. Businesses rarely have systems that distribute heat energy outside of the building that has the solar installation, so a grid-tied arrangement like those for solar electric systems is not normally possible. Solar thermal energy production is a "use it or lose it" situation. While panels that produce hot water can store some of the heat in water tanks, there are practical limits on the size of storage. Solar air heat faces the same issues; businesses have few cost efficient ways to store the heat from the panels for when heat loads are higher. However, thermal solar energy systems can (for economic or physical space reasons) be sized to meet only a portion of the building load and thus make good use of the solar thermal energy.

In some cases, solar thermal water heating systems can provide space heating, but the design must be done carefully. Solar thermal systems produce low temperature heat, but many heating systems are designed to use higher water temperatures; solar thermal energy will not help if the output temperatures are lower than the temperatures in the heating system. Solar thermal systems frequently "pre-heat" water or air before it is used by the building's traditional HVAC or hot water system.

Financial options

Solar energy systems are different in several regards from most other purchases that small businesses will make. Perhaps most prominently, two economic aspects should be considered:

1) *Solar as infrastructure.* Solar energy systems are both expensive and very long-lived, or infrastructural, purchases. Purchasing a system is more similar to purchasing a building or major production equipment than to an energy efficiency investment.
2) *Solar as price hedge.* Solar energy systems provide both cost-reduction (lowering of energy bills) and price hedging benefits. Hedging against the price volatility and price increases associated with traditional energy sources has a value separate from the energy bill reductions. These benefits are typically considered in different ways when vendors bid on a solar project.

Incentives and Finance Information

www.energy.mn.gov
Division of Energy Resources for the State of MN

www.dsireusa.org
U.S. Department of Energy's Database of State Incentives for Renewable Energy (DSIRE)

www.cleanenergyresourceteams.org
Clean Energy Resource Teams (CERTs)

www.nextstep.state.mn.us
Minnesota Sustainable Communities Network

www.rurdev.usda.gov/energy.html
Rural Energy for America Program: Renewable Energy Development Assistant (REAP)

www.NREL.gov
National Renewable Energy Lab – U.S. government renewable energy and energy efficiency laboratory

www.oneglobesolar.com
How Solar Financing Works: Financing Large-Scale Solar Projects. One Globe Solar, April 1, 2010.

The financial options for purchasing a solar energy system need to address both of these aspects. Solar energy vendors will offer a variety of tools to help businesses assess economic benefits and to match businesses' financial circumstances. Businesses will need to independently evaluate these options to ensure they are receiving maximum benefit from the solar energy system based on the businesses' own risk profiles, capital planning priorities, and energy consumption characteristics.

A. Financing Infrastructure

The major components of solar energy systems will last between 20 and 40 years without significant change or degradation in performance. Fully capturing the economic benefit of a solar energy system must take this longevity into account, which generally exceeds the planning horizon for most small businesses. A number of financial incentives to encourage solar investment may be available to businesses, including tax credits, accelerated depreciation, and utility rebates. The solar industry has created a variety of financing options that work in conjunction with financial incentives and help front-load benefits and minimize risk to the business. However, different financial options also pose different kinds of risk for the business or may lower some of the long term economic benefits.

Some of the financing options used by solar energy vendors or financers are describe briefly below. The descriptions identify general categories of financial options, all of which are evolving as the solar industry matures.

Traditional loan – Businesses can self-finance solar energy systems using capital resources already at their disposal. Traditional loans are managed entirely by the business rather than the solar energy vendor, and require the business to explain the benefits and risks of a solar installation to the institution providing the loan. The business will get the full benefit of tax credits, rebates, and depreciation.

Solar lease – Solar contractors or third party financers can arrange for a lease, where a third party owns the solar energy system and leases the system to the business. Leases allow the system to be installed with little or no down payment, and can incorporate accelerated depreciation and incentives such as the Federal tax credit to lower monthly payments. Capital leases are designed to fully amortize the costs of a solar system during the lease term. Operating leases are designed more like auto leases, for a fixed length of time and an option to purchase the system at fair market value at the end of the lease. Leases should include a performance clause to ensure that the system produces energy at or near the rated efficiency of the system.

Purchased Power Agreement (PPA) - PPAs are conceptually similar to a lease, but rather than monthly lease payments, the business pays based on the production of the solar system. PPAs typically have longer terms that reflect the system life and can incorporate a fair market buyout. Tax benefits and other applicable incentives flow to the finance company and are passed on to the business through the energy charges. Operation and maintenance is the responsibility of the finance company/owner. The legal status of PPAs in Minnesota is currently somewhat uncertain, although several installations currently utilize them. Businesses should consult with legal counsel if considering a PPA.

Purchase Power Agreements

A Solar Power Purchase Agreement (SPPA) is a financial arrangement in which a third-party developer owns, operates, and maintains the photovoltaic (PV) system, and a host customer agrees to site the system on its roof or elsewhere on its property and purchases the system's electric output from the solar services provider for a predetermined period. This financial arrangement allows the host customer to receive stable, and sometimes lower cost electricity, while the solar services provider or another party acquires valuable financial benefits such as tax credits and income generated from the sale of electricity to the host customer.

Source: EPA Green Power Partnership, www.epa.gov/greenpower/buygp/solarpower.htm

B. Solar as Price Hedge

In evaluating the financial benefit of solar installations, businesses should consider two distinct economic benefits: 1) energy bill savings and; 2) the "hedge value" of solar energy. Energy bill savings come from reducing the amount of kWh, therms of gas, and KW demand on the business's utility bills from using the solar energy system. The hedge value of solar takes two forms. First, as solar energy is free, the business is less exposed to price volatility of commodity fuels such as natural gas, and thus has a more stable energy bill. Second, the cost of solar energy from an installed system is fixed – it does not increase over time like costs of utility energy. Both of these hedging benefits should be considered in the context of the business's risk profile and expectations of utility cost increases.

In evaluating the economic benefit of the system over time, businesses should use an appropriate assumed rate of growth in utility energy costs. Average commercial electric rates in Minnesota (averaging across energy and demand), for instance, have increased at approximately 2% per year over the last 20 years (nominal rates). Over the last seven years the rate of increase has been higher, increasing at an annual average rate of over 4%.

A 10-KW solar installation designed for a ballasted flat roof, with a solar thermal system in the far corner (Minneapolis Fire Station 19)

Step 2: Assess your solar resource

A solar resource assessment, sometime called a shading assessment, is essential to understanding the viability of solar on your building. The building owner and the system designer can make good choices early in the project and ensure the system will perform as expected.

Do you have a meaningful solar resource?

One of the great aspects about solar energy is that it is everywhere. Except when it isn't. While the sun shines every day, not every building has a solar resource that can be captured. Nature delivers "free fuel" every day, but sometimes the free fuel is just a trickle, and sometimes the fuel is very hard to reach. Businesses need to assess how much of a solar energy resource their building has and where the resource is located on the building site.

What is in a site assessment?

A proper site assessment will look at the available resources and how the equipment necessary to collect that resource will "fit" with your facility. A site assessment will look for features that will support the project or for features that might suggest that a particular system is unsuitable. In the case of roof-top solar installations, professional structural engineers and/or roofers may need to be consulted.

Measuring and mapping the solar resource

Businesses should plan for a solar assessment that will not only identify whether the rooftop solar resource is adequate, but also considers the layout of the system on the roof and future or long-term potential changes to the resource.

A. *The "size" of your solar energy resource*

To produce a meaningful amount of energy, the solar resource needs to be routinely available (unshaded) over time when the sun is highest in the sky. Occasional shading can substantially lower the resource potential on your site. For example, a sunny location at noon might be shaded an hour later or a sunny location in September might be shaded in June, significantly lowering the resource potential. Even small amounts of shading such as from a flagpole can have surprising consequences on solar production. A shading assessment should identify how much shading will affect the system at specific points on the roof at any point in the year. This assessment sets a baseline for how much energy can be produced by a solar energy system.

B. *Adjacent buildings and land uses*

Since the solar fuel is "delivered" by the environment, features adjacent to your building, frequently not even part of your property, can affect the amount of resource on your site. Moreover, building owners need to consider future land uses and vegetation growth on adjacent property. The solar installation is a 20-40 year system, a time period long enough that buildings can change and trees can grow. The solar assessment should identify the risks of future impairment of the solar resource.

40-KW commercial PV installation on energy efficient white membrane roof, designed to fit around roof equipment to minimize shading (Western District Police Station, Saint Paul)

C. *System layout*

For a commercial-sized system, the solar assessment may also need to identify optimal layout of the solar installation on the roof. Solar systems are comprised of a number of separate arrays that can (to some extent) be strategically located on the roof. Moreover, the individual arrays must be located in a manner such that one array does not shade the array behind it.

D. *Energy analysis*

Part of the resource assessment is to evaluate the business's historic energy usage and billing patterns, and to consider the projected usage after the solar installation is complete. There are several reasons why historic and project energy use is critical to a resource assessment:

1) Cost savings realized by the business will greatly vary depending on energy use and billing patterns. In particular, the business needs to understand the potential effect of the solar installation on the demand portion of the electric bill. Management of the business's electric demand during times of solar production can add tremendous value to the solar system.
2) Sizing the system may require detailed knowledge of energy usage, particularly for solar thermal systems. The installer must match the output of the solar thermal system to the business's need for low-temperature (100 – 160 degrees F) thermal energy.
3) Maximizing energy efficiency opportunities can increase the value of the solar system and even provide for an improved financial package by leveraging efficiency savings to improve the project's cash flow.

Who conducts a solar resource assessment?

Businesses can choose to use a solar energy vendor to complete a solar assessment, or an independent site assessor. The ideal situation is to use an independent site assessor trained in your selected technology to recommend the best course of action without biasing your decision to a particular product or installer. The larger and more complex the installation, the more important for the business to hire a third party professional to conduct the assessment and perhaps to put together a bidding specification based on the assessment results. Using a third party assessor will help ensure a reasonable estimate of annual production from PV systems; be careful if the vendor estimate of annual production is much higher than the third party estimate.

The ***Minnesota Renewable Energy Society***, a non-profit institution dedicated to promoting the use of solar and wind power, offers third-party site assessments for commercial or residential buildings on a fee-for-service basis (visit www.mnrenewables.org/site_assessments).

The ***Midwest Renewable Energy Association*** (MREA) trains and certifies third-party site assessors for both wind and solar (see sidebar). MREA has a list of certified assessors on their website at www.midwestrenew.org/siteassessors.

Several institutions train site assessors in Minnesota, including Century College, Dunwoody Institute, St. Paul College, and other institutions. These institutions may be able to help identify third party assessors.

Certified Site Assessors

A MREA-certified Site Assessor will provide you with the information needed to make decisions about renewable energy systems. Site assessors evaluate the proposed site, answer questions, and summarize the site specific information in a written report that will include the following details:

- A review of your goals for having a renewable energy system
- A basic analysis of your energy needs and usage
- An evaluation of the solar or wind resources at your site
- Recommendations for a renewable energy system size and siting to meet your energy goals
- Estimate of shading and snow cover
- Estimate of a solar electric, solar hot water, or a wind system's power production
- A rough cost estimate for the system
- An overview of the incentives for which the system is eligible
- Preliminary economic analysis of the system
- The next steps you need to take to make your system a reality

Source: Midwest Renewable Energy Association
www.midwestrenew.org/siteassessors

Step 3: Assess your building

Most existing buildings were not designed with solar energy systems in mind. While manufacturers of solar equipment are very good at creating systems that account for building idiosyncrasies, businesses should assess the building for potential budget-busting surprises. After determining that the building has a solar resource, businesses must assess several building components for compatibility with a solar energy system:

- Roof type and condition
- Roof structure
- Mechanical and energy systems

Besides providing access to the site, the building owner will need to provide background information, like building design and engineering information and electric or gas utility consumption data to the site assessor.

Roof type and condition

To identify system mounting methods the assessor must identify roof type and condition.

A. Roof type

The assessment should identify the appropriate system(s) for the type of roof on the building. Solar electric and thermal systems need to be affixed to the building via bolts, threaded rod, or similar fastener to account for uplift in 90 mph winds. The following are three common mounting methods for roof top solar systems:

- Curbs - Common mounting method where system is anchored to blocks or beams attached to roof; roof penetrations required.
- Pedestals - Threaded rods/bolts secure the system to the roof through base plates, allowing for more effective sealing.
- Ballasted Racks - Use added weight to anchor panels to roof. The lack of roof penetrations lessens chances of leaks. Drawbacks to be considered include production impediment from snow build-up and the excess dead weight.

B. Roof condition

Other roof-related issues to consider are the age and condition of the roof. Installing a system on an aged roof or a roof in poor condition can be problematic. If the roof is near the end of its life, replace the roof before moving forward with the solar project. Roof replacement could be incorporated into the scope of the solar installation project, but obviously will considerably increase the project cost.

Businesses should also be aware that roof guarantees can be affected by the installation of a solar energy system. Most racking systems are designed not to affect the integrity or longevity of the roof, but the guarantee is frequently managed by a contractor or manufacturer other than the building owner. These companies want to avoid any increase in risk of roof warrantee repairs and realize no benefit from the solar installation. Part of the project may need to be working with the roof contractor or manufacturer to protect the roof warrantee.

Suitability of Roofs for a Solar Installation

- *Concrete pre-cast* – Generally good for solar installs. Need to know the core pattern. The weight of the concrete reduces the uplift concern.
- *Concrete on steel deck* – Typically relatively easy for a solar install. Pedestals can be anchored to the concrete. The weight of the concrete reduces the uplift concern.
- *Steel deck on bar joist* – The most common commercial roof type, has some issues due to limited possible attachment points on the roof. Many factors come into play; E-W or N-S orientation, span, etc.
- *Rubber or other flexible membrane* – This roof system is often a relatively easy installation. Pedestals can be flashed with a standard pipe/plumbing vent jack. These flashings will need to be specific to the particular material for the roofing membrane.
- *Pitch and tar built up* – These types of roofs can be very cumbersome for a solar installation. The costs of the penetrations and the flashings could be preclusive to the budget. If the building has this type of roof, cost for penetrations should be carefully reviewed before starting a project—this is a case where a ballasted rack mounting system might be the best choice if roof load capacity can support the weight.

Roof structure

Commercial roof-mounted solar installations will almost certainly require structural assessments (commercial-scale solar energy systems must have a structural review in order to get a building permit). Few commercial buildings were designed with rooftop solar installations in mind, including newer buildings. Older buildings may no longer meet building code minimums even without a solar installation. Equipment weight (referred to as dead load), "wind loading"(upward and downward forces caused by wind), snow and drift loading, and internal loads on the roof all need to be assessed to determine the building is structurally sound enough accommodate a solar installation. Assessing these requires hiring a professional structural engineer.

Engaging a structural engineer early in the process reduces the risk of a stalled project due to

Roof space allowed for up to a 200-KW PV installation, but structural capacity limited the size of the installation to 40-KW on the Currie Maintenance Facility in Minneapolis

unforeseen engineering issues. For small, uncomplicated projects, professional structural engineering services can wait for the design and permitting stages if all parties (engineering/maintenance staff and the site assessor) believe the roof is in good condition.

Engaging a structural engineer during the assessment phase is rarely a bad idea -- if the roof cannot handle the project, a different approach may be necessary such as a ground-mount solar project. Building structural issues can be a game changing factor for a project and getting the information earlier can save time and money. Moreover, commercial-sized building-mounted solar projects will require a structural review in order to secure the needed permits from the city. Engaging a structural engineer during the assessment process can therefore reduce installation costs.

The structural engineer should have prior experience with solar projects. Until the solar energy market matures, you cannot assume that a structural engineer has experience with the best practices of installing rooftop solar energy systems. A qualified site assessor will be able to refer you to a qualified structural firm.

Mechanical/electrical systems

Solar energy systems need to be integrated with the building's existing energy systems. Not all existing energy equipment is designed to supplement or be supplemented by on-site generation of electricity or heat.

A. Electrical system

Any solar electric project will require evaluation of the capacity and condition of the building's electric system. The building's electric system must have adequate capacity to safely carry the additional electrical energy delivered by the renewable energy installation. If the building documentation is up-to-date and readily available, it may be sufficient to provide that information to the building assessor. In other cases, an electrical engineer may need to be called upon early in the project to determine feasibility.

B. Thermal system

Solar thermal systems must be integrated with the building's heating or hot water system. If a solar thermal system is to be installed, the assessment should identify the following building information:

- Accurate assessment of building hot water usage
- The incoming (input) water temperature
- Availability of space for storage tank in or adjacent to the existing water heating system
- Age and efficiency of current water heating equipment. It is not recommended to incorporate solar into a dilapidated heating system
- Temperature of current water heating storage and distribution. Is an anti-scald or thermostatic mixing valve present?
- Location of the recirculation system tie-in
- Is there a back-flow preventer on the incoming water service or to the water heaters?

Who conducts a building assessment?

Assessment of building systems generally needs to be completed by technical experts (engineers or licensed electricians and plumbers) familiar with solar energy installations. Site assessors sometimes have some of these qualifications and can conduct both a site assessment and, for instance, an assessment of the building's electric system. Even if the site assessor cannot provide these services, they will generally be able to recommend qualified professional. In particular, businesses should be prepared to independently hire a structural engineer to evaluate the building and identify structural improvement that may be necessary for certain types of solar installations.

Wrapping the assessment into the installation bid

If your project team chooses to have a installer do both the site assessment and the installation, make sure:

- that having the assessment done does not commit you to the project;
- you are prepared to pay for the assessment even if you do not proceed with the project;
- the assessment price is clearly delineated;
- that you "own" the assessment report and can use it with another installer if you choose not to proceed with the installer doing the assessment.

Step 4: Bidding, Contracting, Installing

Bidding is almost always the best way to ensure a qualified installer and a fair price. A bidding process works best when there are multiple firms with the capacity and experience to do the job. The Minneapolis Saint Paul area has a number of qualified and experienced solar installation contractors. Some solar energy businesses, however, market specific types of systems or offer relatively unique financing packages. Businesses will need to consider some very different types of proposals. Therefore, the best situation is to create a bidding specification that contains minimum standards that all contractors must meet.

System design must integrate the solar installation into the building's mechanical systems

Creating a bidding specification

For most commercial projects, a detailed bidding document should be created by a third party. An architect, engineer, or construction manager with knowledge of solar installations can develop construction documents and manage the project from bidding to installation and commissioning.

With the construction documents complete, the business will need to encourage qualified firms to submit bids. The design consultant typically handles the bidding process, fielding questions and issuing addenda as needed for clarification. In retrofit projects, a mandatory pre-bid walk through by all bidders is highly encouraged. The consultants will need to closely monitor any deviations from the bid specifications suggested by bidders.

The contractor qualification requirements need to be well defined. The renewable energy industry is relatively immature and many contractors are attempting to break into the renewable energy field. Your design consultants may need to be paid to guide the work. Any risk associated with learning should be borne by the contractor.

A sample set of contents used for three commercial solar installations, from 8 KW to 40 KW in size, is provided in the side bar.

Contracting and Installation

The contracting process includes several steps:

- Contractor screening
- Bid review and award
- Permits and regulatory approvals
- Payments
- Installation
- Commissioning

A. Contractor screening

For small projects, the contractor screening will begin once consultants have been engaged and/or system financing is established. On smaller projects the contractor and the customer, in this case the business, can work together to develop the scope of work.

For projects that go to bidding, the contracting process begins once the bids are received. The apparent low bidder (or most responsive bidder) will need to be qualified as meeting the intent of the bid documents. The qualification includes technical as well as administrative matters (i.e. insurance, affirmative action, etc). The lowest responsible bidder will then be awarded a contract.

While not all projects will go through a bidding process, both small and large projects will need to engage in a contractor screening process.

Steps for selecting a solar installer

1) **Call references**: Ask contractors for customer references and call them. Check the contractor's service, performance and adherence to timeline and budget. Be wary of installers who are hesitant to give references.

2) **Confirm Licenses and Certifications**: Make sure the contractor's licenses are current. Look for renewable energy industry certifications as well, such as NABCEP.

3) **Expect a load evaluation**: The contractor should assess your business's energy needs. A bigger solar energy system isn't always better. A contract should let you know about other less expensive ways to reduce your energy costs.

4) **Get written, itemized estimates**: When comparing contractors' proposals (bids), be sure to compare cost, estimated energy production and warranties. The lowest price may not be the best deal.

5) **Get it in ink**: Sign a written proposal with a contractor before works begins. Specifying project costs, model numbers, job schedule and warranty information may protect you from unforeseen future costs.

B. Bid review and award

The business (or designated bid reviewer) must insure that the lowest or most responsive bidding contractor is qualified and has submitted a responsible bid. The business or a managing contractor makes certain the bid package contains the required documentation, bid surety and appropriate signatures. After the initial paperwork is accepted, the bidder should be interviewed to confirm that they have met the intent of the construction documents in their bid. The business or bid reviewer should conduct the interview confirming the proper equipment was selected, specific scope items unique to the project are included, any unique building interface measures are addressed, installation procedures are understood and the schedule can be met. If both parties agree that the bid is well understood and complete, the reviewer makes a recommendation to award the contract.

C. Permits and approvals from others

Allow for adequate time in the schedule for the acquiring of permits, having inspections, and getting approvals. At this point, formal application for building code approval (permits from the city or state) should begin, to make sure that regulatory authorities have approved the construction before ordered equipment is delivered.

The selected installer must secure all required permits and also work with your electric utility on an interconnection application (for solar electric projects). If the building assessment process was conducted reasonably, the permitting and interconnection process should go smoothly. Both the

permitting process and the interconnection process require third parties (the city, state, and utility) to review documentation, conduct inspections, and in some cases acquire multiple levels of approval. The interconnection process cannot be completed until the project is fully installed and ready to be turned on.

Depending on the financing arrangement for the solar installation, either the business, the installer, or a third party need to complete applications and make documentation for tax credits and rebates. Whose responsibility this is should be spelled out clearly in the bid and the contract.

D. Payments

Payment schedules should be clearly spelled out. In many projects, capital costs for specific pieces of equipment make up a majority of the costs. As a result, major portions of the project cost may be incurred before construction begins necessitating advance payment schedules. Final payment should not occur until the system is fully commissioned.

E. Installation

The contractor will mobilize to the job site. Construction will take place in accordance with measures identified in the construction documents.

With a well-prepared set of construction documents, the construction process will more likely be smooth and seamless. But even with the best design and most experienced contractors issues will arise. The business needs to be prepared to make clarifications and consider change orders as needed.

Businesses need to work with the installer to coordinate the installation of the solar energy system with business and building operations. Some operations will require shut down of the building systems (i.e. connecting a solar electric system may require a service disruption to the whole building) and need to be coordinated with the businesses operating schedules.

Site access, security and safety all need to be addressed as part of the work plan. A safe and secure workplace will help maintain a positive public image of the project.

F. Commissioning

Once the construction is substantially complete, the contractor will initiate the necessary tests to establish system operation and code/ inspection compliance, also called "commissioning." The minimum requirement is the necessary code inspection by the local authority having jurisdiction and completing the utility-required grid system tie-in (anti-island) test and inspection.

If the business owns the system outright (not a lease or PPA) system commissioning and verification of operation should include verification that the system is operating at full design capacity. Commissioning is especially critical since there are usually automatic backup

Contents of a Bid Specification for a Commercial Solar PV Installation

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   - 4.7. Commissioning and Interconnection

systems in place (the electric grid for solar electric systems, backup heating systems for solar thermal). If the solar energy system fails to operate, or operates at sub-optimal capacity, it will not show obvious signs of failure; the backup systems will automatically cover the load.

Finally, commissioning should also include training of the business staff in operation of the system and delivery of an owners' manual. Final payment to the contractor is typically linked to these last two items. Building or business staff should understand the controls and all maintenance requirements. This includes learning:

- How to read the current status of the system
- How much electric or thermal energy is being produced
- What to do in case of utility power disruption
- How to disconnect the system
- Other maintenance tasks, depending on the level of staff training

A leased 40-KW solar system on a commercial building roof. The system owner (Solarflow) rather than the building owner (Transfiguration Church), maintains the system. Photo: Solarflow

Glossary

Commissioning: The process whereby mechanical and electrical equipment, such as a renewable energy system, is brought into service at the end of construction. Commissioning procedures ensure that the equipment is operating as designed.

Construction documents: Construction documents are a set of plans that specify in detail how a renewable energy system will be constructed and what materials will be used. Construction documents are first used by contractors to develop accurate cost estimates and bids for system construction, and then they are used to guide the actual construction.

Data logger: An electronic device for collecting data (from an anemometer or the output levels of a photovoltaic system) and storing it digitally for transfer to a computer for display and analysis.

Double-Walled Heat Exchanger: A plumbing component that allows for the transfer of heat from one fluid to another without direct contact of the fluids. In solar thermal systems, heat exchangers are used to transfer heat from antifreeze and/or un-pressurized solar collector piping to the pressurized, potable water system. A double-walled heat exchanger has two layers of barrier material (usually metal) between the antifreeze and the potable water, with a drainable air space in between, that allow for the detection of a fluid leak if it occurs. Double-walled heat exchangers are a plumbing code requirement for solar hot water heaters in Minnesota if antifreeze is used in the system.

Federal Investment Tax Credit: The "Energy Improvement and Extension Act of 2008," signed into law on October 3, 2008, includes an eight year extension of the 30% residential and business Investment Tax Credit for solar systems. Third party ownership models introduce a tax paying entity, allowing the host to indirectly benefit from the federal investment tax credits, which significantly reduce the cost of a PV system.

Federal Modified Accelerated Cost Recovery System (MACRS): The IRS allows taxed entities to use a five-year accelerated depreciation schedule for qualified assets of a solar installation, thus reducing income subject to taxation in the early years of a project.

Grid-tied system: A renewable energy system producing electricity that is connected to the utility electrical grid. A grid-tied system allows the utility to seamlessly supplement the renewable energy system production when the renewable energy system does not meet the load. Conversely, it allows excess renewable electricity production to be used by other customers on the grid.

Insolation: The amount of sunlight hitting a horizontal surface. A measure of solar radiation energy received on a given surface area in a given time. It is commonly expressed as average irradiance in watts per square meter.

Islanding: A hypothetical situation that could occur with a grid-tied renewable energy system during a utility power outage. When islanding occurs, the renewable energy system has kept producing power during the outage and delivers the power back on the grid, thus creating an "island" of energized wiring that pose a threat to utility crews making repairs. In practice, grid-tied systems are connected to the utility grid through special inverters that have "anti-islanding" controls that disconnect and shut-down the renewable energy system in the event of a utility outage. This is why grid-tied solar electric systems do not continue to work during a power outage.

Inverter: An electronic device that converts direct electric current (DC) (such as that coming from batteries or photovoltaic panels) to alternating electric current (AC). In a grid-tied renewable energy system, the inverter also conditions the power for compatibility with the grid and disconnects the renewable energy system from the grid in the event of a power failure.

Micro-Inverters: Small inverters sized for just one solar panel. Micro-inverters contrast with the conventional "string inverter" devices, which support a large number of solar panels connected to single inverter. Compared to photovoltaic systems with a central inverter(s), micro-inverters allow the system to

function better when one or more panels are shaded. Some micro-inverters also allow remote monitoring of individual panel performance.

Net metering: A protocol of electric utility billing and metering that accounts for on-site renewable electricity production. The electric meter accounts for the incoming electricity from the utility, and any outflow of electricity when the renewable energy system does not meet the load. The customer is billed for the net energy consumption. In some cases, net metering allows for a credit to be paid to the customer for the net generation of excess electricity during the billing period or other time period.

Poly Amorphous Silicon: A type of photovoltaic panel made with silicon in multiple smaller crystals (polycrystalline) or even many microscopic crystals (amorphous). Amorphous silicon can be created in a very thin film layer that allows the construction of flexible photovoltaic panels.

Power Purchase Agreement (PPA): A contract between one party that is producing electricity to sell electricity to another party. PPAs could be between a building owner and a renewable energy generator who owns a renewable energy system located on business property, or a renewable energy generator (which could be a business) and an electric utility that is purchasing the generation from the business.

Renewable Energy Credits (RECs): Also known as Green Tags, Renewable Electricity Certificates or Tradable Renewable Certificates (TRCs). These are tradable, non-tangible energy commodities in the United States that represent proof that 1 megawatt-hour (MWh) of electricity was generated from an eligible renewable energy resource. Solar RECs are specifically generated by solar systems. These certificates can be sold, traded or bartered and the owner of the REC can claim to have purchased renewable energy. Renewable energy system owners can use the proceeds from RECs to finance their system construction costs.

Shading Analysis: Measurements that determine when (time of day and time of year) a particular location will be shaded by adjacent trees, structures and other obstacles. One tool for doing this analysis is a Solar Pathfinder.

Solar Air Heat: Solar air heat is a type of energy collector in which the energy from the sun is captured by an absorbing medium and used to heat air.

Solar Pathfinder: A device for determining (with one measurement) on what days of the year and at what times of the day a particular location will be shaded from the sun. It is used to determine what locations are suitable for solar electric and thermal systems, and how the panels should be mounted and oriented.

Solar Photovoltaic: Panels convert sunlight directly into electricity to power homes and businesses.

Solar Water Heating: Panels harness heat from the sun to provide hot water for homes and businesses. Most solar water heating systems for buildings have two main parts: a solar collector and a storage tank. There are two types of collectors; a flat-plate collector and an evacuated tube collector. These can also provide space heating.

Third-party financing: Financing arranged and managed by someone other than the source of capital and the beneficiary of the renewable energy project. In the case of a commercial business project, the third party would be someone other than the business or building owner and the entity(s) providing the capital, who has contracts with both, in order to make the project work.

Watts peak capacity: Often labeled Wp, the watts peak capacity of a photovoltaic panel indicates how much electricity the panel will produce under standardized temperature and solar radiation conditions. In some cases, entire photovoltaic systems with many panels are given an overall peak capacity rating in kilowatts peak capacity (KWp). A kilowatt equals 1,000 watts.