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Procuring Solar Energy:

A Guide for Federal Facility Decision Makers

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NOTICE

Cover Photos: *(left)* The Department of Energy's (DOE) Forrestal Headquarters building (PIX 16802); *(middle)* Nellis Air Force Base, Las Vegas, Nevada, PV plant (PIX 17447); *(right)* The Naval Base Coronado in San Diego, California is a covered structure with approximately 81,470 square feet of PV panels (PIX 12373). *Photo Credit: SunPower*

Procuring Solar Energy: A Guide for Federal Facility Decision Makers

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NOTE TO READER

This document is intended to provide federal agencies with initial guidance on how to procure solar energy. It is not meant to replace agency-specific legal guidance. This document is based on best practices and the experience of agency personnel and laboratory and industry collaborators. Each agency, however, develops internal rules and regulations regarding procurement, therefore it is important to emphasize that the experiences and outcomes vary greatly. Additionally, different federal statutes govern long-term energy purchases. For example, there are substantial differences between statutes for military agencies as compared to those for most civilian agencies. Further, the procurement of solar energy in the federal sector (as well as in U.S. market sectors) is a dynamic and rapidly evolving industry. As federal agencies work to navigate their own procurement rules, many others in the solar industry also endeavor to understand how to incorporate sophisticated financing models and legal agreements into the federal procurement process. It therefore is vital to acknowledge that new lessons, information, and projects likely will develop in the future, and could provide new or different guidance not included in this document.

For the most current version of this guide, visit www.solar.energy.gov/federal_guide/.

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The DOE Solar Energy Technologies Program (SETP) and Federal Energy Management Program (FEMP) provided the funding for this report.

Acronyms and Abbreviations

AC .... alternating current electricity
ACHP .... Advisory Council on Historic Preservation
AFO .... alternative financing options
AWC .... area-wide contract

BAFO .... best and final offer
BLM .... Bureau of Land Management
BOA .... basic ordering agreement
Btu .... British thermal unit

CEC .... California Energy Commission
CEQ .... Council on Environmental Quality
CFR .... Code of Federal Regulations
CO .... contracting officer
COR .... contracting officer's representative
COTS .... commercially available off-the-shelf

DC .... direct current electricity
DESC .... Defense Energy Support Center (now DLA Energy)
DG .... distributed generation
DLA Energy .... Defense Logistics Agency (formerly DESC)
DOD .... United States Department of Defense
DOE .... U.S. Department of Energy
DSIRE .... Database of State Incentives for Renewable Energy

EA .... environmental assessment
ECM .... energy conservation measure
EE .... energy efficiency
EERE .... DOE Office of Energy Efficiency and Renewable Energy
EIA .... Energy Information Administration
EIS .... environmental impact statement
EISA 2007 .... Energy Independence and Security Act of 2007
E.O. .... executive order
EPA .... United States Environmental Protection Agency
EPAct 2005 .... Energy Policy Act of 2005
ESA .... energy services agreement
ESCO .... energy services company
ESPC .... energy savings performance contract
EUL .... enhanced use lease

FAR .... Federal Acquisitions Regulation
FEMP .... DOE Federal Energy Management Program
FFS .... federal financing specialist
FMV .... fair market value
FONSI .... finding of no significant impact
FPR .... final proposal revision

GHG .... greenhouse gas
GSA .... U.S. General Services Administration

IDIQ .... indefinite delivery, indefinite quantity
IGA .... investment grade audit
IMBY .... In My Backyard
IRR .... internal rate of return
ITC .... investment tax credit

J&A .... justification and approval

kV .... kilovolt
kW .... kilowatt
kWh .... kilowatt-hours

L&MP .... lease and management plan
LCC .... life-cycle cost
LEED .... Leadership in Energy and Environmental Design
LD .... liquidated damages
LPTA .... low price, technically acceptable

M&V .... measurement and verification
MAC .... multiple-award contract
MW .... megawatt
MWh .... megawatt-hours

NAFTA .... North American Free Trade Agreement
NAVAIR .... Naval Air Systems Command
NAVFAC SW ..... Naval Facilities Engineering Command Southwest
NEPA .... National Environmental Policy Act
NHPA .... National Historic Preservation Act
NMCI .... United States Navy/Marine Corps Intranet
NOL .... notice of opportunity to lease
NPV .... net present value

O&M .... operations and maintenance
OMB .... Office of Management and Budget

PA .... preliminary assessment
PEIS .... programmatic environmental impact statement
PF .... project facilitator
PO .... purchase order
PPA .... power purchase agreement
PTC .... production tax credit
PV .... photovoltaic
PVA .... photovoltaic array

RE .... renewable energy
REC .... renewable energy credit
RFI .... request for information
RFP .... request for proposal
RFQ .... request for qualifications
RPS .... renewable portfolio standard

SETP .... DOE Solar Energy Technologies Program
SHC .... solar heating and cooling
SIR .... saving investment ratio
SOW .... scope of work
SPB .... simple payback
SRCC .... Solar Rating and Certification Council
SREC .... solar renewable energy credit
SSO .... senior sustainability officer
SWH .... solar water heating

UESC .... utility energy services contract
URESC .... utility renewable electricity service contract

Western .... Western Area Power Administration
WRL .... work release letter

Executive Summary

Federal agency leaders are expressing growing interest in generating solar energy on their sites, motivated by both executive branch sustainability targets and a desire to lead by example in the transition to a clean energy economy. *Procuring Solar Energy: A Guide for Federal Facility Decision Makers* presents an overview of the solar project process in a concise, easy-to-understand, step-by-step format. This guide is designed to help agency leaders turn their interest in solar into successful installations. Detailed information and sample documents for specific tasks are referenced with Web links or included in the appendixes. This guide concentrates on distributed solar generation and does not consider all the complexities of large, centralized solar energy generation.

Because solar energy technologies are relatively new, their deployment poses unique challenges. In addition, solar technologies are commonly used for on-site applications, meaning that a solar project is likely to be connected to both an electrical system and a building. The methods for procuring solar energy are evolving rapidly, ranging from direct purchases to more sophisticated long-term agreements. This guide outlines methods that federal agencies have used to procure solar energy with little to no capital costs. Each agency and division, however, can have its own set of procurement procedures. As a result, this guide was written as a starting point, and it defers to the reader's set of rules if differences exist.

The global solar industry is maturing rapidly, and solar project developers are gaining experience in working with federal agencies. Technology improvements, cost reductions, and experienced project developers are making solar projects easier to put into service. In this environment, federal decision makers can focus on being smart buyers of solar energy instead of attempting to become experts in solar technology.

Federal agencies have many reasons to consider implementing solar energy on their sites, including legislation, executive orders, and agency targets, among others. For agencies who want to pursue solar, the recommended first step is to determine your preliminary solar potential by conducting a solar site screening or an agency-wide screening that identifies the best solar project sites.

A two-part process has been developed as a guide to implementing a smooth and successful solar project. Part 1 of the process includes five project planning steps that cover identification of needs and goals, assembling an on-site team, evaluating the site's solar screening, project requirements and recommendations, and making a financing and contracting decision. Part 2 of the process includes process guidance on the following financing and contracting options:

- **Agency-funded project** – funds have been designated for the outright purchase of a project
- **Power purchase agreement** – a private entity installs, owns, operates, and maintains customer-sited solar energy, and the site purchases electricity or thermal energy through a long-term contract with specified energy prices
- **Energy savings performance contract** – an energy services company incurs the cost of implementing an energy project and is paid from the operations savings resulting from the project
- **Utility energy services contract** – an agreement with a "serving" utility to finance and install an energy project
- **Enhanced use lease** – prospective developers compete for an energy project site lease with payment being either monetary or in-kind consideration; renewable power can be part of the consideration.

The U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP) can provide assistance or answer questions about solar or energy efficiency projects. Call 877-EERE-INF (877-337-3463) or visit www.eere.energy.gov/informationcenter/.

Contents

Introduction

The global solar industry is maturing rapidly, and solar project developers are gaining experience working with federal agencies. Technology improvements, cost reductions, and experienced project developers are making solar projects easier to put into service. In this environment, federal decision makers can focus on being smart buyers of solar energy instead of attempting to become experts in solar technology.

This step-by-step manual guides readers through the process of implementing an on-site solar project. After discussing the importance of solar projects, agency targets, and preliminary solar site screenings at the agency level, the guide presents a two-part process for implementing a solar project on a federal site. Each part has several sub-steps and considerations.

At the point in the process when a financing and contracting decision has been made (see Part 1, Step 5), the process diverges. Part 2 follows the process for each financing and contracting option through to the end of the project. This guide presents the major components of successful solar projects so that readers can achieve their own solar energy goals, which might include a single facility installation, a multi-facility procurement, or an agency-wide procurement plan, among others.

Supplemental information for this guide can be found in the following appendixes: Appendix A presents background material on solar technologies; Appendix B contains a step-by-step self-guided solar screening, along with several other types of checklists; and Appendix C includes case studies of solar projects at federal facilities.

Although this guide focuses on solar projects, it is important to note that energy efficiency is important for reducing both site energy costs and the environmental impacts of using conventional methods of energy production.

Of particular importance is a solar project champion who can help clear project barriers and see the project through to completion. This champion can come from many areas, such as facility or regional management, headquarters leadership, or another leadership area. But no matter where a champion is found, he or she must help move the project forward and overcome barriers that might otherwise stop or delay a project. Experience has shown that strong project leadership is a common factor in successful solar projects.

As the nation's largest energy consumer, the federal government presents a tremendous opportunity for jump-starting a significant increase in domestic solar production. The following subsections summarize some of the reasons why.

The U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP) can provide assistance or answer questions about solar or energy efficiency projects. Call 877-EERE-INF (877-337-3463) or visit **www.eere.energy.gov/informationcenter/** for more information.

Making the Case for Federal Solar Energy Projects

As the nation's largest energy consumer, the federal government presents a tremendous opportunity for jump-starting a significant increase in domestic solar production. The following subsections summarize some of the reasons why.

Federal Requirements—Bringing the Backdrop to the Forefront

The Energy Policy Act of 2005 (EPAct 2005) set the primary renewable energy requirements for federal agencies. It requires that renewable energy be tapped—to the extent that is economically feasible and technically practicable—to generate the following percentages of the federal government's total electricity usage:

- Not less than 3% in fiscal years 2007 through 2009
- Not less than 5% in fiscal years 2010 through 2012
- Not less than 7.5% in fiscal year 2013 and thereafter.

EPAct 2005 defines renewable energy as "electric energy generated from solar, wind, biomass, landfill gas, ocean (including tidal, wave, current, and thermal), geothermal, municipal solid waste, or new hydroelectric generation capacity achieved from increased efficiency or additions of new capacity at an existing hydroelectric project" (www.eere.energy.gov/femp/technologies/renewable_requirements.html; accessed June 8, 2010). By granting a bonus for electricity from renewable energy generated on a federal or tribal site, EPAct 2005 also created a strong incentive for on-site projects.

Executive Order (E.O.) 13423, Strengthening Federal Environmental, Energy, and Transportation Management, signed on January 24, 2007, sets even more challenging goals for the federal government. The 2007 E.O. mandates that 50% of all renewable energy required under EPAct 2005 must come from "new" renewable energy (meaning energy from facilities placed in service after January 1, 1999). The guidance under E.O. 13423 allows a limited amount of thermal energy to count toward the E.O. goal for new renewable energy, but not toward the EPAct goal. (See www.eere.energy.gov/femp/regulations/eo13423.html.) The FEMP guidance on E.O. 13423 and EPAct 2005 requires agencies to own the renewable energy credits (RECs) associated with any renewable energy counted toward the goal.

The Energy Independence and Security Act of 2007 (EISA 2007) requires that 30% of the hot water demand of new federal buildings (and major renovations) be met with solar water heating equipment, as long as the solar system remains cost effective over its life cycle (www.eere.energy.gov/femp/regulations/eisa.html; accessed July 20, 2010).

E.O. 13514, Federal Leadership in Environmental, Energy, and Economic Performance, was signed on October 5, 2009. This order establishes "an integrated strategy towards sustainability in the Federal Government" and makes "reduction of greenhouse gas emissions a priority for federal agencies" (www.eere.energy.gov/femp/pdfs/eo13514.pdf; accessed June 8, 2010). This E.O. builds on the federal energy efficiency mandates of EPAct 2005, EISA 2007, and E.O. 13423 by using greenhouse gas (GHG) emissions as a unifying metric for federal sustainability. The order requires agencies to:

- Appoint a senior sustainability officer (SSO)
- Establish a GHG-emission baseline for fiscal year 2008
- Set GHG-emission reduction targets for fiscal year 2020
- Create a strategic sustainability performance plan to document progress toward achieving the fiscal year 2020 goals
- Inventory and report its GHG emissions for the previous fiscal year (beginning in January 2011).

Each agency is responsible for setting its own goals for GHG emission reduction through a strategic sustainability plan, with review and approval by the chair of the Council on Environmental Quality (CEQ) and in consultation with the director of the Office of Management and Budget (OMB).

Environmental Protection—Doing the Right Thing

In the United States it is estimated that in 2010, energy consumption in buildings will generate 38% of U.S. carbon dioxide emissions. As some of the largest single owners and occupants of buildings, federal agencies have the opportunity to greatly reduce carbon dioxide emissions by implementing energy efficiency and renewable energy measures (2009 Buildings Energy Data Book, table 1.4.1; available at http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=1.4.1; accessed July 9, 2010).

Photovoltaic (PV) and solar thermal installations emit no GHGs as they operate. By installing a PV system, an agency can generate clean electricity and reduce the amount of electricity it needs to purchase. And installing solar thermal systems can reduce electricity use or the direct use of fossil fuels like natural gas, with a bonus of decreased GHG emissions. Installing solar energy, then, increases the use of renewable energy and reduces an agency's carbon footprint at the same time.

The U.S. Environmental Protection Agency (EPA) maintains a Web site that lists GHG emission factors for electricity from different regions in the United States (http://cfpub.epa.gov/egridweb/ghg.cfm; accessed July 20, 2010). The GHG emissions vary with the mix

DOE Office of Energy Efficiency and Renewable Energy (EERE) Web sites offer a wealth of information about the various requirements. See, for example, the following:

Federal requirements are listed at www.eere.energy.gov/femp/technologies/renewable_requirements.html.

FEMP training courses for federal renewable energy goals can be found at www.eere.energy.gov/femp/technologies/renewable_training.html.

Additional resources are available at www.eere.energy.gov/femp/technologies/renewable_energy.html and www.eere.energy.gov/femp/technologies/renewable_solar.html.

Guidance on federal facility reporting requirements is available at www.eere.energy.gov/femp/regulations/facility_requirements.html.

When it is final, guidance on GHG accounting and reporting under E.O. 13514 will be accessible on the FEMP Web site.

President Barack Obama, Col. Dave Belote, 99th Air Base Wing commander, and Senator Harry Reid, D-Nevada, tour the Nellis Air Force Base, Nevada, photovoltaic array (PVA) on May 27, 2009. The PVA has over 72,000 solar panels which save the base approximately $1 million a year in energy costs. *(Photo Credit: Senior Airman Nadine Y. Barclary, Nellis Air Force Base, PIX 17160)*

of fuels utilities use to generate electricity. Because using solar energy displaces peak plant production, the non-baseload emission factors are the most appropriate when estimating GHG emission reductions. Most solar thermal projects do not require separate calculations of GHG emission reductions because they directly reduce the use of fossil fuel or electricity that a site would otherwise have to report in its GHG inventory.

Leadership by Example—Paving the Way

As the largest consumer of energy and, therefore, the greatest emitter of GHG in the U.S., the federal government can greatly impact GHG reduction and accelerate the solar market by implementing solar energy projects. Federal agencies have many reasons to lead by example and to provide visible demonstrations of solar projects. E.O. 13514 sets the vision for federal agency management to lead by example to help "create a clean energy economy that will increase our Nation's prosperity, promote energy security, protect the interests of taxpayers, and safeguard the health of the environment" (www.eere.energy.gov/femp/pdfs/eo13514.pdf, accessed June 8, 2010). Federal agencies will reach this vision by reducing GHG emissions through building or retrofitting more efficient buildings, increasing the use of renewable energy, and reducing fleet petroleum use.

Designing or renovating a facility to Leadership in Energy and Environmental Design (LEED) standards is also part of leading by example. Including a solar project in any design or retrofit helps earn points toward LEED certification. Typically, the number of points a facility can earn toward a LEED rating is based on the percentage of building energy cost that is offset by the system. More information about how renewable energy can affect a LEED project can be found at www.leeduser.com/leed-credits (accessed July 2010); choose the appropriate LEED rating system and then select the "Energy and Atmosphere" category for renewable energy.

Part of leading by example and meeting an agency's renewable energy targets is documenting the installed system's performance. The DOE Solar Energy Technologies Program (SETP) tracks the performance and reliability of system installations. For more information about having DOE track a specific system, contact Michael Quintana at Sandia National Laboratories (maquint@sandia.gov).

Cost Savings—Doing the Math

Solar technology advances and improved financing approaches are steadily reducing the cost of implementing solar energy projects. In many cases, solar energy is the lower cost energy solution. As an added benefit, it's possible to know the energy costs for the system's output for 20 or more years. The cost of energy from fossil fuel production can be volatile, and with the potential need to account for climate change and GHG emissions in economic terms, the benefits of a currently competitive and known cost of energy are clear. When a good site, supportive incentives, and strong leadership come together, solar becomes a smart investment.

If site conditions preclude implementing a solar project, an agency can still purchase renewable energy. More information is available at www.eere.energy.gov/femp/technologies/renewable_purchasingpower.html (accessed June 8, 2010).

Agency-wide Planning: Solar Energy Screening

One of the first steps agencies can take to begin pursuing solar is to conduct an agency-wide solar energy screening. An agency-wide solar energy screening is a preliminary assessment of the viability of the agency's sites to host solar energy systems. This screening will include a basic overview of the potential of sites to host solar installations with approximate size estimation and energy production. The screening process enables agency decision makers to select the best sites for renewable energy investment and to meet their renewable targets more economically. In some cases, a DOE laboratory can perform the screening. DOE labs have several resources to help with screenings such as NREL's Renewable Energy Optimization (REO) service. A solar screening can also be conducted internally or externally under an energy savings performance contract (ESPC) or by engaging a contractor listed in the U.S. General Services Administration (GSA) Comprehensive Professional Energy Services Blanket Purchase Agreement (available at www.gsa.gov/portal/content/105339; accessed July 19, 2010). The organization selected to perform the agency-wide screening must have a good understanding of solar technology applications and performance. A successful solar screening will give agencies valuable information they can use to begin the process for developing targeted site or regional solar procurements, described in the next section of this guide. More information related to solar screening can be found in Appendix B on page 77.

Part 1. Plan a Solar Energy Project

The impetus for implementing a specific solar energy project may come from top-down agency guidance such as a solar energy screening, or from specific site needs and goals. This section walks through the steps needed to execute a specific site solar procurement and is intended to help those charged with carrying out the solar project. Though this section largely considers single site installations, agencies should look for innovative ways to aggregate procurements as much as possible to benefit from economies of scale and to reduce transaction costs.

The Project Planning Process

Details on each step are included in this section

- Step 1. Identify needs and goals
- Step 2. Assemble an on-site team
- Step 3. Evaluate candidate solar energy sites
- Step 4. Consider project requirements and recommendations
- Step 5. Make a financing and contracting decision

PART 1: PLANNING

DIRECTION »	STAFFING »	SITE EVALUATION »	CONSIDERATIONS »	FINANCING »
Identify Needs and Goals	Assemble an On-site Team	Evaluate Candidate Solar Energy Sites	Consider Project Requirements and Recommendations	Make a Financing and Contracting Decision

DIRECTION

Common Reasons for Considering a Solar Project

- The agency must meet renewable energy targets.
- The appropriations are available for improving a facility.
- The project is a good way to meet a site's needs—depending on site conditions, there can be many smart reasons to implement a solar project.
- The project can provide energy cost savings.
- The project can reduce future energy cost volatility and uncertainty.
- The project will earn credits toward LEED certification.

Potential Goals or Criteria

- Maximize on-site solar energy production (particularly within a restricted budget)
- Maximize the return on investment
- Meet a minimum annual solar energy production target
- Maximize GHG reductions

STAFFING

Initial Team Members

- Solar project manager
- Contracting officer
- Energy manager
- Environmental expert
- Facility manager
- Site managers
- Solar technology expert
- Utility point of contact.

Additional Team Members

- Attorney or general counsel (e.g., for contract and authority issues)
- Budget officer
- Facility master planner
- Real estate officer
- Safety officer
- Sustainability officer.

SITE EVALUATION

Project Solar Screening

- Roof condition, manufacturer's warranty, and age of roof
- Shading analysis
- Available square footage
- Estimate of the system's size
- Structural issues and height considerations
- Historic building issues
- Cost of energy at a site
- Economic analysis of project
- Estim. annual energy production
- Hot water/space heating demand
- Incentives (federal, state, local, utility, RECs)

Project Solar Feasibility

- Capacity of the local industry to supply and maintain system
- Utility interconnection issues
- Electrical/mechanical room issues
- Recommended system size
- Site load requirements
- Analysis of 15-minute load data for peak demand
- Estim. monthly peak production
- Annual O&M
- Magnitude and timing of the electric/heating loads at a site
- Size, condition, and efficiency of existing heating systems.

CONSIDERATIONS

Considerations

- Utility interaction
- NEPA compliance
- Site master plan review
- Requirements for meeting renewable energy goals
- Project incentives
- Historic building issues
- Computer network connectivity authority
- Buy American Act provision

FINANCING

Agency Funded Project

A project for which funds have been designated for the outright purchase of a project, in this case a solar energy project. The government owns the system, its energy production, and all the attributes of the system (e.g., SRECs). (p.21)

Power Purchase Agreement (PPA) Project

A private entity (typically a group consisting of developers, construction companies, and finance companies) installs, owns, operates, and maintains customer-sited (behind the meter) solar energy generation equipment. The site purchases electricity or thermal energy through a long-term contract with specified energy prices. Payment is based on actual energy (kilowatt-hours or therms) generated from the solar equipment and consumed by the site. (p.31)

Energy Savings Performance Contract (ESPC)

Requiring no up-front cost, an energy services company (ESCO) incurs the cost of implementing a range of energy conservation measures (ECMs)—which can include solar—and is paid from the energy, water, and operations savings resulting from these ECMs. (p.43)

Utility Energy Services Contract (UESC)

An agreement that allows a "serving" utility to provide an agency with comprehensive energy- and water-efficiency improvements and demand-reduction services. The contract is between the federal agency and the "serving" utility. (p.49)

Enhanced Use Lease (EUL)

A real estate agreement that focuses on underutilized land. Prospective developers compete for the lease, and payment can be either monetary or in-kind consideration (in this case, renewable power can be part of the consideration). (p.55)

Step 1. Identify Needs and Goals

Several common reasons for considering a solar project follow:

- The agency must meet renewable energy targets.
- The appropriations are available for improving a facility.
- The project is a good way to meet a site's needs—depending on site conditions, there can be many smart reasons to implement a solar project.
- The project can provide energy cost savings.
- The project can reduce future energy cost volatility and uncertainty.
- The project will earn credits toward LEED certification.

The reasons for considering a solar project help to define the needs and goals that the project will address. Needs and goals comprise the vision, the touchstone, and the principles that guide the process of setting priorities, creating decision criteria, and making decisions. Solar should be part of a broader vision of whole systems design for buildings and sites. Potential goals or criteria include the following:

- Maximize on-site solar energy production (particularly within a restricted budget).
- Maximize the return on investment.
- Meet a minimum annual solar energy production target.
- Maximize GHG reductions.

Goals could adjust or change as the project develops, but they always should be at the forefront during the decision-making process.

PV solar array installed at Marina Del Rey USPS Postal Station in Los Angeles, California. *(Credit: George Marsh, PIX 11015)*

Step 2. Assemble an On-Site Team

At this point, a solar project team should be identified. The team is important not only for getting the work done, but also for making sure that all issues are considered. Even small oversights can be costly in terms of dollars and time, and can even result in a failure to accomplish project goals.

One of the most important features of the team should be its alignment with the project's goals. The project goals can adjust with team input—and healthy debate on project questions is useful—but if any team member hasn't bought into the goals *before* being invited to join the team the project won't go smoothly. Referring to Step 4, "Consider Project Requirements and Recommendations," can help when considering the makeup of the team. That step outlines the diverse considerations that feed into successful project completion. It's important to recognize that it takes a diverse group of people with a wide range of skills to bring a project to fruition.

The initial solar project team might be small and include only those members relevant to the immediate task; this type of team can grow as the project requires. As an alternative, the team could include—from its inception—everyone who has a stake in the project process. This decision should be based on best judgment and staff availability.

If starting with a small team, the people who should participate, particularly in Step 3, where the site's solar screening step is evaluated, include the following:

- Solar project manager
- Contracting officer
- Energy manager
- Environmental expert (responsible for environmental review under the National Environmental Policy Act [NEPA])
- Facility manager
- Site managers (if multiple people are responsible for different parts of the site)
- Solar technology expert (depending on procurement option selected)
- Utility point of contact.

As the project progresses, adding other team members should be considered:

- Attorney or general counsel (e.g., for contract and authority issues)
- Budget officer
- Facility master planner
- Real estate officer
- Safety officer
- Sustainability officer.

Several factors will ensure the team's success. For example, a high-level person from the agency should participate. This person doesn't need to be involved in the details of the project, but should check in periodically to help move the project forward and overcome barriers that might otherwise stop or delay a project. It's also critical to select a contracting officer and legal advisor with strong leadership characteristics, because it might take initiative and innovation to push a project through ambiguous areas of the procurement process. Team dedication and creativity are crucial as well, because these traits are essential for finding innovative, cost-effective solutions, if necessary. The solar energy system procurement process is relatively new, and although challenges are being addressed and resolved, issues may still exist. Navigating around these obstacles requires leadership, commitment, and creativity.

Building and site occupants are also stakeholders in the project. A representative of this group can be included in the team as a liaison to keep communications open—especially if the project will have any sort of significant impact on occupants.

After the team is assembled, its roles, responsibilities, and timelines should be established. Scheduling periodic meetings will keep the project moving forward on track.

Step 3. Evaluate Candidate Solar Energy Sites

This section outlines the detailed information needed to evaluate specific sites for solar energy installations. These findings may be available from an agency-wide solar screening if your agency has one, or they may need to be compiled by the solar project team.

There are two recommended levels of solar site evaluation:

1. A project solar ***screening***, which is a high-level, preliminary analysis used to determine a site's likely viability, and
2. A project solar ***feasibility study***, which is a more rigorous engineering and economic analysis to define specific system design considerations for use in requests for proposals and/or scope of work development.

For projects that propose to use alternative financing (see Part 2), a project solar *screening* is sufficient to proceed. For agency funded projects, a solar *feasibility study* is recommended. The points that both types of solar evaluations should cover are defined in the sections that follow.

If the team finds that the site screening doesn't cover all the issues relevant to the project and site, a more complete feasibility study should be obtained. To determine what resources might be available based on the specifics of a project, call FEMP (202-586-5772) or hire a private contractor to perform the study. Be sure to address all the relevant points listed below based on the individual site. If the screening or feasibility study covers all of the relevant issues but the quality of the report is questionable, a first-order check can be performed using the solar screening evaluation checklist located in Appendix B.

Project Solar Screening

A project solar screening should encompass the following.

STRUCTURAL OR MECHANICAL CONSIDERATIONS

- Roof condition, manufacturer's warranty, and age of roof (if considering a rooftop system)
- Shading analysis (identification of obstructions that might shade the array location)
- Available square footage for a solar system
- Preliminary estimate of the system's size
- Structural issues and—if the system is to be mounted on a building—height considerations
- Historic building issues (if the system will be on a building that could be a historic property or is located in a historic district).

United States Coast Guard – The Williams Building in downtown Boston, Massachusetts, now has a 28 kW AC PV system integrated into the roof consisting of 372 panels. *(Credit: SunPower, PIX 08466)*

Alfred A. Arraj U.S. Courthouse; Denver Federal Courthouse; PV system supplied by Atlantis Energy Systems PV shade structure on the top floor is cantilevered over facade; first federal courthouse to get PV glazing. *(Credit:Atlantis Energy Systems, Inc., PIX 13999)*

ECONOMIC CONSIDERATIONS

- Cost of energy (electricity and fuels) at a site, plus any details of rate schedules that could favor or penalize solar
- Economic analysis of project (e.g., simple payback, internal rate of return [IRR], net present value [NPV], life cycle cost [LCC], projected savings)
- Estimated annual energy production
- Hot water or space heating demand
- Incentives (federal, state, local, utility, RECs) and their time sensitivities.

Project Solar Feasibility Study

A project solar feasibility study should encompass the following in addition to the project solar screening components.

STRUCTURAL OR MECHANICAL CONSIDERATIONS

- Capacity of the local industry to supply and maintain such systems
- Utility interconnection issues (if planning an electric project, it's important to know whether the utility has special hardware or contractual requirements)
- Electrical room or mechanical room issues (e.g., space for equipment, alternate location, capacity limits, access between system and equipment room).

ECONOMIC CONSIDERATIONS

- Recommended system size
- Site load requirements (these should be checked against system sizing)
- Analysis of 15-minute load data for peak demand
- Estimated monthly peak production
- Annual operations and maintenance (tasks, annual costs)
- Magnitude and timing of the electric and heating loads at a site
- Size, condition, and efficiency of existing heating systems.

Step 4. Consider Project Requirements and Recommendations

If, at this point, the solar screening demonstrated that the project is viable, the following should be considered:

- Utility interaction
- NEPA compliance
- Site master plan review
- Requirements for meeting renewable energy goals
- Project incentives
- Historic building issues
- Computer network connectivity authority
- Buy American Act provision

Utility Interaction

If a project includes PV, it also includes an electrical interconnection with the utility. The interconnection agreement is made between the organization and the utility regardless of the solar project developer's role. It's important to communicate with the utility about the proposed project early in the process. This ensures that all interconnection issues are taken into account early on, and helps avoid unpleasant surprises after significant effort has been expended. Depending on the utility and the local distribution system design, the project can be adversely affected by expensive interconnection hardware and requirements. Some requirements can be addressed during the design stage through equipment specifications, which incurs only a nominal extra cost as compared to purchasing additional equipment.

Changes in the electricity tariff rate structure should also be explored and discussed with the utility. Based on the system's projected hourly and seasonal performance, a more optimal tariff could be available that could potentially offset both energy (kilowatt-hour [kWh]) charges and demand (kilowatt [kW]) charges. Although utilities are important partners in the process, they might not be enthusiastic about reduced electrical consumption. Thousands of utilities operate in the United States—each with unique rate structures and policies—so it's important for those planning a renewable energy project to understand their rights as consumers and know what impact the solar system will have on future utility billings. For example, a utility could impose a standby charge to cover the cost of maintaining generation resources that are used when the solar energy system is not generating. An agency should also determine whether it can sign a utility interconnection agreement that has indemnification clauses.

The system owner and utility will eventually develop an interconnection agreement that defines all the specific requirements and terms of the interconnection. Information on state-specific interconnection standards can be found at www.irecusa.org/index.php?id=86 (accessed June 8, 2010).

NEPA Compliance

Opinions differ among agency representatives about when NEPA should be addressed during the process, but it's best to consult the environmental expert responsible for NEPA early in the process. This will ensure that the expert is informed about the decisions and the directions regarding the site locations for the project. This (and possibly other information) will help guide information that will eventually go into the request for proposal (RFP) and ensure that the project stays on track. The following is a general overview of the National Environmental Policy Act.

TRIGGER

If the project is located on federal land or uses federal funding, it must comply with NEPA. The effort involved to comply with NEPA greatly depends on where the project is located on the site and also on the project's scale. The impact of a rooftop system, for example, is typically less than that of a ground-mounted system. As a result, it's usually easier for such systems to

By using solar power to generate electricity, agencies can reduce GHG emissions and produce environmental attributes from the solar power project (e.g., RECs)

comply with NEPA. A NEPA resource can be found at www.epa.gov/Compliance/ resources/ faqs/nepa/index.html (accessed June 8, 2010).

PROCESS

The agency environmental expert assesses the proposed system, and the assessment produces one of the following three results:

Level 1 – Categorical exclusion:
A letter stating exclusion is issued and the process is complete. (Note that rooftop and small ground-mounted projects generally receive a categorical exclusion.)

Level 2 – Environmental assessment (EA):
This has two possible outcomes.

A. Finding of no significant impact (FONSI): If an EA is required, the best outcome is receipt of a FONSI. This process usually costs less than $500,000 and takes less than 6 months.

B. If the EA finds that environmental consequences could be significant, an environmental impact statement (EIS) must be completed.

Level 3 – EIS:
If the environmental expert finds that the project could have a significant environmental impact from the start, an EIS is completed without completing an EA first. This process can cost $1 to $2 million and take up to 18 months. If successful, a record of decision is received and the project can move forward.

Site Master Plan Review

If there is a master plan for the site, it should be reviewed at this stage. A solar energy project is a long-term commitment, typically in place for 25 years or longer. When reviewing a master plan from a 25-year perspective, things to consider include plans for undeveloped land that might be a site for ground-mounted collectors or, in the case of rooftop arrays, determining if and when a building is scheduled for retirement. Also important is whether any architectural plans include aesthetic features that could preclude the installation of solar energy equipment. In such cases, site managers have found that their project site options can be significantly limited.

Requirements for Meeting Renewable Energy Goals

Meeting federal renewable energy goals is a common motive for implementing a renewable energy project. When this is the case, it's important to understand the rules for counting renewable energy toward the EPAct 2005 requirements and the E.O. 13514 GHG requirements, as well as toward individual agency mandates. By using solar power to generate electricity, agencies can reduce GHG emissions and produce environmental attributes from the solar power project (e.g., RECs). This includes all environmental attributes under federal guidance under EPAct 2005 and

E.O. 13423. The agency can choose to sell these attributes, allow the developer to sell them, report them to meet EPAct 2005 requirements, or use them to reduce carbon dioxide emissions under E.O. 13514. Under generally accepted GHG accounting principles, however, an entity must own the RECs from a project before it can claim emissions reductions. The rules governing REC usage vary from agency to agency, they aren't always intuitive, and they dictate how project generated RECs are used. The agency energy manager can explain the agency's approach.

General Services Administration (GSA) gives an example in which more valuable PV RECs were sold to a local utility for $0.24/kWh and inexpensive replacement RECs from wind energy were purchased for less than $0.01/kWh. This greatly increased the economic viability of the PV project. Based on FEMP guidance for the EPAct renewable energy goal, because the renewable energy project is located on federal land, this transaction enabled the party to claim the bonus for the electrical production from the project. The FEMP allows substitutions of RECs for projects on federal or tribal lands to claim the bonus under the EPAct 2005. The generally accepted rules for GHG reporting are different, allowing only single counting of the environmental attributes owned (in this case, the purchased wind energy RECs). Federal guidance for GHG accounting under E.O. 13514 is currently being reviewed. Visit the FEMP Web site for current information (www.eere.energy.gov/femp/; accessed June 8, 2010).

One problem with selling more valuable solar RECs and buying cheaper replacement RECs is the uncertainty surrounding the ability of federal agencies to sell federal property (in this case the solar REC). Solutions that will allow other agencies to sell solar RECs are being evaluated. One solution, similar to the approaches used to take advantage of incentives, is to arrange for the private developer to own and sell the RECs in return for offering the agency a better deal on the project. In this case, because the agency never takes ownership of the RECs, it's not directly involved in the sale.

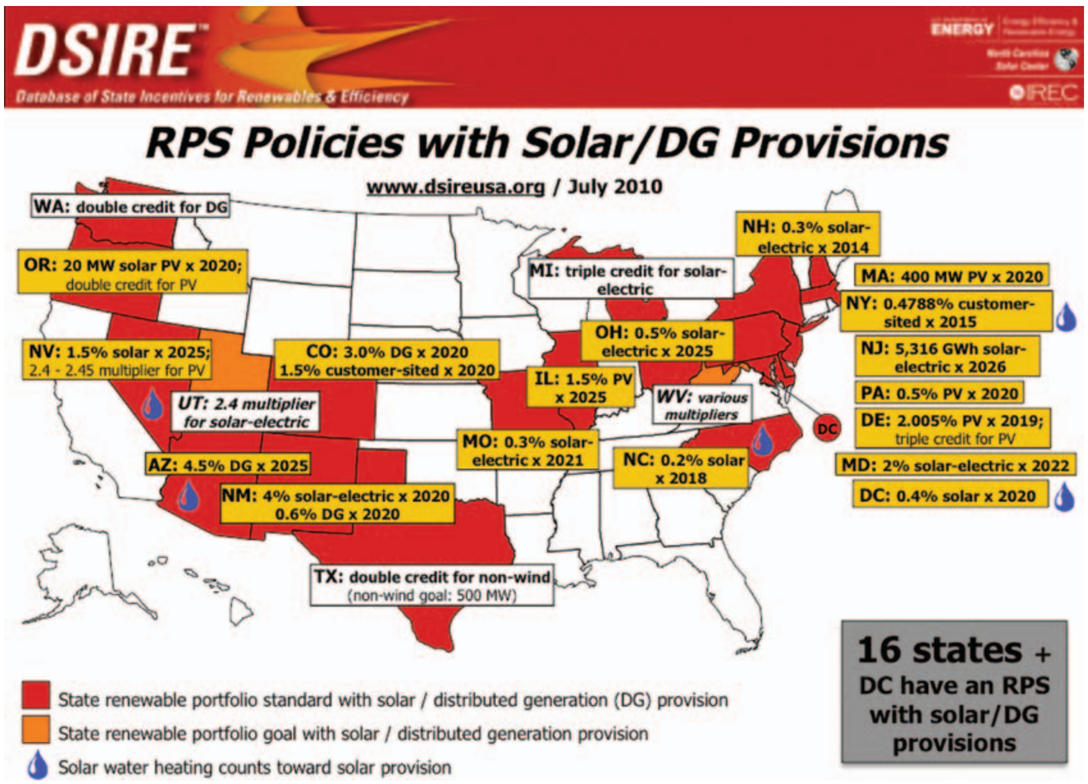
Project Incentives

The solar screening should include all potential incentives that would help the economics of the project. At this point in the process, it's wise to ensure that all incentives have been included and important to understand federal requirements and the agency's policies on incentives. The economics of renewable energy projects are often dependent on federal and state incentives, and the federal government is ineligible for many of these incentives. Private developers, however, can take advantage of the tax credits, grants, and other incentives that drive the renewable energy markets. This becomes a key consideration in deciding whether to fund the solar project through direct appropriations or alternative financing.

Most states have energy incentive programs that help offset energy costs and promote energy

Based on FEMP guidance for the EPAct renewable energy goal, because the renewable energy project is located on federal land, this transaction enabled the party to claim the bonus for the electrical production from the project.

The DSIRE map below illustrates the Renewable Portfolio Standards (RPS) across the United States that also include a solar or distributed generation carve out.



efficiency and renewable energy technologies. FEMP staff members research these programs on a state-by-state basis to help federal agencies meet their energy management goals. (See www.eere.energy.gov/femp/financing/energyincentiveprograms.html; accessed June 8, 2010.) A Database of State Incentives for Renewable Energy (DSIRE) is available at www.dsireusa.org (accessed June 8, 2010). A summary and details for incentive programs can be accessed by state, and information on federal incentives is available as well. This information can aid in determining which incentives apply to an agency's specific circumstances and help estimate any economic impact on the project. It is also critical to consider the time limitations on the incentives and confirm that they will still be offered when the project will be applying to receive them. Although DSIRE information is typically up to date, it's always a good idea to verify the status and availability of incentives with the administering agency or utility.

Renewable energy credits are the property right attribute created when electricity is generated by a renewable energy source. The RECs specific to solar energy generation (solar renewable energy credits or SRECs) generally have greater value. The RECs and SRECs can be sold to a utility to help meet its renewable portfolio standard (RPS) needs, sold on the voluntary market, or "retired" and counted by the agency toward its mandated renewable energy requirements. If RECs are sold or retained by the developer, however, the project no longer qualifies as renewable energy required to meet the EPAct 2005 goal and likely will not be allowable for reducing GHG emissions.

An agency might also have a policy on accepting certain incentives. Several agencies are evaluating whether accepting financial incentives from limited financial pools reduces the incentives available to private-sector investment. If this is the case, agencies could establish policies prohibiting the use of available renewable energy and energy efficiency incentives in projects.

Historic Building Issues

Section 106 of the National Historic Preservation Act (NHPA; www.achp.gov/nhpa.html; accessed June 8, 2010) requires federal agencies to consider the effects of their projects (or projects requiring their assistance or approval) on historic properties, and to give the Advisory Council on Historic Preservation (ACHP) an opportunity to comment. Historic properties are defined as "any prehistoric or historic district, site, building, structure, or object included in or eligible for inclusion in the National Register, including artifacts, records, and material remains related to such a property or resource" [16 U.S.C. § 470(w)]. Section 106 of the NHPA does not mandate preservation, but outlines a process for considering alternatives and allows the public to influence decision making. For more information, see www.achp.gov/docs/Section106FactSheet.pdf (accessed June 8, 2010).

If a project can cause adverse effects on historic sites or buildings, a legally binding agreement is typically used to resolve those effects. If no agreement can be reached, the ACHP issues advisory comments that the head of the agency must consider. Regulations governing the review process are found at www.achp.gov/regs-rev04.pdf (accessed June 8, 2010).

Computer Network Connectivity Authority

Many renewable energy systems—especially electric systems—require automated monitoring and control. This is usually accomplished by connecting the renewable energy system to a facility's existing building-monitoring system through a computer network connection. Some computer networks are operated under contracts that have very specific requirements. These contracts can be restrictive, allowing only network connection of specific devices, and sometimes even permitting only a limited set of preapproved software and hardware. It's crucial that the parties controlling the computer network be involved early in the process, because it's difficult and time-consuming to acquire the "authority to operate" a system connected to the network. An example is the United States Navy's computer networks, which are operated by a contractor under the Navy/Marine Corps Intranet (NMCI) contract. A renewable energy system that required a network connection was installed, but because of the contract it couldn't be operated until required permissions were obtained—which was a long and difficult process.

Buy American Act Provision

The Buy American Act restricts the federal government's purchase of supplies and construction materials that are not made domestically. The act contains many provisions, and when looking at the specification of components for a solar system, it's difficult to determine which products comply and which do not. The current understanding is that a product manufacturer self-certifies its products as meeting the provisions of the Buy American Act, and that an audit system exists for this certification process. This guide cannot confirm the correctness of this process, but it provides the best information available at the time of publication. If a project team decides to install solar equipment that complies with the Buy American Act, the equipment can be purchased directly from a manufacturer that meets this requirement, or this requirement can be specified in the RFP and in the final contract. It's important to consult with an agency's buyers and procurement office about their latest understanding of the agency's specific requirements.

Installation of skylight glass laminated with PV cells at the Thoreau Center for Sustainable Development, Presidio National Park, San Francisco, California.. *(Credit: Lawrence Berkeley Lab, PIX 01056)*

Step 5. Make a Financing & Contracting Decision

If a project reaches the financing and contracting point in the process and is moving forward, the solar screening has established—and the project team concurs—that a solar project is worth pursuing through the next step, "Make a Financing and Contracting Decision." Unless funding is designated for the project (i.e., the agency will fund the project), this can be a complex decision. If no direct funding is available, financing options must be considered. Before choosing an available financing option, review the options and information presented in this guide. Then contact a financing specialist to discuss the specifics of the project and confirm the appropriateness of the financing decision. For option-neutral direction on this topic, contact Michael Callahan at National Renewable Energy Laboratory (NREL) (michael.callahan@nrel.gov). In addition, FEMP maintains a Web site and offers Webinars and workshops to educate participants on the different financing options available. The FEMP financing information can be found at www.eere.energy.gov/femp/financing/mechanisms.html (accessed July 26, 2010). The FEMP training information is available at www.eere.energy.gov/femp/services/training.html (accessed June 8, 2010).

The financing options considered in this guide follow:

- Power purchase agreement (PPA)
- ESPC and optional energy services agreement (ESA)
- Utility energy services contract (UESC)
- Enhanced use lease (EUL).

This guide also describes the process for agency-funded or direct-appropriation projects.

Part 2. Execute a Solar Energy Project

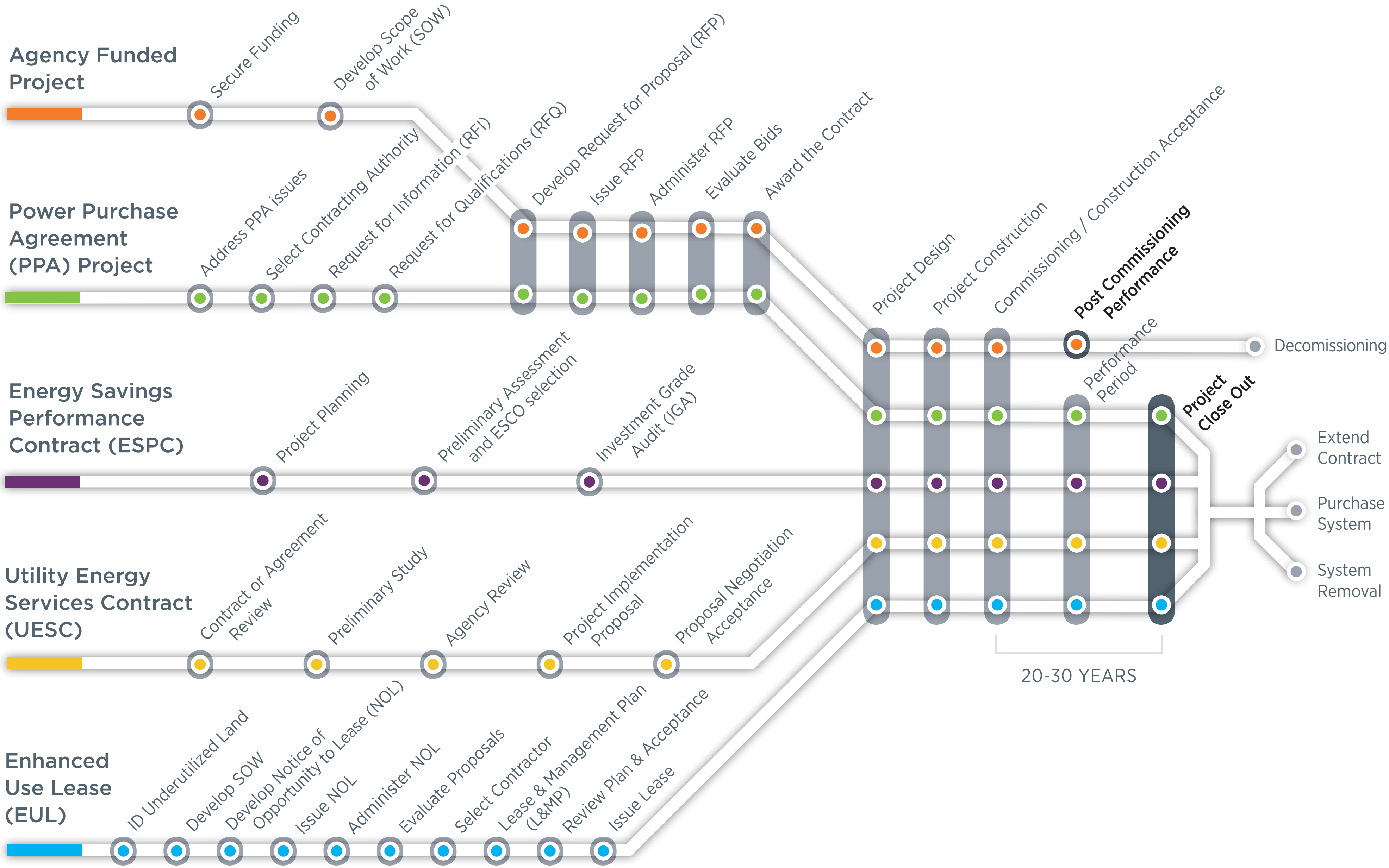
After a financing and contracting option has been selected, the next part is to execute the project. Each project follows a process that is unique to the financing and contracting option selected. The ESPC option has a rigid process and the UESC has a less rigid process. The other processes, however, can be seen more as recommended guidelines. For each of the options listed, the sections below describe general characteristics, provide case studies and project process, and list available resources.

Financing Options

- Agency Funded Project
- Power Purchase Agreement (PPA) Project
- Energy Savings Performance Contract (ESPC)
- Utility Energy Services Contract (UESC)
- Enhanced Use Lease (EUL)

PART 2: EXECUTION

IMPLEMENTATION »



Agency-Funded Project

An agency-funded or agency-appropriated project is one for which funds have been designated for the outright purchase of a project, in this case a solar energy project. The government owns the system, its energy production, and all the attributes of the system (e.g., SRECs).

PROS	CONS
▪ Well-understood mechanism. ▪ Common to many federal capital projects. ▪ Does not incur any financing costs. ▪ Long-term energy-cost reduction.	▪ Site is responsible for operations and maintenance arrangements (including inverter replacement) but can purchase an operations and maintenance (O&M) service contract. ▪ No assurance of long-term performance (can purchase optional long-term performance guarantees, which differ from a manufacturer's warranty). ▪ Could be more human-resource intensive than other options. ▪ Will not be able to monetize available tax incentives.

1 Secure Funding

Unless funding has been secured for this project, a case must be made for the project and funding must be requested. The primary source for this funding will be the individual agency—as it is the agency that is responsible for meeting renewable energy targets. Typically, agencies want to examine a business case. The data for a business case should be in the project solar feasibility study but, in some cases, additional data or analysis must be confirmed or put in place. An example is a PV project that was evaluated in 2003 but which did not meet the financial requirements for funding. Three years later (2006), a state law requiring that a percentage of the utility's electricity come from solar power was passed. This essentially required a utility to buy SRECs, which sold for a premium of $0.24 per kWh. Thus, the project changed from an unacceptable investment to a good investment and funding was granted. This is a good example of how incentives can help make the business case for a project.

Steps to Follow

1. Secure funding
2. Develop the scope of work
3. Develop a request for proposal
4. Issue a request for proposal
5. Administer a request for proposal
6. Evaluate the proposals
7. Award the contract
8. Design the project
9. Construct the project
10. Commission the system
11. Post-commissioning performance

Case Studies

(see Appendix C)

- **United States General Services Administration, Federal Center PV Project, Denver, Colorado**

  1.19-megawatt (MW) PV

  www.gsa.gov/portal/content/105165

- **Social Security Administration, high-temperature hot-water project, Philadelphia, Pennsylvania**

  54-m^2 solar thermal system

  www.eere.energy.gov/femp/services/yhtp/energy_projects_detail.cfm/id=8

Social Security Administration, high-temperature hot water project, Philadelphia, Pennsylvania, 54-m^2 solar thermal system (*Credit: Ed Hancock, Mountain Energy Partnership*)

Note that it is recommended that a project solar feasibility study be completed before this process is started. For more information, see Part 1, Step 3, "Evaluate Candidate Solar Energy Sites."

2 Develop the Scope of Work

The scope of work becomes the basis of the RFP used to solicit project proposals from solar developers. The form and detail of this scope of work (SOW) are based on the selection of contract type. Typical contract types are:

- GSA schedule,
- Design-bid-build, and
- Design-build.

The GSA schedule identifies contractors that specialize in solar installations. Several of these contractors offer turnkey solutions and can assess the site, design the system, and install the system. Pricing is based on published rates, but vendors might offer discounts. The GSA schedule system can be a quick and efficient contracting mechanism.

Using the design-bid-build method, the scope of work is built around a complete design and specification of the system. This is a very prescriptive approach and the solar developer bids using the complete specifications. Typically this approach is used only when there are very specific design and engineering requirements which necessitate a defined design. In comparison, what is sought in solar projects typically is more performance based.

For the design-build process in the case of a solar project, the scope of work is built around a performance specification. The performance specification typically is not prescriptive and it allows the proposing developers latitude to design systems using their unique competitive advantages. This can lead to good performance per dollar invested.

The project's solar feasibility study should provide the basis for the project's scope of work. The team's solar expert is a key person in the development of this document. The SOW should include:

- Location on-site,
- Performance specification (or project design in the case of design-bid-build),
- Specific site requirements, and
- Type of solar system.

A performance specification can include the following.

- The performance metric used to define the performance. This could include DC output, AC output, and delivered energy. It is not difficult to measure the output of a solar system, but a calculation often is required to normalize these measurements to conditions (solar resource, load) used to derive the performance statement. A performance specification for PV, for example, could state minimum performance based on actual measured solar (e.g., not less than 80% of calculated levels). A specification for solar thermal could state that the system operate above a stated level of efficiency when measured (e.g., 25%).

- Inverter warranty and efficiency (e.g., a minimum of 10 years, 94% California Energy Commission (CEC) weighted efficiency). See, for example, the Go Solar California "List of Eligible Inverters," at www.gosolarcalifornia.org/equipment/inverters.php (accessed June 9, 2010).
- PV module warranty (e.g., 90% of nameplate rating for first 10 years, 80% at 25 years). See, for example, the Go Solar California "List of Eligible SB1 Guidelines Compliant Photovoltaic Modules," at www.gosolarcalifornia.org/equipment/pv_modules.php (accessed June 8, 2010).
- A solar heating- and cooling-system warranty—if it is a custom-built system such as a large concentrator array. For commercial flat-plate and evacuated tube collectors, it is common to specify collectors and systems that are tested to Solar Rating and Certification Council (SRCC) standards and certified by the SRCC. Federal tax credits and most state incentives require SRCC certification. Testing and certification standards currently are being developed for air collectors.
- Minimum annual kWh or Btu production (if needed, for example, to meet minimum SREC production target).
- Interface requirements. Any physical and operational requirements that are imposed by connecting to existing systems (e.g., locations, voltages, temperatures) in such a way that performance of both solar and conventional systems is optimized.
- If a system is ground-mounted, then vegetation preparation and re-establishment as well as its height above the ground should be addressed. This is important because shading due to vegetation and snow accumulation at the lower edge of collectors can impair performance.

Sample performance specifications and SOWs are available at https://www.fbo.gov/download/d22/d22e91f03f8ff7af7105083a2b0b7f94/ARRA_Roof_Final_Specs_9-28-2009.pdf (accessed June 9, 2010); and https://www.fbo.gov/files/archive/ade/ade31d57bafa783a18f8d802437a060a.pdf (accessed July 19, 2010).

The GSA schedule identifies contractors that specialize in solar installations. Several of these contractors offer turnkey solutions and can assess the site, design the system, and install the system.

AGENCY-FUNDED PROJECT
CASE STUDY

Denver Federal Center (GSA)

The Denver Federal Center (DFC) is a 640-acre, secured federal facility operated by the GSA. Twenty-six federal agencies occupy approximately 50 active buildings, with approximately 6,000 employees on site. The GSA is striving to make this facility the most sustainable business park in the country. In 2004, the state of Colorado established a renewable energy standard, which started the process by which the DFC could obtain its first PV electrical generating facility. The REC system created by the standard enabled the DFC to sell RECs produced from a PV system at a price that made the system economical. With technical assistance from NREL, the DFC awarded the design-build contract through a competitive RFP and was able to get the project installed in just a few months to meet REC sale obligations. The system is a 1.19 MW fixed tilt system that generated 1,726 megawatt hours (MWh) in 2008. Generation in 2008 was 2.5% of DFC's total annual load. Less expensive RECs from Texas were purchased to help the GSA meet its renewable energy targets. A performance specification in the contract allowed the DFC, who owns the system, to confirm the continued performance of the system during the first year of operation.

Credit: Dave Mowers; U.S. General Services Administration (GSA), PIX 17421

3 Develop a Request for Proposal

An RFP is the document issued to the public to solicit proposals; in this case, from solar developers. (If using the GSA schedule, then an RFP is not required and there is no need to go through the RFP process.) The RFP describes how the proposal process is to be conducted and provides information that can be used as a basis for a developer's proposal. An RFP should include the following elements (listed alphabetically, and not in order of importance).

- Clarification of party responsible for procuring permits
- Commissioning plan
- Criteria and process to be used to evaluate proposals
- Definition of infrastructure requirements (if any)
- Delineation of historic building requirements (if any)
- Description of NEPA requirements (if any)
- Due diligence
- Explanation of how the proposal process is to be administered (e.g., proposal meetings, site visits, responses to questions)
- Limits on proposed project timeline
- Requirements for priced options (for example, extended warranty and maintenance agreements priced in 5-year increments)
- Restrictions (or preferences) on parties allowed to submit proposals (e.g., small business, woman owned, veteran owned); this is a policy decision that can be based on agency- or site-specific preferences
- SOW
- Specification of post-commissioning performance
- Timelines for proposal process.

CRITERIA AND PROCESS FOR EVALUATING PROPOSALS

Describing the criteria and the process to be used to evaluate the proposals helps developers to structure their responses and ensures that the project's primary issues are addressed. This also makes it easier to review proposals. The respondents address identified criteria in separate sections, eliminating the need for a reviewer to pick statements from the entire proposal that apply to the criteria. The three common processes used for evaluating proposals are listed below.

- ***Best Value.*** In the best-value approach, a set of evaluation criteria (typically four to five categories) is developed. Each category is weighted to signify both its importance and how much it counts in the evaluation. Although agencies make their best attempts at systematizing this process, this can be a very subjective approach and could lead to an arduous process of contentious evaluations. This process should be considered if the project has specific high-priority issues, such as tight schedules, historic building issues, environmental issues, or specific technical issues.
- ***Low Price, Technically Acceptable (LPTA).*** In the low-price, technically acceptable approach, the proposals first are reviewed for technical acceptability and the price information is excluded. Proposals that meet or exceed the technical acceptability requirements continue in the process to then compete on price alone.
- ***Low Price.*** In the low-price approach, the developer that offers the lowest cost proposal (e.g., installed cost; projected annual production in kWh) and meets minimum requirements (e.g., equipment-quality specifications) is chosen.

DUE DILIGENCE

Describing how to handle due diligence on the developer's part has important contractual implications. Due diligence is the effort that a developer must put forth to fully understand the project and the risk of any unknowns that could arise. Contractually, the developer desires recourse if something unexpected comes up that is outside of its ability to perform or that will cause significant cost increases (such as roof structural issues, or discovery of subterranean rock that precludes using standard trenching machines). In such circumstances, the developer might want to be able to walk away from the project or have the option to renegotiate. Agency options range from giving developers what they want contractually to telling developers to factor the risk into their proposals and handle any unexpected circumstances that arise.

Depending on the project, due diligence can require considerable effort and expense. If this is the case with the project, or if this becomes apparent as the RFP process progresses, consider adding steps to the process. Additional steps can include an initial proposal review and the creation of a short list of prospective developers. Those on the short list are invited to continue with the RFP process, which includes expending additional effort and incurring more expense for due diligence. The purpose of this extra step is to assure the developers on the short list that they have a good chance at being successful, and that it is worthwhile to put forth the extra effort and expense required for due diligence. A site due diligence date—after which the developer will have entered into an irrevocable contract—should be specified.

PROPOSAL PROCESS ADMINISTRATION

The description of proposal administration includes the timing and location of proposal meetings and site visits, and the process for answering questions. The proposal meeting is the forum for presenting the project requirements in detail to interested developers and for developers to ask questions. The site visit enables interested developers to assess site conditions and to ask additional questions. The site visit can be held in conjunction with the proposal meeting or be conducted separately. Depending on site conditions and the process chosen, additional site visits could be necessary for respondents to perform additional due diligence.

Questions that arise during and after the proposal meeting and site visit must be handled such that all developers have access to the same information. There are many variations on how this can be accomplished. A recommended method is to write down every question, answer each, and post the questions and answers on a Web site. This process can help avoid variation in answers, minimize participant misunderstanding, and eliminate the possibility of one party receiving more information than another.

POST-COMMISSIONING PERFORMANCE SPECIFICATION

Consider adding a post-commissioning performance guarantee into the RFP. This guarantee ensures a minimum level of performance for a specified time after the renewable energy system has been commissioned. An example of this is a PV system that requires quarterly performance verification for the first year of service and which has a guarantee that the system output is to be at least 80% of calculated output based on actual solar insolation (solar energy) for the period. Sample performance specifications and SOWs are available at https://www.fbo.gov/download/d22/d22e91f03f8ff7af7105083a2b0b7f94/ARRA_Roof_Final_Specs_9-28-2009.pdf (accessed June 9, 2010); and https://www.fbo.gov/files/archive/ade/ade31d57bafa783a18f8d802437a060a.pdf (accessed July 19, 2010).

4 Issue a Request for Proposal

After the RFP is complete, announce it somewhere that developers can find it. One prominent Web site that is familiar to most developers is Federal Business Opportunities, www.fbo.gov (accessed June 8, 2010). Another Web site option is the Green Power Network, http://apps3.eere.energy.gov/greenpower/financial/ (accessed June 8, 2010). If using the GSA schedule, then it typically is desirable to receive proposals from three different vendors on the schedule. See www.gsaelibrary.gsa.gov/ElibMain/sinDetails.do?executeQuery=YES&scheduleNumber=56&flag=&filter=&specialItemNumber=206+3 (accessed June 8, 2010).

5 Administer the Request for Proposal

After the RFP is issued, follow the defined timeline and described RFP process. Adjust both as necessary if unforeseen events arise. This step may include site visits, pre-bid meetings, and correspondence related to the project's questions and answers.

6 Evaluate the Proposals

Assemble a small team to evaluate the proposals received. The number of team members to include depends upon the specific project, but the team should have at least three people. Most of the people on this team probably will come from the project team. Other key people to consider including on this team are the:

- Energy manager,
- Facilities manager,
- Project manager,
- Site manager (if there are managers for different areas of a site),
- Solar expert, and
- Utility representative (if a good relationship with the utility exists, then a representative could be included as a non-voting member).

The process for evaluating the proposals should have been established as the RFP was being developed. It is recommended that the merit-review sessions be set up well in advance, to ensure the availability of key personnel. Follow the proposal evaluation criteria described in the RFP and, from the start, clearly define the meaning of each criteria and score. Each agency is also likely has its own review process to follow, and it is important to address that as well.

Evaluating assumptions and exclusions included in the proposal requires particular care. Are the assumptions and exclusions reasonable, based on the information available about the project? Do they demonstrate good judgment? What should be avoided are the costly change orders or price increases that can come with the low cost proposals that are based on poor assumptions or excessive exclusions. The risk is that what initially seems to be the lowest cost proposal actually could be much more costly in the end.

7 Award the Contract

There are several options that can be used in awarding the contract.

- **Award Based on Proposal.** The contract is awarded solely on the merits of the proposal as they are determined when the proposals are evaluated.
- **Award with Discussions.** The contract is awarded on the merits of the proposal but is contingent, in part, on further discussions to clarify understandings, agreements, and responsibilities.

One option to help ensure system performance is to include performance verification as part of the contract. Performance verification should extend for a specified period after commissioning, and the verified performance should meet a predetermined threshold.

USPS Marina Mail Processing Center, Los Angeles, California. *(Credit: Bill Golove, PIX 11059)*

- **Award with Discussions and Negotiation.** The contract is awarded on the merits of the proposal but is contingent on further discussions and negotiations. This can be used in the case of receipt of a good proposal that requires adjustments to meet the specific needs of the project. This approach can be employed when unanticipated ambiguities in the RFP or project specifics arise during the RFP process and result in varied proposals that do not quite meet the objectives.
- **Award with Best Proposal.** In this process, a short list of developers is created based on their proposals. The short-list contractors then are asked to develop their best and final offer (BAFO). This request for a BAFO can include information such as updated pricing and design specifications. At this point it is assumed that developers on the short list are technically competent, therefore the evaluation is based primarily on price unless the best value method is employed. This approach also can be used in conjunction with projects that have significant due diligence issues, as noted in the "Develop a Request for Proposal" section. It is recommended that the short list include not more than three developers. As the number of developers on the short list increases, the odds of success decrease for each individual developer as does the willingness of the developers to expend money and effort to tighten their proposals.

8 Design the Project

After the contract is awarded the project design phase begins. The design parameters that the system designer will work within should be clear from the RFP, any questions that arose during the RFP process, and the due diligence performed by the developer. The design kickoff should confirm these design parameters for all parties. It is recommended that design reviews be performed by a third-party, qualified solar-design expert at 25%, 50%, and 100% design completion, to confirm that site requirements are met. When utility interconnection agreements are part of the project, it is recommended that the utility also reviews and approves the project design.

If the design-bid-build contract type is employed, then the system design already has been completed. The developer, however, could have recommendations on design changes that would improve the system. Any changes should be reviewed by a third-party, qualified solar-energy system expert to help confirm that no unanticipated consequences will occur due to the change. A thorough design review always is faster and less expensive than fixing design flaws later. To help with the design reviews, a "Photovoltaic Project Design Evaluation Checklist" is included in Appendix B. The SRCC Web site has links to extensive design guidance for commercial-scale solar heating and cooling systems at www.solar-rating.org/commercial/guidelines.htm (accessed June 8, 2010).

9 Construct the Project

The actual construction of the project typically is not much different from a standard mechanical electrical construction project. If the project includes PVs, then more utility involvement might be required because of the electrical-generation component. This should not be a problem if the utility has been involved with the project from its early stages and has approved the plan.

10 Commission the System

When the system is significantly complete and operational, it is recommended that it be commissioned and inspected by a third-party expert. This is where superior system design and solid performance specifications help to ensure good value. A top-notch commissioning makes certain that the system has been installed properly and is operating to specifications. It also confirms that there are no apparent safety issues due to poor installation (e.g., damaged wire insulation, unprotected high-voltage connections). It also is recommended that a good commissioning plan be established and agreed upon during the RFP process. The commissioning plan can be written into the RFP or be proposed by the developer. If proposed by the developer, then the agency solar expert should review it and make sure that it meets all requirements. A "Photovoltaic Commissioning Checklist" is located in Appendix B.

11 Post-Commissioning Performance

If the agency owns its system, then it is concerned with how it will operate over time and what recourse is available if the system ceases to operate according to expectations. Equipment manufacturers warranty their products and developers might provide a warranty on the system. The key questions are, "What does the warranty cover?" and "How can it be determined whether there is a problem if there is no obvious malfunction?" It is recommended that there be clear agreement with the developer regarding system performance expectations and what constitutes a system failure.

One option to help ensure system performance is to include performance verification as part of the contract. Performance verification should extend for a specified period after commissioning, and the verified performance should meet a predetermined threshold. An example of this is a PV system that requires quarterly performance verification for the first year of service, and a contractual mandate that system output must be at least 80% of calculated output based on actual solar insolation for the period. If desired, the project team and solar expert can develop a reasonable agreement with the developer for a guarantee of this nature.

Long-term monitoring of the system to understand reliability and operations and maintenance costs also is an important part of continued performance and economic benefits. The DOE SETP can track performance and reliability of system installations. If interested in having the DOE track a specific system, contact Michael Quintana at Sandia National Laboratories (maquint@sandia.gov).

Power Purchase Agreement Project

Power Purchase Agreements (PPAs) have been used to finance solar projects since 2003 and they are now driving most commercial solar installations. They are increasingly being utilized by the federal sector. Under a PPA, a private entity (typically a group consisting of developers, construction companies, and finance companies) installs, owns, operates, and maintains customer-sited (behind the meter) solar energy generation equipment. The site purchases electricity or thermal energy through a long-term contract with specified energy prices. Payment is based on actual energy (kilowatt-hours or therms) generated from the solar equipment and consumed by the site. So far, PPAs only have been applied to electricity purchases, but there is no obvious reason why they couldn't be used to purchase thermal energy as well. Be aware that some of the obstacles to PPAs—such as their legality in certain states—does not apply to thermal projects because thermal energy is not regulated in the same manner as electricity production.

A PPA is a relatively new contracting option and, as such, the PPA section of this guide is based on a limited level of federal PPA experience. This section will be updated periodically to reflect new information and recommended best practices—especially if long-term renewable contract authority legislation is passed to make PPAs more financially viable within the federal sector (PPAs almost always require long-term contracts to make the offered price of energy competitive). To address the contract length limitation, federal agencies are exploring methods that are available under existing federal laws and regulations, and also are making other contractual issue improvements. Agencies and industry are encouraged to work to find successful solutions and to share any lessons learned.

Note that innovative options are being used to reduce the transaction costs of completing PPAs, such as multi-award contracts (MACs) that are indefinite delivery, indefinite quality (IDIQ) contracts made with preapproved solar developers. In this example, only a smaller set of project specific details must be worked out and several of the steps listed above can be shortened or can be skipped altogether. An example of this approach is the MAC that the Naval Facilities Engineering Command Southwest (NAVFAC SW) division is pursuing with five solar developers for PPA projects in its region, and which only can be used by U.S. Navy and Marine Corps facilities.

Steps to Follow

1. Address power purchase agreement-specific issues
2. Select a contracting agent (if needed)
3. Develop and issue a request for information (optional)
4. Develop and issue a request for qualifications (optional)
5. Develop a request for proposal
6. Issue a request for proposal
7. Administer the request for proposal
8. Evaluate the proposals
9. Award the contract (issue any needed indefinite delivery, indefinite quantity [IDIQ] task order)
10. Design the project
11. Construct the project
12. Commission the system
13. Monitor the performance period
14. End contract oversight

Case Studies

(See Appendix C)

- **NREL PV Project, Golden, Colorado**
  720-kW PV
  www.eere.energy.gov/femp/pdfs/pfs_mesatoparray.pdf
- **Fort Carson PV Project, Colorado Springs, Colorado**
  2-MW PV
  www.3phases.com/news/news-item.php?id=32

PROS	CONS
Renewable energy developer is eligible for tax incentives and accelerated depreciation, which could lead to reduced energy costs.	Transaction costs include a significant learning curve and time investment.
Agency is not required to provide up-front capital.	Federal-sector experience is limited.
Renewable energy developer provides operations and maintenance for the duration of the contract (no agency O&M responsibilities).	Civilian agencies are limited to 10-year term PPA utility contracts (the U.S. Department of Defense [DOD] has 2922A authority, which permits 30-year terms).
Government faces minimal risk.	Site-access issues are complex.
Agency typically receives a known long-term electricity or thermal energy price for a portion of the site load (which reduces the price risk of fluctuating utility energy prices).	Management and ownership structures are complex.
Developer has incentive to maximize production by the system (compared to the case of a direct purchase of the system).	Contract termination penalties.
Agency potentially can use available funds for a front-end buy down to get a better PPA price or a larger system.	

1 Address Power Purchase Agreement–Specific Issues

Before beginning the power purchase agreement process, confirm that a PPA is allowed in the state in which the project is located. The restriction information for PPAs is available on the DSIRE Web site at www.dsireusa.org/summarymaps/index.cfm?ee=1&RE=1 (accessed July 19, 2010). If DSIRE indicates that PPA status is unclear or apparently disallowed, it is recommended that the state's energy office or public utility commission be contacted to help determine whether a PPA is legal for the site.

In general, PPAs typically are used only to implement larger projects (typically 100 kW or greater). This is based on several cost factors, including transaction costs, securing financing, and economies of scale that make the PPA electric price more acceptable. Recently, however, there have been indications that developers might consider smaller projects. For a relatively small project, several options exist. Multiple smaller solar projects can be aggregated into one larger project, could be bundled with energy efficiency in an ESPC or UESC, or can use agency funding. Generally PPAs can be used for a solar thermal project, but the assumption is that most solar thermal projects are not large enough to interest developers.

To be economical, most PPAs require long-term contracts—generally 15 to 20 years—and most agencies do not have the authority to enter into utility contracts of this length. Congress might change this but at present a workaround is required. Western Area Power Administration (Western) can help with long-term contracts for sites in its area (www.wapa.gov; accessed June 8, 2010). Western can negotiate and sign the PPA on behalf of a federal agency, but the federal agency actually must select the solar developer.

Innovative methods to address the contract length limitations are being explored. An example is a long-term land-use agreement that includes a provision requiring the solar project developer to give the federal agency hosting the solar project right of first refusal on purchase of the power at a predetermined price. If the agency does not purchase the power, then the developer is free to sell it to the local utility. Before utilizing this method, investigate legal issues and determine any possible effect on a developer's proposed electricity price. The developer could perceive more income risk and increase the price of electricity to compensate.

The secretary of the DOD has the authority (10 U.S.C. §2922A) to allow long-term contracts of up to 30 years in duration (with approval of the secretary of defense). The U.S. Navy plans to use this authority for the NAVFAC SW division multiple-award contract. Approval through the U.S. Secretary of Defense, delegated to the U.S. Secretary of the Navy, will be sought under task order awards for these projects.

2 Select a Contracting Agent

Determine the best contracting route to use. Typical options include local, regional, or headquarters contracting staff, Defense Logistics Agency (DLA Energy, formerly Defense Energy Support Center), or Western Area Power Administration. Contact the contracting agent early after project identification to determine the best approach for the next steps in the process. Note that Western only signs the PPA, the agency for the site must select the solar developer.

3 Develop and Issue a Request for Information *(Optional)*

A request for information (RFI) is a way to obtain feedback on the proposed project to help refine and develop the RFP. Recommendations of types of projects for a specific site typically are helpful. The U.S. Navy used an information-request process in California, and respondents overwhelmingly recommended behind-the-meter PV projects sized to meet on-site loads. This is due to local interconnection requirements for large systems connecting directly into the grid. The information was used to refine the government's requirements for the scope of work used in the RFP. An RFI also allows industry to comment on the proposed process.

4 Develop and Issue a Request for Qualifications *(Optional)*

Another optional step that has been used for at least one federal site is a request for qualifications (RFQ). The purpose of the RFQ is to obtain a list of developers that are interested in the project and to learn about their specific qualifications. Developers that meet a stated qualification level can submit a proposal based on the RFP created in the subsequent step in the process. Developers typically decide which

RFPs to respond to based on the limited development funds available. Developers have indicated a preference for this step because responding to an RFQ is relatively easy and inexpensive, and it reduces the field of competitors. A smaller field of competitors increases the probability of success, and qualified developers are assured that they are competing against other qualified developers. Receiving proposals only from qualified developers also can reduce the team's review workload and encourage qualified developers to invest more in their proposals, as there is a greater chance of being awarded the contract. The criteria to be used to qualify proposers must be stated. If the RFQ step in the process is not used, then the information that would have been received in the RFQ must be requested in the next step, the RFP. The following list includes items to consider including in the RFQ.

- Executive bios
- Letters from investors
- Professional affiliations
- Project experience (e.g., size, type, year built, customer)
- References
- Sample PPA
- Three years of audited financial statements
- Evaluation criteria and/or evaluation process, if selecting a short list of proposers

5 Develop a Request for Proposal

A request for proposal is the document issued to the public to solicit proposals; in this case, from solar developers. The RFP describes how the proposal process is to be conducted and provides information that can be used as a basis for a developer's proposal. Sample documents can be found at the FEMP PPA Web site (www.eere.energy.gov/femp/financing/ppa_sampledocs.html; accessed July 19, 2010). An RFP should include the following elements (listed alphabetically, and not in order of importance).

- Assignment of renewable energy attributes (ownership of the RECs)
- Drawings and maps (if available)
- Building restrictions (for rooftop installations) such as roof penetrations, warranty considerations, roof replacement plans, and maximum roof weight capacity
- Contracting officer representative information (if applicable)
- Current energy-consumption data
- Infrastructure requirements (if any), such as roads, fences, electrical system upgrades, tree removal, and determining which party is responsible for coordination and payment
- Environmental requirements such as NEPA, NHPA, Endangered Species Act, and other applicable federal, state, and local requirements
- Due diligence
- End-of-project options
- Evaluation criteria and process
- Land-use agreement (include this as an attachment)
- Language of the PPA (optional)
- Limits on proposed project timeline
- Liquidated damages
- Proposal process administration plan (e.g., proposal meetings, site visits, answers to questions)
- Qualifications (if RFQ step is not used)
- Required submittals (can include acceptable pricing formats; for example, fixed-price only with escalation)
- Restrictions (or preferences) on parties allowed to submit proposals (e.g., small business, woman owned, veteran owned); this is a policy decision that can be based on agency- or site-level preferences
- Safety restrictions for construction
- Site addresses
- Site design criteria

- Site fire standards and safety requirements
- Specific site-access requirements
- Solar energy system requirements, including system type and location
- Termination for convenience (provisions and termination schedule)
- Timelines for proposal process

ASSIGNMENT OF RENEWABLE ENERGY ATTRIBUTES

The RFP must be clear on ownership of the attributes of the renewable energy generated. Depending on the markets for these attributes, they can be a major factor in determining the PPA electricity price. These attributes also might factor into the agency's renewable energy goal requirement (for information, contact the person responsible for such requirements). It is important to be clear that renewable energy credits include GHG emissions and all other environmental attributes. If the renewable energy credits are sold, then replacement RECs can be purchased for credit towards the EPAct 2005 renewable energy goal. Present guidance is that no credit towards the E.O. 13514 goal is allowed if the RECs (including the GHG emissions) are sold or are retained by the developer.

CRITERIA AND PROCESS FOR EVALUATING PROPOSALS

Describing the criteria and the process to be used to evaluate the proposals helps developers to structure their responses and ensures that the project's primary issues are addressed. This also makes it easier to review proposals. The respondents address identified criteria in separate sections, eliminating the need for a reviewer to pick statements from the entire proposal that apply to the criteria. The three common processes used for evaluating proposals are listed below.

- ***Best Value.*** In the best-value approach, a set of evaluation criteria (typically four to five categories) is developed. Each category is weighted to signify both its importance and how much it counts in the evaluation. Although agencies make their best attempts at systematizing this process, this can be a very subjective approach and could lead to an arduous process of contentious evaluations. This process should be considered if the project has specific high-priority issues, such as tight schedules, historic building issues, environmental issues, or specific technical issues.
- ***Low Price, Technically Acceptable.*** In the LPTA approach, the proposals first are reviewed for technical acceptability and the price information is excluded. Proposals that meet or exceed the technical acceptability requirements continue in the process to then compete on price alone.

Under a PPA, a private entity (typically a group consisting of developers, construction companies, and finance companies) installs, owns, operates, and maintains customer-sited solar energy generation equipment.

POWER PURCHASE AGREEMENT PROJECT
CASE STUDY

NREL Mesa Top PV (DOE)

In order to meet its EPAct 2005 goal of 7.5% of electricity from renewable sources, NREL, in Golden, Colorado, utilized a power purchase agreement to build a PV system on top of the mesa above its campus. The system is a 720 kW, ground mounted, single axis tracking array that produces 1,200 MWh annually or more than 7% of the lab's electricity use in 2008. NREL selected SunEdison to do the project. Western Area Power Administration used its long-term contract authority to sign a 20-year solar power and services agreement with SunEdison to provide solar-generated electricity to DOE for use at NREL. SunEdison financed, built, owns, and operates the PV system. The company sells the RECs to Xcel Energy, and NREL purchases replacement RECs to maintain its carbon-neutral status and meet federally-mandated renewable energy goals. The price per kilowatt-hour for electricity from the array is equal to or less than the price NREL pays for utility-supplied power. There were no up-front costs to NREL, and the EPAct goal was achieved four years ahead of requirement. SunEdison provides data on system performance that help NREL track target achievement. The system has been operational since December 2008.

Credit: SunEdison, PIX 17423

- ***Low Price.*** In the low-price approach, the developer that offers the lowest cost proposal (e.g., installed cost; projected annual production in kilowatt-hours) and meets minimum requirements (e.g., equipment-quality specifications) is chosen.

Different variations on these three evaluation processes have been created in an effort to elicit a better proposal and to reduce the investment required in the proposal process. One example essentially is an RFQ combined with an indicative price. The RFQ addresses the technical acceptability of the developer. The indicative price is meant to provide a "reasonable" idea of the price terms, and requires less developer investment than that required for a full proposal. Based on the evaluation of the proposals, one or two respondents are chosen to submit a full proposal.

Evaluation criteria can include the following.

- Amount of energy generated on an average hourly, monthly, and annual basis over the term of the agreement, including a degradation factor
- Developer's experience and performance track record and references
- Developer's financial health
- Developer's ongoing long-term ability to service the system
- How specific site issues and requirements will be addressed
- Implementation plan
- Local sourcing of components and labor
- Price
- Performance plan
- Quality components
- Quality plan

DUE DILIGENCE

Describing how to handle due diligence on the developer's part has important contractual implications. Due diligence is the effort that a developer must put forth to fully understand the project and the risk of any unknowns that could arise. Contractually, the developer desires recourse if something unexpected comes up that is outside of its ability to perform or that will cause significant cost increases (such as roof structural issues, or discovery of subterranean rock that precludes using standard trenching machines). In such circumstances, the developer might want to be able to walk away from the project or have the option to renegotiate. Agency options include—but are not limited to—giving developers what they want contractually or telling developers to factor the risk into their proposals and handle any unexpected circumstances that arise. Government agencies do have language for equitable adjustments in price given increased scope of work, however. Also, in accordance with Federal Acquisitions Regulation (FAR) 15.208(e), a contractor has the right to withdraw its proposal at any time prior to the contract award. After award, this becomes a contract-termination issue.

LAND-USE AGREEMENTS

Land-use agreements govern the site access given the developer during the term of the project. There can be two phases addressed by this agreement, the construction phase and the production phase. The site-access requirements during these two phases can be quite different, which is why they could have different limitations and may be handled separately. The term of the power purchase agreement could start after construction is completed, therefore certain terms and conditions of the PPA might need to be included in the construction phase. Land-use agreements typically take the form of leases, easements, licenses, or land purchase. Leases are for a limited term and usually are for exclusive occupation rights. Easements are a nonexclusive right to occupy and cross a property and primarily are irrevocable. Licenses typically are easier to use and have been used by several agencies for rooftop systems. Another option is for the solar developer to purchase nearby nonfederal land as the location for the system. When considering land-use agreement options, work with the team's legal counsel and real property staff, because agencies have different requirements. Sample land use agreements are available at: www.eere.energy.gov/femp/financing/ppa_sampledocs.html (accessed July 19, 2010).

Fort Carson PV Project, Colorado Springs, Colorado, 2-MW PV *(Credit: U.S. Army Fort Carson. PIX 17394.)*

LANGUAGE OF A POWER PURCHASE AGREEMENT

It is recommended that preferred PPA language or key legal considerations for the contract agreement be included in the RFP, as this affects the proposals submitted by developers. The power purchase agreement language incorporated in the RFP can be negotiated. It should, however, cover the pricing request for the term of the agreement (with escalators), termination fees for each year, and disposition of equipment at the end of the contract term. Experience has shown that RFPs that do not contain this language have produced administrative problems due to ambiguity.

System purchase options can be included if the agency foresees that it might want to purchase the system before the end of the PPA. This usually is considered after the sixth year of the project, after all the investment tax credits and accelerated depreciation benefits are exhausted. Buyout provisions are based on fair market value (FMV) or the present value of income expected from the remaining life of the PPA. The advantage of owning the system is the owner does not have to pay for the power produced. If an owner has not signed an O&M contract, however, then that owner is responsible for the operation and maintenance costs. At the end of the PPA contract, the agency could purchase the system for fair market value, extend the PPA (if allowed), issue a follow-on RFP, have the contractor abandon the system in place, or have the contractor remove the system.

LIQUIDATED DAMAGES

It is recommended that the contract include a clause regarding liquidated damages (LD). This clause should address and develop a method for calculating damage payments for the failure to perform contractual obligations. If failure to meet obligations has clear and quantifiable monetary consequences, then damages can be calculated easily. Damages that arise from failures that do not have clear and quantifiable monetary consequences should be addressed by this clause. Most examples of situations to which an LD clause would apply are related to not meeting stage-gate requirements. Stage-gate requirements might include:

- Design submissions,
- Permitting,
- Procurement of modules, and
- Commissioning or completion.

PROPOSAL PROCESS ADMINISTRATION

The proposal administration description includes the timing and location of proposal meetings and site visits, and the process for answering questions. The proposal meeting is the forum for presenting the project requirements in detail to interested developers and for developers to ask questions. The site visit enables interested developers to assess site conditions and to ask additional questions. The site visit can be held in conjunction with the proposal meeting or be conducted separately.

Depending on the site conditions and the process chosen, additional site visits could be necessary for respondents to perform additional due diligence.

Questions that arise during and after the proposal meeting and site visit must be handled such that all developers have access to the same information. There are many variations on how this can be accomplished. A recommended method is to write down every question, answer each, and post the questions and answers on a Web site. This process can help avoid variation in answers, minimize participant misunderstanding, and eliminate the possibility of one party receiving more information than another.

REQUIRED DESIGN AND CONSTRUCTION SUBMITTALS

The RFP should be clear on what submittals are required from the developers for the proposals and, if successful, what is required during the design and construction of the system. The proposal submittal could include:

- Conceptual layout;
- Detailed project implementation plan;
- Line diagram (electrical schematic diagram);
- Projected energy performance (average hourly, monthly, and total with degradation factored over the term of the agreement); and
- System components, such as modules, inverters, and racking, with specifications and warranty information.

Submittals required during the project construction should include as-built drawings and final system specifications.

SYSTEM REQUIREMENTS

The system requirements section of the RFP should include a description of expectations regarding the project and any pertinent information that will help the developers give a solid proposal. Include one or more location options and, if desired, a minimum system capacity for each location. Note whether each PV system will be evaluated separately or as part of a group. System requirements (e.g., PV panel types, configuration) should not be prescriptive and instead should give developers the opportunity to propose a system that is most economical based on individual experience.

The system description should include expected technology type, size or performance range, location, and any site-specific considerations or limitations (e.g., roof penetration preference, roof-replacement schedule). Site information that should be provided, if available, includes pertinent electrical information and drawings, site characteristics (e.g., soil studies, roof plans), site load information (maximum/minimum demand for each month), consumption information (hourly if available), environmental factors, historic information, interconnection options, acceptable inverter locations, and any other pertinent information. Sample RFPs are available at www.eere.energy.gov/femp/financing/ppa_sampledocs.html (accessed July 19, 2010).

6 Issue a Request for Proposal

After the RFP is complete, announce it somewhere that developers can find it. One prominent Web site that is familiar to most developers is Federal Business Opportunities, www.fbo.gov (accessed June 8, 2010). Another Web site option is the Green Power Network, http://apps3.eere.energy.gov/greenpower/financial/ (accessed June 8, 2010), or www.fedconnect.net (accessed June 8, 2010).

7 Administer the Request for Proposal

After the RFP is issued, follow the defined timeline and described RFP process. Adjust both as necessary if unforeseen events arise. This step may include site visits, pre-bid meetings, and correspondence related to questions and answers related to the project.

What should be avoided are costly change orders or price increases that can come with the low cost proposals that are based on poor assumptions or excessive exclusions. The risk is that what initially seems to be the lowest cost proposal actually could be more costly in the end.

8 Evaluate the Proposals

Assemble a small team to evaluate the proposals received. The number of team members to include depends upon the specific project, but the team should have at least three people. Most of the people on this team probably will come from the project team. Other key people to consider including on this team are:

- Energy manager,
- Facilities manager,
- Legal/procurement expert,
- Project manager,
- Site manager (if managers for different areas of site), and
- Solar expert.

The process for evaluating the proposals should have been established as the RFP was being developed. It is recommended that the merit-review sessions be set up well in advance to ensure the availability of key personnel. Follow the proposal evaluation criteria described in the RFP and, from the start, clearly define the meaning of each criteria and score. Each agency also likely has its own review process to follow, and it is important to address that as well.

Evaluating the assumptions and exclusions included in the proposal requires particular care. Are the assumptions and exclusions reasonable, based on the information available about the project? Do they demonstrate good judgment? What should be avoided are costly change orders or price increases that can come with the low cost proposals that are based on poor assumptions or excessive exclusions. The risk is that what initially seems to be the lowest cost proposal actually could be more costly in the end.

When evaluating proposals for pricing options, be aware that if an acceptable pricing structure is not specified in the RFP then many different options could be given. Common pricing structures include escalation factor (usually 1% to 3%), firm-fixed price, utility-rate linked, or a de-escalation factor. An escalator is the percentage that the PPA price per kilowatt-hour will increase annually. A first year price with escalator usually is less than a fixed price but will increase to more than the fixed price during the term of the PPA. Typically, an evaluation of these pricing structures can be based on lowest present cost for the expected production and term of the project.

The winning proposal should be compared to current utility rates and the expected future rates, based on inflation and discount rates taken from the National Institute of Standards and Technology (NIST)/Energy Information Administration (EIA) "Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis—May 2010, Annual Supplement to Handbook 135" (available at www.eere.energy.gov/femp/pdfs/ashb10.pdf; accessed July 19, 2010). Other price forecasts also can be used for comparison purposes to help the site decide whether a contract award is recommended. Other time- and project-specific requirements, such as when funds will be available to pay for production (e.g., a large amount of funds might be available in the first year of the project, but perhaps more significant funds will not be available until a subsequent year) also can be considered. As noted, standby charges and possible utility tariff changes should be compared to historic and projected utility costs.

9 Award the Contract

The process for contract award depends on the type of evaluation used, and could include negotiations with the proposers. Several options can be used for awarding the contract. (Sample contracts are available at www.eere.energy.gov/femp/financing/ppa_sampledocs.html; accessed July 19, 2010.)

- ***Award Based on Proposal.*** The contract is awarded solely on the merits of the proposal as determined when the proposals were evaluated. This scenario is very unlikely, as discussion almost always is required.
- ***Award with Discussions.*** The contract is awarded on the merits of the proposal but is contingent in part on further discussions to clarify understandings, agreements, or responsibilities.
- ***Award with Discussions and Negotiation.*** The contract is awarded on the merits of the proposal but is contingent on further discussions and negotiations. This can be used in the case of receipt of a good proposal that requires adjustments to meet the specific needs of the project. This approach can be employed when unanticipated ambiguities in the RFP or project specifics arise during the RFP process and result in varied proposals that do not quite meet the objectives.
- ***Award with Best Proposal.*** In this process, a short list of developers is created based on the proposal. Those on the short list then are asked to develop their best final proposal revision (FPR). This request for FPR can include information such as updated pricing and design specifications. At this point it is assumed that developers on the short list are technically competent, therefore the evaluation primarily is based on price unless the best value method is employed. This approach also can be used in conjunction with projects that have significant due diligence issues, as noted in the "Develop a Request for Proposal" section. It is recommended that the short list include not more than three developers. As the number of developers on the short list increases, the odds of success decrease for each individual developer, as does the willingness of the developers to expend money and effort to tighten their proposals.

10 Design the Project

After the contract is awarded the project design phase begins. The design parameters that the system designer will work within should be clear from the RFP, the final revised proposal, any negotiations that occurred during the RFP process, and due diligence performed by developer. The design kickoff should confirm these design parameters for all parties. It is recommended that design reviews be conducted by a third-party, qualified solar-design expert at 25%, 50%, and 100% design completion stages, to confirm that requirements are met. A thorough design review always is faster and less expensive than fixing design flaws later. To help with the design reviews, a "Photovoltaic Project Design Evaluation Checklist" is included in Appendix B.

11 Construct the Project

During project construction, the primary considerations are regarding coordinating with the developer. To enable a successful coordination during this phase, first identify a single point of contact. Major areas of coordination include the timing of work (particularly if construction could interfere with the site's mission), ensuring that critical deadlines are met (especially those regarding incentives), assisting with interconnection issues (including interconnection and

A good commissioning ensures that the system has been installed and is operating to specifications. It also confirms that there are no apparent safety issues due to poor installation (e.g., damaged wire insulation, unprotected high-voltage connections).

net metering agreements), and handling incentive applications. The final piece of the construction process is the commissioning of the system—which makes possible the system interconnection and start up.

12 Commission the System

Although the system is owned and operated by a third party and the agency is just purchasing the energy output of the system, the system still is located on the agency's site and the agency has an interest in how well the system performs (for the credit toward renewable energy targets). Commissioning of the system is the responsibility of the solar developer; however, it is recommended that the agency be aware of any issues and reports resulting from the commissioning. A good commissioning ensures that the system has been installed and is operating to specifications. It also confirms that there are no apparent safety issues due to poor installation (e.g., damaged wire insulation, unprotected high-voltage connections). There could also be requirements from the REC purchaser that must be met. A "Photovoltaic Commissioning Checklist" is provided in Appendix B.

13 Monitor the Performance Period

The primary duty during the PPA's performance period is to track actual production and pay for electrical production. Operation and maintenance usually is the responsibility of the developer. If the developer owns the RECs produced by the project and the agency needs to meet renewable energy targets, then it can purchase replacement RECs every year.

If the developer agrees to long-term monitoring of the system, then the DOE Solar Energy Technologies Program can track performance and reliability of system installations. For information on having the DOE track a specific system, contact Michael Quintana at Sandia National Laboratories (maquint@sandia.gov).

14 End Contract Oversight

The end of the power purchase agreement is characterized by the decision on the preferred system purchase or other termination option (discussed above in "Language of a Power Purchase Agreement" section). This could be oversight of the system removal, extension of the PPA, or purchase of the system and continuation of the O&M. The choice of options most likely will be influenced by circumstances existing 20 years in the future, and this should be taken into account when developing the options at the start of the project.

Energy Savings Performance Contract

Energy savings performance contracts (ESPC) have a long history of use in the federal sector and have primarily been used for energy efficiency projects. They are increasingly being seen, however, as a long-term financing method for solar projects. An ESPC is a guaranteed savings contracting mechanism that requires no up-front cost. An energy services company (ESCO) incurs the cost of implementing a range of energy conservation measures (ECMs)—which can include solar—and is paid from the energy, water, and operations savings resulting from these ECMs. The ESCO and the agency negotiate to decide who maintains the ECMs. Payments to the contractor cannot exceed savings in any one year. These contracts are recommended for renewable energy projects only if energy-efficiency measures also are being performed.

Multiple contracting options are available to agencies interested in an ESPC. The DOE offers an indefinite delivery, indefinite quantity contract designed to make an ESPC as cost-effective and easy to implement as is possible for federal agencies. Several ESCOs are prequalified and have accepted the terms of the IDIQ contract; these companies thus can respond to project requests. The U.S. Army also has an IDIQ contract in place as an alternative to the DOE option. The discussion below focuses on the DOE ESPC process, which is explicitly defined. Additional information is available on the FEMP Web site at www.eere.energy.gov/femp/financing/espcs.html (accessed June 10, 2010). Also, the FEMP has extensive resources including contract templates, flowcharts, and process guidance on its Web site at www.eere.energy.gov/femp/financing/espcs_resources.html (accessed July 19, 2010).

Steps to Follow

1. Plan the project
2. Perform a preliminary assessment and ESCO selection
3. Perform investment grade audit to award
4. Design the project
5. Construct and install the system
6. Commission the system
7. Monitor the performance period
8. Perform project close out

Case Studies

(See Appendix C)

- **U.S. Marine Corps Base PV Project, Twenty-nine Palms**

  www.bp.com/liveassets/bp_internet/solar/bp_solar_usa/STAGING/local_assets/downloads_pdfs/29PalmsTag.pdf

- **Federal Correctional Institution, Phoenix, Arizona**

  Parabolic trough solar water-heating system

  www.eere.energy.gov/femp/pdfs/33211.pdf

These contracts are recommended for renewable energy projects only if energy-efficiency measures also are being performed.

PROS	CONS
▪ The 25-year contract length fits well with longer renewable energy paybacks. ▪ The performance is guaranteed. ▪ The operations and maintenance can be included as part of the contract. ▪ The agency in charge of the site can require that solar be a part of the project. ▪ A project facilitator is assigned (FEMP-funded through initial proposal or preliminary assessment). ▪ The sale of excess electricity and thermal energy is allowed (EISA provision). ▪ The agency contracting officer (CO) has the discretion to allow ESCO or third-party ownership of the renewable energy conservation measures eligible for federal and state tax incentives.	▪ Since ESCOs traditionally do not own assets, it is difficult to monetize tax incentives related to solar. ▪ Not recommended for renewable-only projects.

1 Plan the Project

The DOE Super ESPC (a DOE IDIQ contract with approved energy services companies) requires the involvement of a federal financing specialist (FFS) and a project facilitator (PF). The services of the FFS are provided at no cost throughout the project. The services of the PF are provided by the FEMP at no cost up through agency review of the preliminary assessment. When further PF services are required, they are contracted on a reimbursable basis for labor and travel costs. Once the FFS and PF have been identified, assemble the site team, FFS, and PF and put together a notice of opportunity that is to be sent to all energy services companies on the approved list.

The notice of opportunity can be as simple as a one-page letter that gives a summary of what might be included in the project and includes a request for a response from interested ESCOs. The notice of opportunity could include site data for known energy-system improvements, indicate the desire for renewable energy projects, include a schedule of the ESCO site visits, and provide the timeline for submission of a preliminary assessment (PA). It is recommended that the project scope be open to all types of projects. As in any federal procurement, it is important that fair opportunity be given to all potential contractors, especially if large projects materialize after some ESCOs are removed from consideration.

If details are provided in a notice of opportunity or site data package, the results of a renewable energy screening may be included. NREL offers a renewable energy optimization screening at no cost to federal agencies upon request. Other energy efficiency screening reports may also be included. (for more information, see the FEMP ESPC Web site at www.eere.energy.gov/femp/financing/espcs_techplanning.html; accessed June 8, 2010). Site information for other systems that should be targeted for upgrades can be included along with utility usage data. Requested information from the ESCO could include qualifications, past performance, and markups—these can help in the ESCO-selection process that the project team must develop. The ESCOs that are interested in the project submit the requested information to the agency's contracting officer's representative (COR). The team evaluates the responses and one or more ESCOs to proceed to the next step.

2 Perform a Preliminary Assessment and ESCO Selection

The beginning of the preliminary assessment (PA) phase is a kickoff meeting between the site team and the selected ESCOs. A preliminary site assessment follows the kickoff meeting. This assessment identifies the renewable energy and energy-efficiency measures to be considered for the project. The ESCOs develop preliminary assessments (proposals) which the team then reviews. Sample criteria for evaluating a PA can be found online at www.eere.energy.gov/femp/pdfs/4_4_preliminaryassessmentguidance.pdf (accessed July 19, 2010).

The ESCO selection can occur before or after the preliminary assessment depending on ESCO responses in Step 1(Plan the Project). Contracting officers (CO) are given broad discretion in the DOE IDIQ as to their contractor selection approach. Regardless of the approach and the timing of the selection, fairness must be demonstrated to all contractors and the approach must follow section H.3 of the DOE IDIQ. Aside from some exceptions to "Fair Opportunity", the agency CO must consider price in the selection decision. When the agency downselects to a single ESCO, the agency CO must document the basis for the downselection. The DOE IDIQ contract can be found online at www.eere.energy.gov/femp/pdfs/generic_idiq_espc_contract.pdf (accessed August 20, 2010)

During this phase, the agreement for continuing the PF services—which are required for the ESPC process—must be finalized. These services are estimated to cost between $50,000 and $75,000 for an average project.

3 Perform an Investment Grade Audit to Award

The IGA is the detailed assessment of prospective energy and water projects. This audit determines the economic viability and bankability (investor financing requirement) of the project. The audit is a joint effort between the ESCO and the agency team, and is characterized by ongoing negotiation. Items that are a product of this effort and must be agreed upon include baseline usages, correct calculation methods, and appropriate measurement and verification (M&V) procedures. The result of this effort is a final proposal that is produced by the ESCO. Note that all ESCO costs up to this point are borne by the ESCO, and that the IGA is a significant effort that can cost $1,000,000 or more (for complex projects). Agency review of the proposal and final negotiations precede the award of the task order.

ENERGY SAVINGS PERFORMANCE CONTRACT
CASE STUDY

U.S. Marine Corps Base PV Project, Twenty-nine Palms

The procurement of a 1.1 MW solar energy project was awarded under an Army Corps ESPC agreement to Johnson Controls Inc. in 2002. The military base also received a rebate of $4.5 million from the State of California to buy down the cost of the system. The total cost of the PV project was about $12.6 million after the rebate. As a part of the ESPC agreement, there is an annual guarantee of $400,000 in energy cost savings in conjunction with an estimated 2,500,000 kWh of annual production from the PV system. The PV system was installed as a part of a larger project that included installation of a new cogeneration plant. The project also included upgrades to the energy management system, chilled water plants, and daylighting. Total savings from the overall project to date equal $6.9 million. The PV system utilizes 8,700 modules sited on 6.5 acres. It is tied into the cogeneration plant at 12.47 kilovolt (kV).

Credit: Daniel C. Kariuki, Energy Projects Manager, Marine Corps Air Ground Combat Center, 29 Palms, California

Before the contract is completed the task order RFP must be developed. The IDIQ contract language is the default contract language. The task order RFP includes agency-specific contract language, however, that supersedes corresponding IDIQ contract language, and its development can be a significant effort. The final contract consists of three pieces, the task order RFP, the IDIQ, and the final proposal, and it is important to ensure consistency between all three documents. The final result of this phase is the task order award.

Under an ESPC, the title to the improvements installed under the ESPC transfers to the agency upon final project acceptance. For solar energy projects or the solar energy piece of a larger project, the agency contracting officer (CO) has the discretion to allow private-party ownership of renewable energy systems by the ESCO or a third party. With private-party ownership there is an option to implement an energy services agreement as part of the ESPC. To take advantage of tax benefits, an ESA allows a third party (ESCO or investor) to hold title to the solar energy portion of the project and to reap the tax benefits—and enables the third party to pass some of these benefits back to the agency to improve the economics of the project. For projects in which solar energy generation only reduces site load, the energy production is measured and counted toward offsetting utility energy purchases. When entering into an ESA, the agency may also consider buyout or removal provisions that come into effect at the end of the project.

4 Design the Project

After the contract is awarded the project design phase begins. The design parameters that the system designer will work within should be clear from the final proposal. The design kickoff should confirm these design parameters for all parties. It is recommended that design reviews be performed by a third-party, qualified solar-design expert at 25%, 50%, and 100% design completion, to confirm that requirements are met. A thorough design review always is faster and less expensive than fixing design flaws later. To help with the design reviews, a "Photovoltaic Project Design Evaluation Checklist" is included in Appendix B. After the design has been reviewed and accepted, a notice to proceed is issued, and construction can begin.

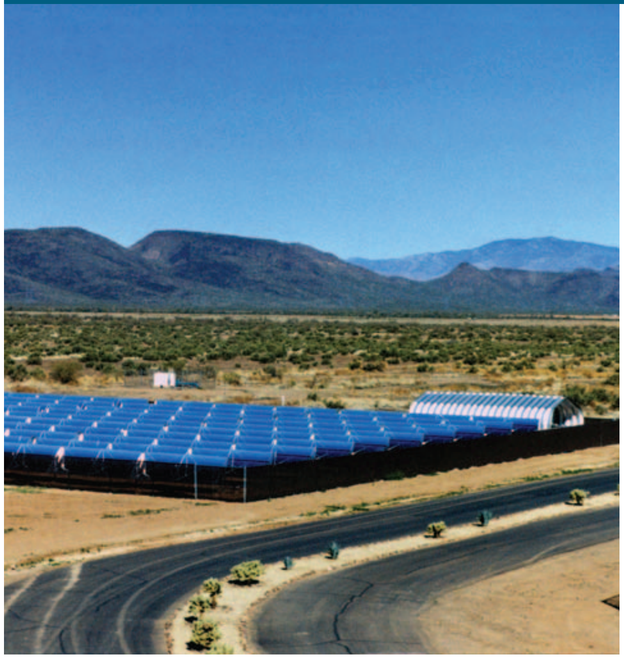
5 Construct and Install the System

The construction phase of the process is much like that of any other construction project; however, most of the team's work is to coordinate with the construction crews, ensure that the site mission is not unduly impeded, and to meet any milestones and any agency contractual obligations. The contract should be clear on which party is fiscally responsible if obligations are not fulfilled.

If a project is complex, then there could be partial project acceptances that occur as different measures are completed. The motivation for partially accepting projects is to start accruing savings that can be set aside until final project acceptance. Any money set aside due to savings or other agency funding (e.g., funding that was earmarked for upgrades that the ESCO now is performing) can be used to buy down the project financing before final project acceptance. This reduces interest payments over the life of the project and provides potentially significant savings. After the project is accepted, the payments cannot exceed savings and there is no additional option to buy down or prepay the project unless a termination for convenience is exercised. When engaging in partial project acceptance, an agency must commission the measure and implement the M&V protocol to verify the savings before it can start banking any savings.

6 Commission the System

When the solar energy system is significantly complete and operational, the ESCO will commission the system. It is recommended that the agency have a knowledgeable representative present at the commissioning to represent the agency's interest. This is where superior system design helps ensure good value. A top-notch commissioning makes certain that the system has been installed properly and is operating to specifications. It also confirms that there are no



Phoenix Federal Correctional Institution, Phoenix, Arizona, parabolic trough solar water-heating system. *(Credit: Ed Hancock, Mountain Energy Partnership. PIX 09048.)*

apparent safety issues due to poor installation (e.g., damaged wire insulation, unprotected high-voltage connections). The commissioning plan can be written into the final proposal (a "Photovoltaic Commissioning Checklist" is included in Appendix B). It is important to ensure the quality of the installation and to make sure that the measures are operating as expected. When commissioning is satisfactorily complete and post-installation M&V has started, final project acceptance is given and the performance period phase of the project begins.

7 Monitor the Performance Period

The performance period involves measuring ECM performance and verifying savings annually, confirming ESCO or agency maintenance to keep project measures operating as expected, and ensuring agency payments on the contract. The M&V and maintenance activities are carried out as specified in the contract. Any discrepancies or objections to the reported savings must be resolved and then the annual payment can be made. It is important to decide whether to pay in advance or in arrears; the difference equals a year of interest on the project loan.

If the developer agrees to long-term monitoring of the system, then the DOE Solar Energy Technologies Program can track performance and reliability of system installations. If interested in having the DOE track a specific system, contact Michael Quintana at Sandia National Laboratories (maquint@sandia.gov).

8 Close Out the Project

At the end of the performance period the task order is closed out. At this point the agency will no longer be required to make payments on the contract.

Utility Energy Services Contract

Utility energy services contracts (UESC), like ESPCs, have a history of use in the federal sector primarily for energy efficiency projects. Now, these contracts are also being seen as a method of long-term financing, with the added benefit of usually being a sole source contract. A UESC is an agreement that allows a "serving" utility to provide an agency with comprehensive energy- and water-efficiency improvements and demand-reduction services. The utility could partner with an ESCO to provide the installation, but the contract is between the federal agency and the "serving" utility. This contracting mechanism primarily is for bundled energy-efficiency and renewable energy projects, and typically is not used for standalone renewable energy projects. The steps in the UESC process are well defined, but different utilities might describe them differently. The process steps described below are representative of the general process. See www.eere.energy.gov/femp/financing/uescs.html (accessed June 7, 2010).

An effort currently is underway to define a process for a utility renewable electric service contract (URESC) for parties interested in pursuing a standalone solar electric project with a utility in a specific service territory. The URESC concept is envisioned to produce a cross between a PPA and an UESC. It is hoped that an URESC project will commence in 2010 and define this financing and contracting option.

Note that the following discussion focuses on the renewable energy portion of a UESC project. For general information and assistance with UESCs, the FEMP offers *Utility Energy Service Contract: Enabling Documents*, available at www.eere.energy.gov/femp/pdfs/uesc_enabling_documents09.pdf (accessed June 7, 2010).

Steps to Follow

1. Introduction: Contract or agreement review
2. Perform a preliminary study
3. Perform an agency review
4. Project implementation proposal (investment grade audit/detailed feasibility study)
5. Negotiate and accept the proposal (construction contract)
6. Detailed design acceptance
7. Construct project
8. Construction acceptance
9. Monitor performance period
10. Close out the project

Case Studies

(See Appendix C)

- **Camp Pendleton, North San Diego County, California**
  PV Project, 75kW PV
  www.eere.energy.gov/femp/pdfs/46348.pdf
- **Joshua Tree National Park, California**
  PV/propane hybrid
  www.eere.energy.gov/femp/pdfs/26358.pdf

The UESC enabling legislation is silent on whether the agency must take title to the project (except for the U.S. Department of Defense, which must take title but with no specification as to when). It is recommended that the utility be given title to the project for at least a few years (currently 6 years) so that tax benefits can improve the economics of the project. (See Step 5)

PROS	CONS
▪ The UESC contract term is 10 to 25 years, and varies by agency (average project term is 14 years). The EISA (section 513) prohibits agency policies that limit privately financed contract terms to a maximum period of less than 25 years. ▪ The GSA legal opinion states that extended utility agreements are allowed (*Utility Energy Services Contracts: Enabling Documents*, www.eere.energy.gov/femp/pdfs/uesc_enabling_documents09.pdf; accessed June 7, 2010). ▪ Utilities now are eligible for a renewable investment tax credit (the utility must own a renewable energy plant). ▪ Interconnection, tariff, and standby issues should be minimal with utility ownership (but this is not always true and should be explored prior to proceeding). ▪ Utilities are interested in a wide range of project sizes (large and small dollar value projects). ▪ A relationship already exists. ▪ Utilities often have access to reduced financing rates due to their financial strength.	▪ Not all utilities offer UESCs (the FEMP is helping utilities launch UESC programs). ▪ The utility might have limited renewable experience and could be uncomfortable with renewable projects. ▪ Issues could arise regarding contracts for terms of more than 10 years; 10 years is acceptable for energy efficiency but renewable energy projects usually require a longer contract to be economically feasible.

1 Introduction: Contract or Agreement Review

This first step provides a more detailed description of the UESC, discusses whether the local utility offers one, and—if a UESC is offered—examines what agreements might be in place. It is important to review available agreement or contract options to understand the types of projects they cover. If the type of project being considered is not covered under an existing agreement, then an agreement can be developed with the utility.

The three UESC contract or agreement types are the area-wide contract (AWC), the basic ordering agreement (BOA), and the master agreement. An AWC is a blanket contract that the GSA establishes with utilities that permits federal agencies to place orders with a utility (if contracted) for services offered under the AWC. A basic ordering agreement is made between an agency and a utility and establishes general terms and conditions for future contracts. Model agreements are template agreements developed for federal agencies, and contain required clauses for federal contracts. Template agreements can be used in whole or in part as the basis for an AWC or a BOA, or can be used alone to form a master agreement between the agency and utility. A list of area-wide contracts currently in place and a list of master agreements can be found on the FEMP Web site (www.eere.energy.gov/femp/financing/uescs_types.html; accessed June 10, 2010). It is important to understand that if none of the local utilities offers an UESC, then the FEMP and GSA have resources to inform the utility about UESCs (with the goal of urging the utility to offer one).

If an area is serviced by more than one utility, it is recommended that "fair consideration" be given to all utilities servicing the area. When performing a fair consideration of a utility, request descriptions of its capabilities and experience, references, and a disclosure of its markups on projects of this type. If considering a very complex project (greater than $10,000,000), the agency could choose to request more information from the utilities to help make a choice between them. After selected utilities express interest in the project, execute a justification and approval (J&A) document. It should be noted that UESCs do not have a traditional RFP process unlike the agency funded or PPA procurement mechanisms.

The FEMP can provide expert help in working through the UESC. The FEMP project facilitators and federal financing specialists have expertise in these types of projects and with alternative financing mechanisms. For more information on types of UESCs, see www.eere.energy.gov/femp/financing/uescs_types.html (accessed June 7, 2010).

2 Perform a Preliminary Study

A preliminary study essentially is a walkthrough of the facility. The walkthrough constitutes a preliminary audit that is seeking energy-efficiency and renewable energy opportunities. The result of the audit is a report that outlines possible project scope and preliminary economics. This report is used as the basis of the decision to proceed with the project's next steps.

3 Perform an Agency Review

An agency review examines the preliminary study report. The review should look at the planned SOW and confirm that all projects that are deemed necessary (e.g., failing equipment replacement, solar project) are included in the scope. Additionally, economics and term of contract should be considered in the decision to move forward with the next step.

4 Project Implementation Proposal (Detailed Feasibility Study)

The two main components of this step are performing an IGA and drafting a project proposal based on that IGA. The IGA can be paid for up front or rolled into the financing of the overall project. The proposal provides the

UTILITY ENERGY SERVICES CONTRACT
CASE STUDY

Camp Pendleton (U.S. Marines)

Naval Facilities Engineering Command (NAVFAC SW) Southwest has a vibrant and effective energy program. The team has used many tools to accomplish energy efficiency and renewable energy objectives, of which the utility energy services contract (UESC) is one. At Camp Pendleton, the phased approach started with a low cost, minimal design, energy efficiency effort that also financed the costs of audits and design for their next energy project. Using this phased approach in combination with UESCs, Camp Pendleton has installed numerous solar projects including solar thermal on five pools and a 75 kW rooftop PV system that generates 116,000 kWh/year. The phase that included the rooftop PV bundled with energy efficiency resulted in a total project cost of $11.2 million and a savings-to-investment ratio of 1.94. The contract term for the phase is 10 years. The system has been online since July 2008.

Credit: U.S. Marine Corps. PIX 16462

project scope and description, costs, schedule, and other pertinent information.

5 Negotiate and Accept the Proposal

If the proposal meets all of the needs for the project, then it either can be accepted as is or changes can be negotiated. It is anticipated that the agency-review step will address expectations of which items are to be included in the proposal, but it's important to confirm that all of the required items are incorporated. Any critical design requirements also should be checked and confirmed (e.g., design requirements regarding a rooftop PV system). Cost information should be checked and confirmed with experts on the team, and be negotiated if that is deemed necessary. Include buy down, prepayment, and termination formulas, as they can reduce finance costs and alleviate future contract administration problems. After achievement of a mutually acceptable proposal, authorization to award the contract must be received. Typically, a work release letter (WRL) or purchase order (PO) that references the requirements of the master contract and the specifics of this proposal is drafted and signed.

Another major contract consideration is determining who takes title to the renewable energy portion of the project. The UESC enabling legislation is silent on whether the agency must take title to the project (except for the U.S. Department of Defense, which must take title but with no specification as to when). It is recommended that the utility be given title to the project for at least a few years (currently 6 years) so that tax benefits can improve the economics of the project.

6 Detailed Design Acceptance

After the contract is awarded the project design phase begins. The design parameters that the system designer will work within should be clear from the accepted project proposal. The design kickoff should confirm these design parameters for all parties. It is recommended that a third-party, qualified solar-design expert (for the renewable energy portion of the project) conduct a design review at 25%, 50%, and 100% of completion, to confirm that site requirements are met. A thorough design review always is faster and less expensive than fixing design flaws later. To help with the design reviews, a "Photovoltaic Project Design Evaluation Checklist" is provided in Appendix B.

7 Construct the Project

During project construction the primary considerations are regarding coordinating with the developer. To enable successful coordination during this phase, first identify a single point of contact. Major areas of coordination are timing of work (particularly if the construction could interfere with the site's mission), ensuring that critical deadlines are met (especially those regarding incentives), assisting with interconnection issues, and handling incentive applications. The final piece of the construction process is the commissioning of the system—which makes possible the system interconnection and start up.

8 Construction Acceptance

When the system is significantly complete and operational, it is recommended that it be commissioned by a third-party expert. This is where good system design and performance specifications help ensure good value. A top-notch commissioning makes certain that the system has been installed properly and is operating to specifications. It also confirms that there are no apparent safety issues due to poor installation (e.g., damaged wire insulation, unprotected high-voltage connections). It is recommended that a good commissioning plan be established and agreed upon during the proposal process. A "Photovoltaic Commissioning Checklist" is provided in Appendix B.

Utility energy service contracts are not required to include M&V of performance and do not have to guarantee performance (as is the case for ESPCs). It is important, however, to have a plan in place that ensures that the project continues to deliver the expected savings.

9 Monitor the Performance Period

In addition to making monthly or annual payments, other concerns center on how the system operates over time and what recourse is available if it ceases to meet expectations. Utility energy service contracts are not required to include M&V of performance and do not have to guarantee performance (as is the case for ESPCs). It is important, however, to have a plan in place that ensures that the project continues to deliver the expected savings.

One option to help ensure system performance is to include performance verification as part of the contract. Performance verification should extend for a specified period after commissioning, and should confirm that the verified performance meets a predetermined threshold. An example of this is a PV system that requires quarterly performance verification for the first year of service, and an agreement that mandates that the system output be at least 80% of calculated output based on actual solar insolation for the period. The project team and solar expert can create a reasonable agreement with the developer for a guarantee of this type, if desired. The FEMP also offers guidance and recommendations for performance assurance on page 134 of *Utility Energy Service Contract: Enabling Documents*, available at www.eere.energy.gov/femp/pdfs/uesc_enabling_documents09.pdf (accessed June 7, 2010).

If the utility agrees to long-term monitoring of the system, then the DOE Solar Energy Technologies Program can track the performance and reliability of the system installation. If interested in having the DOE track a specific system, contact Michael Quintana at Sandia National Laboratories (maquint@sandia.gov).

10 Close Out the Project

After all the payments have been made and the project term expires, either the renewable energy system is the agency's to own and maintain or the utility owns the system. Note that the DOD, however, is required to take title at some point, and civilian authority is silent on the subject of ownership. Even when the agency owns the system, performance-assurance measures still are important to the project and should be continued. If the utility owns the system, then the original contract language governs the options for what can happen to the system. Options include buying the system for fair market value, continuing to have the utility operate the system, removing the system, and abandoning the system in place. Other options that are legal under legislative authorities and acceptable to parties involved also can be considered.

Enhanced Use Lease

In the federal sector, enhanced use leases (EULs) have a history of being used to implement infrastructure building projects. Now, they are also being used to realize solar energy projects. An EUL is a real estate agreement that focuses on underutilized land. Prospective developers compete for the lease, and payment can be either monetary or in-kind consideration (in this case, renewable power can be part of the consideration). The value of the lease is used to determine the amount of consideration. An EUL typically is used for large projects, for example those having a capacity that is greater than the site load. A few agencies have the authority to execute an EUL.

PROS	CONS
▪ Discovers unrealized value of underutilized property. ▪ Supplements underfunded facilities costs. ▪ Can be used in combination with the ESPC, UESC, and PPA.	▪ Currently only the DOD, the DOE, National Aeronautics and Space Administration (NASA), and the U.S. Department of Veterans Affairs (VA) have the authority to execute an EUL. ▪ Must not be excess property as defined by 40 U.S.C. § 102.

Steps to Follow

1. Identify underutilized land
2. Develop the scope of work
3. Develop a notice of opportunity to lease
4. Issue a notice of opportunity to lease
5. Administer the notice of opportunity to lease
6. Evaluate proposals
7. Select a contractor
8. Complete a lease and management plan (contractor submittal)
9. Review and accept the plan
10. Issue the lease
11. Design the project
12. Construct the project
13. Commission the project
14. Monitor the performance period
15. Perform project close out

1 Identify Underutilized Land

The prerequisite for an EUL is that the site has "underutilized" land that is not "excess property" as defined in 40 U.S.C. §102. Identify land that meets the "underutilized" requirement and that is a reasonable site for a solar project. A market appraisal must be completed to determine land value.

Case Studies

(See Appendix C)

- **NASA Kennedy Space Center/ Florida Power & Light Company, Merritt Island, Florida**

  10-MW PV, owned by Florida Power & Light Company with in kind consideration of a 990-kW NASA-owned PV

  www.smartgridnews.com/artman/uploads/1/nasa_space_coast_solar.pdf

  www.fpl.com/environment/solar/spacecoast.shtml

- **Fort Irwin (in process), Barstow, California**

  500-MW solar thermal/PV by 2022

  http://eul.army.mil/ftirwin/

2 Develop the Scope of Work

The SOW becomes the basis of the notice of opportunity to lease (NOL) used to solicit project proposals from solar developers. This is a statement of all the requirements of the project. The solar feasibility study should provide the basis of the project's SOW. The team's solar expert is a key person in the development of this document.

The SOW should include:

- Type of renewable energy systems required,
- Expected size of systems,
- Location on-site, and
- Specific site requirements.

3 Develop a Notice of Opportunity to Lease

An NOL is the document issued to the public to solicit offers from solar developers. This document describes the content to be included in proposals and provides relevant information that developers can use when a making an offer. The NOL should include the following elements.

- Clarification of which party is responsible for procuring permits and arranging contracts for energy generation offtakers.
- Commissioning plan.
- Criteria used to evaluate proposals.
- Description of how the proposal process is to be administered (e.g., proposal meetings, site visits, process for answering questions).
- Due diligence.
- Limits on proposed project timeline.
- Post-commissioning performance.
- Proposed financing structure and financial industry commitments.
- Scope of work.
- Timelines for proposal process.

The description of the proposal process administration includes the timing and location of industry forums and site visits, and the process to be used for answering questions. The industry forum provides the opportunity to present the project requirements in detail to interested developers, and for developers to ask questions. The site visit allows interested developers to assess site conditions and ask additional questions. The site visit can be held in conjunction with the industry forum or can be conducted separately. Depending on the site conditions and the process chosen, additional site visits could be necessary for respondents to perform additional due diligence.

Questions that arise during and after the industry forum and site visit must be handled such that all developers have access to the same information. There are many variations on how this can be accomplished. A recommended approach is to write down every question, answer each, and post the questions and answers on a Web site. This process can help to avoid variation in answers, participant misunderstandings, and the potential for one party to receive more information than another.

Describing the criteria and the process to be used to evaluate proposals helps developers structure their responses and ensures that all primary issues are addressed. This also makes it easier to review proposals. The respondents address identified criteria in separate sections, eliminating the need for a reviewer to pick statements from the entire proposal that apply to the criteria. Evaluation criteria should include the considerations that are most important to the specific project, and could include the following.

- In-kind consideration.
- Developer's experience, performance track record, and references.
- Developer's financial health.
- Developer's ongoing long-term service capacity.
- How specific site issues and requirements will be addressed.
- Amount of energy generated.
- Quality of components.
- Local sourcing of components and labor.

Describing how to handle due diligence on the developer's part has important contractual implications. Due diligence is the effort the developer must put forth to fully understand the project and the risk of any unknowns that could arise. Contractually, the developer wants to have recourse if something unexpected comes up that is outside its ability to perform or that will cause significant cost increases (such as roof structural issues or subterranean rock that would preclude standard trenching machines). Under such circumstances, the developer might want to be able to walk away from the project or have the option to renegotiate. Typically, developers should factor the risk into their proposals and be required to deal with the unexpected.

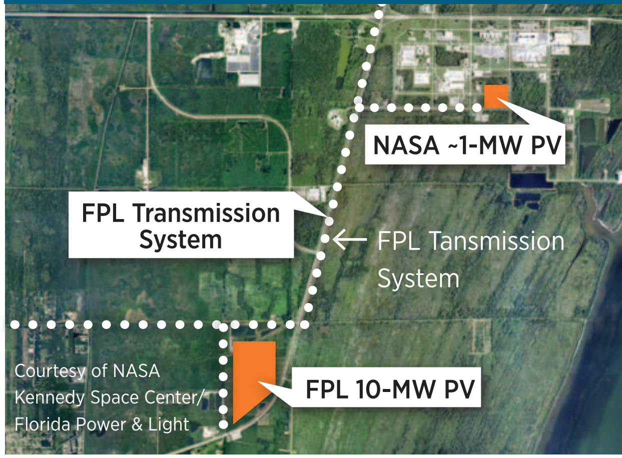
Depending on the project, due diligence could require considerable effort and expense. If this is the case with a project, or if this becomes apparent as the NOL process progresses, consider adding additional steps to the NOL process. Additional steps can include an initial proposal review to generate a short list of developers. Those on the short list are invited to continue with the NOL process, which includes expending additional effort and incurring additional expense for due diligence. The purpose of this extra step is to assure the developers on the short list that they have a good chance at being successful, and that it is worthwhile to put forth the extra effort and expense required for due diligence. A site due diligence date—after which the developer will have entered into an irrevocable contract—should be specified. An example of a NOL can be found at http://eul.army.mil/ftirwin/Docs/FinalNOL20Mar09.pdf (accessed June 8, 2010).

4 Issue the Notice of Opportunity to Lease

After the NOL is complete, announce it somewhere that developers can find it. One prominent Web site that is familiar to most developers is www.fbo.gov (accessed June 8, 2010). Another Web site option is the Green Power Network, http://apps3.eere.energy.gov/greenpower/financial/ (accessed June 8, 2010). It should be noted that EULs do not have a traditional RFP process unlike the agency funded or PPA procurement mechanisms.

5 Administer the Notice of Opportunity to Lease

After the NOL has been issued, follow the defined timeline and described NOL process. Adjust it as necessary if unforeseen events arise. This step may include site visits, pre-bid meetings, and correspondence related to project questions and answers.



ENHANCED USE LEASE PROJECT CASE STUDY

Kennedy Space Center (NASA)

Operation and mission changes at the Kennedy Space Center led to the search for expanded business opportunities. Capitalizing on the vast amount of land on Florida's Space Coast, NASA's history and experience with renewable energy, and NASA's strong partnership with Florida Power and Light (FPL), renewable energy projects became a focus of investigation. Wind energy was the first choice due to cost and power density, but issues with the resident wildlife refuge put wind projects on hold. Photovoltaics became the preferred project type. NASA and FPL agreed on appraised value, lease terms, and two sites totaling 60 acres for development in phase 1. The thirty-year lease is for a site where FPL will construct, own, and operate a 10MW PV plant that will feed power directly into the FPL transmission system. The $6,300,000 consideration for this lease is a NASA-owned 990kW PV plant that will feed into the NASA-owned distributions system but that will be constructed and maintained by FPL.

6 Evaluate the Proposals

A small team should be assembled to evaluate the offers received. The number of team members to include depends upon the specific project, but the team should have at least three people. Most of the people on this team probably will come from the project team. Other key people to consider including on this team are the:

- Energy manager,
- Facilities manager,
- Project manager,
- Site manager (if managers for different areas of a site), and
- Solar expert.

The process for evaluating the offers should have been established during the development of the NOL. It is recommended that the proposal-evaluation sessions be scheduled well in advance to ensure the availability of key personnel. These review sessions typically take a week, unless an unusually great number of proposals (more than 10) is received. Follow the proposal evaluation criteria described in the NOL and, from the start, clearly define the meaning of each criteria and score.

7 Select the Contractor

The proposal evaluation scores the offers. This helps determine the most advantageous offer and, consequently, which contractor to select.

8 Complete a Lease and Management Plan

Once selected, the contractor and agency initiate steps toward entering into a lease and management plan (L&MP). The L&MP describes what the contractor will do and how elements will be completed. An L&MP can include the following components.

- Architecture and engineering.
- Community and stakeholder relations.
- Consultation and coordination in accordance with the Section 106 process as required by the National Historic Preservation Act (NHPA) (if applicable).
- Consultation and coordination with federally recognized Native American tribal governments (if applicable).
- Cultural or archeological documentation.
- Financial.
- Legal services.
- Master planning.
- Marketing.
- NEPA and other environmental documentation.
- Site assessment.

The L&MP is a significant piece of work, and a minimum of 18 months elapses from the time a contractor is selected to the completion of a lease. Prior to completion of L&MP, all NEPA compliance analysis addressing proposed project impacts on land within the lease must be completed, through either environmental assessments or environmental impacts studies. The contractor submits the completed L&MP to the agency.

9 Review and Accept the Plan

The completed lease and management plan are reviewed by the agency. If there are any unresolved issues, then last negotiations are completed and the L&MP is accepted.

10 Issue the Lease

After the lease and management plan is accepted, a lease can be finalized and issued. A sample EUL contract can be found at www.eere.energy.gov/femp/pdfs/nasa_lease.pdf (accessed July 19, 2010).

11 Design the Project

After the contract is awarded, the project final design phase (based on preliminary design work in the L&MP) begins. The design kickoff should confirm the design parameters for all parties. It is recommended that a third-party, qualified solar-design expert conduct reviews at the 25%, 50%, and 100% design completion, to confirm that site requirements are met. A thorough design review always is faster and less expensive than fixing design flaws later.

12 Construct the System

During project construction the primary considerations are regarding coordinating with the developer. To enable a successful coordination during this phase, first identify a single point of contact. Major areas of coordination include the timing of work (particularly if construction could interfere with the site's mission), ensuring that critical deadlines are met (especially those regarding incentives), assisting with interconnection issues (including interconnection and net metering agreements), and handling incentive applications. The final piece of the construction process is the commissioning of the system—which makes possible the system interconnection and start up.

13 Commission the System

When the system is significantly complete and operational, it is recommended that it be commissioned by a third-party expert. This is an important step, as this system is located on the agency's site and system performance can affect the in-kind consideration. A good commissioning ensures that the system has been installed properly and is operating to specifications. It also confirms that there are no apparent safety issues due to poor installation (e.g., damaged wire insulation, unprotected high-voltage connections).

An EUL is a real estate agreement that focuses on underutilized land. Prospective developers compete for the lease, and payment can be either monetary or in-kind consideration (in this case, renewable power can be part of the consideration).

An EUL typically is used for large projects, for example those having a capacity that is greater than the site load. A few agencies have the authority to execute an EUL.

14 Monitor the Performance Period

Operation and maintenance of the system is the responsibility of the developer. If in-kind consideration is dependent on the system's energy production, then a process for monitoring energy production should be in place. If the developer owns the RECs produced by the project and the agency must meet renewable energy targets, replacement RECs can be purchased. These RECs can count twice toward the agency's targets as long as the project produces energy at levels greater than or equal to the quantity of RECs purchased.

If the developer agrees to long-term monitoring of the system, then the DOE Solar Energy Technologies Program can track performance and reliability of system installations. If interested in having the DOE track a specific system, contact Michael Quintana at Sandia National Laboratories (maquint@sandia.gov).

15 Close Out the Project

The end of the lease options and decisions are characterized by the economic value and viability of the installed system. If the system still can be operated economically then several options can be considered, including extending the lease, purchasing the system for fair market value, or entering into a PPA-type agreement with the developer. If the system has limited or no economic viability at the end of the lease then it can be abandoned in place or removed. This choice most likely will be influenced by circumstances existing 20 to 75 years in the future, and this should be taken into account when developing the options at the start of the project.

Glossary and Related Solar Terminology

A

Agency-funded project

The project is funded through an agency appropriation and the agency owns the project.

Alternating current (AC)

The movement of electric charge periodically reverses direction. AC is the form of electric power delivered to businesses and residences.

Alternative compliance payment

In lieu of standard means of compliance with renewable portfolio standards, electricity suppliers may make alternative compliance payments to make up for deficiencies (in megawatt-hours) between the amount of electricity from renewable resources mandated and the amount actually supplied. Payment amount varies among states.

Array

A group of photovoltaic (PV) modules (also called solar panels) or solar thermal collectors.

Authority having jurisdiction (AHJ)

A federal, state, or local entity having statutory authority for approving equipment, an installation, or a procedure.

Avoided-cost rate

The cost per kilowatt-hour a utility would have incurred by supplying electricity generated from its traditional generation sources.

B

Behind the meter

Refers to the location where a generating technology (such as a PV system) is connected to the electricity grid. A behind-the-meter PV system is connected between the utility meter and the facility using the electricity, so all electricity generated by the PV system that is not being used by the facility flows through the utility meter to the grid.

Binomial tariff

A utility rate structure that includes both a fixed demand charge and a variable (per kilowatt-hour) energy charge.

British thermal unit (Btu)

The amount of heat required to raise the temperature of one pound of water from 60°F to 61°F at a constant pressure of one atmosphere. Water heating is commonly measured in Btus.

Building energy code

Establishes minimum energy performance features in buildings.

Building integrated PV (BIPV)

Standard PV modules, transparent modules, and thin-film covers and tiles are used to replace or enhance conventional building materials such as roofs, walls, facades, awnings, and skylights. These materials generate electricity from sunlight and perform other functions integral to the building's design.

Building integrated solar water heating (BISWH)

Similar to BIPV, BISWH incorporates solar water heating materials into traditional building materials.

Buy-down

A reduction in costs to purchasers.

C

Capacity limit for individual systems

A limit placed on the capacity of individual PV systems, usually set to a certain percentage (for example, 125%) of a customer's energy load. Capacity limits can vary by utility type, solar energy system type, or customer type.

Carbon dioxide (CO_2)

A colorless, odorless, noncombustible gas present in the atmosphere. It is formed by the combustion of carbon and carbon compounds (such as fossil fuels and biomass); by respiration, which is a slow combustion in animals and plants; and by the gradual oxidation of organic matter in the soil. Considered a greenhouse gas that contributes to global warming.
See also *emissions*.

Clean renewable energy bond (CREB)

Special-purpose tax credit bonds that provide the equivalent of an interest-free loan for certain qualifying energy facilities. Bondholders receive a tax credit on their federal income taxes instead of an interest payment from the bond issuer.

Credit multiplier

A credit multiplier for solar offers additional credit toward compliance with a renewable portfolio standard for energy derived from solar resources.

Code official

Local government employee who enforces codes and standards, ensuring that solar energy system installations meet applicable safety, building, electrical, and plumbing codes in a region.

Commercial energy conservation ordinance (CECO)

A CECO requires commercial property owners to complete certain energy conservation measures in their buildings upon transfer of property ownership or when additions or renovations are made.

Customer aggregation program

A program that coordinates group purchases of solar energy systems, helping defray some of the up-front costs of solar installations by giving aggregated individuals or businesses a discounted rate for bulk purchases of solar energy systems.

Customer generator

Utility customer who generates electricity on his or her property using a distributed generation technology such as PV.

Customer-sited distributed generation

Refers to distributed generation technologies such as PV installed on the property of a utility customer.

D

Demand charge

A charge incurred by a utility customer in return for the utility having built adequate generating capacity to supply the power needed for a facility (like a manufacturing plant) to operate at its maximum capacity.

Design development

Takes the preferred alternative from Schematic Design and develops the details such as the transport phenomenon (wire and pipe sizes), and assembles schedules of the required equipment.

Direct current (DC)

The unidirectional flow of electric charge. DC is the form of electric power produced by photovoltaics and batteries.

Direct incentive

Cash back to consumers for a qualified solar installation. Direct incentives include up-front rebates and grants and production-based incentives that are typically distributed over several years.

Distributed generation

Electricity production that occurs on site (or close to the load center) and is interconnected to the utility's electric distribution system.

Dollars per watt ($/Watt)

The standard metric for assessing the cost of a solar electric system. This metric is either the total installed cost of a system (or a component of the system) divided by the name plate capacity of the system (or inverter, if looking only at the inverter).

Due diligence

The work a developer needs to do to ensure it has assessed a project and its risks to the extent necessary to commit to a binding contract.

E

Electric capacity

The amount of electricity-generating resources a utility must supply to meet the demands of a particular facility or region.

Electric utility

A corporation, agency, authority, or other legal entity aligned with distribution facilities for delivery of electric energy for use primarily by the public. Investor-owned electric utilities, municipal and state utilities, federal electric utilities, independent system operators, and rural electric cooperatives are included.

Electricity distribution system

The portion of the electricity grid that distributes lower voltage electricity from high-voltage transmission lines to individual homes and businesses.

Emissions

In the context of global climate change, emissions refer to a release of greenhouse gases into the atmosphere, such as CO_2, methane, and oxides of nitrogen.

Energy audit

A survey that determines how much energy is used in buildings and facilities, which helps identify ways to use less energy.

Energy conservation mechanism (ECM)

A training program, facility improvement, or equipment purchase used to reduce energy or operating costs in a building.

Energy savings performance contract (ESPC)

An agreement between a building owner (or facilities manager) and a private energy services company (ESCO) that uses future energy savings to pay for the entire cost of a building's electricity and energy efficiency retrofits.

Energy service agreement (ESA)

An agreement contained within an energy savings performance contract (ESPC) that addresses the assignment of ownership of a system to allow a private party to benefit from tax incentives afforded the renewable energy system.

Energy services company (ESCO)

A company that offers energy management services to reduce a client's utility costs. Cost savings are often split with the client through an energy performance contract or a shared-savings agreement.

Enhanced use lease (EUL)

A real estate agreement that leases "under-utilized land" to a developer for cash or in-kind consideration.

Environmental justice

The fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Escalator

Regarding solar projects, this is the rate an energy price will increase annually. An escalator can be part of a power purchase agreement (PPA) price, which means that the PPA price for energy increases by the escalator rate every year.

Expected performance rebate

Cash incentive based on the expected energy output from a solar energy system over a given period of time.

External utility-accessible AC disconnect switch

A hardware feature that allows a utility employee to manually disconnect a customer-owned PV system (or other type of generation) from the electricity grid.

F

Feasibility study

Engineering and economic viablity of a project are evaluated in a feasibility study. Engineering viablilty considers the physical equipment and connections to existing infrastructure to determine if a system will work physically. Economic feasibilty estimates the costs and revenues of a project and applies economic theory to determine if a project will be financially viable. A feasibilty study must also include issues such as environmental constraints (endangered species, etc), historic preservation, or any other factors which may delay or impede implementation.

Federal investment tax credit

A credit against federal income taxes, usually computed as a percentage of the cost of investment in solar energy assets. The federal investment tax credit for installing solar energy systems is set at 30% of the installed system cost, and is set to expire in 2016.

Feed-in tariff (FIT)

A renewable energy policy that typically offers renewable energy project developers a guaranteed payment for electricity produced by their renewable energy system over a fixed amount of time (usually 15 to 20 years).

G

General fund

The primary operating fund of a governmental entity, usually in place to support operating expenditures.

Generating capacity

The amount of power-generating resources a utility can supply to meet the demands of a particular facility or region.

Gigawatt (GW)

A unit of power equal to 1 billion watts, 1 million kilowatts, or 1,000 megawatts.

Green pricing

A mechanism for utility customers to support their utility's investments in renewable energy projects through direct charges on their monthly utility bills. Green pricing is a market-based solution to account for the nonmarket (meaning environmental) benefits of renewable energy.

Greenhouse gas

Atmospheric gasses that absorb and emit radiation. Greenhouse gases as defined by E.O. 13514 include carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

I

IEEE 1547

IEEE was originally an acronym for the Institute of Electrical and Electronics Engineers, Inc. Today, the organization's scope has expanded into so many related fields that it is simply referred to by the letters IEEE ("I-triple-E"). IEEE 1547 refers to the *Standard for Interconnecting Distributed Resources with Electric Power Systems*.

Indefinite-delivery/indefinite-quantity (IDIQ) contract

A base contract with preapproved suppliers that accepted the contract terms. Meant to streamline the contracting process, as only project specific contractual issues need to be negotiated.

Installation baseline

An accounting of all solar energy installations currently in place.

Installation target

A set goal for future solar installations in an agency by a specific date. A solar installation target is often set to achieve broader environmental, climate, or sustainability goals.

Installed capacity

The total amount (usually measured in terms of size; in kilowatts or megawatts for PV) of solar energy systems operating in a given region or sector.

Interconnection

The process of connecting an electricity-producing technology (like a PV system) to the electricity grid.

Interconnection agreement

Agreement between a utility and a customer that specifies the terms and conditions under which solar electric systems or other approved customer-owned generation will be connected and operated.

Interconnection standard

A technical, legal, and procedural requirement that customers and utilities must abide by when a customer wishes to connect a PV system to the grid.

Investment Tax Credit

A tax incentive based on the initial cost (investment) of an energy system.

K

Kilowatt (kW)

A standard unit of electrical power equal to 1,000 watts.

Kilowatt-hour (kWh)

A unit of energy: 1,000 watts acting over one hour.

L

Leadership in Energy and Environmental Design (LEED)

LEED is a voluntary, consensus-based national rating system for developing high-performance, sustainable buildings operated by the U.S. Green Building Council.

Levelized cost (of energy) (LCOE)

A means of calculating the cost of generating energy (usually electricity) from a particular system that allows one to compare the cost of energy across technologies. LCOE takes into consideration the installed solar energy system price and associated costs such as the cost of financing, land, insurance, operation and maintenance, and other expenses.

Life cycle cost

The present value of all costs associated with purchasing and operating an asset (solar system) during its expected life.

Liquidated damages (LD)

These are typically the financial penalties assessed on developers who fail to meet certain deliverable stage gates in an established timeframe or fail to complete the project at all or in the established timeframes.

Load

Describes the amount of power (amps) consumed by an electrical circuit or device. Loads are usually expressed in amps but sometimes in watts.

M

Megawatt (MW)

Standard measure of electric power plant generating capacity equal to 1,000 kW or 1 million watts.

Megawatt-hour (MWh)

1,000 kWh or 1 million watt-hours.

Metric ton of carbon dioxide equivalent ($MtCO_2e$)

Standard measurement of the amount of CO_2 emissions reduced or secluded from the environment.

N

National Environmental Policy Act (NEPA)

This act requires all projects implemented on federal property or built with federal funding to follow a process that considers the environmental impacts and mitigation measures, if necessary, for the project.

Net metering

Net metering is a billing mechanism that credits solar system owners for the electricity exported onto the electricity grid. Under the simplest implementation of net metering, a utility customer's billing meter runs backward as solar electricity is generated and exported to the electricity grid and forward as electricity is consumed from the grid.

P

Peak sun hours

The equivalent number of hours per day when solar irradiance averages 1,000 watts per square meter.

Permitting incentive

Incentive that reduces or waives local permit fees, plan check fees, design review fees, or other such charges consumers and businesses may incur when installing a solar energy system.

Photovoltaic (PV) system

A set of components for converting sunlight into electricity. Comprises the solar modules or array that captures the sunlight along with balance-of-system (BOS) components, such as the array supports, electrical conductors/wiring, fuses, safety disconnects and grounds, charge controllers, inverters, and battery storage.

Power purchase agreement (PPA)

A legal contract between an electricity generator and electricity purchaser. Solar PPAs typically provide a long-term contract to purchase electricity generated from a solar installation on public or private property; a type of third party ownership model.

Procurement specification

Procurement specifications describe the requirements of a project so that offerors may prepare a bid. Specifications often include an introductory background; scope of work, deliverables, and schedule. Specifications include the goals of the project, specified performance requirements, quality control requirements, interface requirements (how the new system touches existing systems), scheduling and access requirements, reporting requirements, and any other restrictions on how the offereror may complete the scope of work.

Production-based (or performance-based) incentive

Cash payment to project owners based on electricity production on a dollar-per-kilowatt-hour basis over a specified duration.

Production tax credit

A tax incentive based on the MWh production of an energy system.

Project developer

A company that provides services for solar installations including planning, organizing, executing, and managing resources for installation projects.

Public benefits fund

A fund dedicated to supporting renewable energy and energy efficiency projects. The fund is typically financed through a small charge on the bill of utility customers (sometimes referred to as a system benefits charge) or through specified contributions from utilities, although other means of funding such as legislative appropriations are possible.

R

Radial electric distribution system

The dominant electric distribution system in the United States where electricity is supplied from a single source and there are no closed “loops” in the system.

Real-time pricing (RTP)

The instantaneous pricing of electricity based on the cost of the electricity at the time it is used by a utility customer. RTP rates are volatile and are generally very high when demand for electricity is high.

Rebate

Cash incentive issued to a purchaser of a solar energy system to help defray the up-front cost of installing the system.

Renewable energy (RE)

Energy from resources that naturally replenish themselves and are virtually inexhaustible. Renewable energy resources include biomass, hydropower, geothermal, solar, wind, ocean thermal, wave action, and tidal action.

Renewable energy certificate or credit (REC)

A REC represents the property rights to the environmental, social, and other non-power qualities of renewable electricity generation. A REC, and its associated attributes and benefits, can be sold separately from the underlying physical electricity associated with a renewable-based generation source.

Renewable energy certificate (REC) marketer or aggregator

A REC marketer or aggregator buys RECs at wholesale prices and sells RECs at retail, similar to a commodities dealer.

Renewable energy certificate (REC) trading mechanism

An exchange for trading RECs much like the New York Stock Exchange for trading shares in companies.

Renewable portfolio standard (RPS)

A mandate requiring that renewable energy provides a certain percentage of total energy generation. The mandate is sometimes referred to as a renewable electricity standard or RES.

Request for Information (RFI)

A document that requests feedback from interested parties on the best approach to development on sites. Information gathered from this process is typically used to inform development of an RFP.

Request for proposal (RFP)

A document issued to the public to solicit project proposals from solar developers.

Request for qualifications (RFQ)

A publically issued request for statements of qualification from solar developers that are interested in bidding on a solar project. The purpose is to obtain a pre-qualified list of developers that will be allowed to respond to the RFP.

Revolving loan fund

A source of money from which loans are made. As loans are repaid, funds become available for new loans to other entities.

S

Sales tax incentive

Exemption from or refund of sales tax for purchasing and installing solar energy components and systems.

Schematic design

Schematic design describes the size and type of major components, and the relationships between those components. Schematic design should answer all questions related to thermodynamics (energy balance) but not necessarily related to transport phenomenon (wire and pipe sizes). Issues of physical size and location should be addressed. Schematic design often involves evaluation of alternatives and selection of a preferred alternative.

Screening

Screening is a preliminary analysis based on existing (or easily collected) data to determine which sites are candidates for a feasibility study. Screening is often based on high-level information such as utility bills and published climate data. Screening is most often conducted on a large number of sites to focus an agency's effort on sites most likely to have viable projects.

Secondary network distribution system

A type of electric distribution system that serves central business districts in many cities. These systems contain multiple feeders and transformers to provide excellent service reliability and the capacity to serve large loads, such as high-rise buildings.

Service entrance capacity

The amount of power a building is designed to handle. A service entrance is the point at which electricity enters a building. A service entrance switchboard has metering equipment and devices for overcurrent protection and electrical control.

Set-aside

A mandate or goal for some fraction of a renewable portfolio standard to be met with designated technologies such as PV.

Solar access

The ability of one property or area to continue to receive sunlight without obstruction from a nearby home or building, landscaping, or other impediment.

Solar aggregation purchasing program

See customer aggregation programs.

Solar bulk purchasing

See customer aggregation programs.

Solar Decathlon

An international competition between colleges and universities in which teams compete to design, build, and operate the most attractive, effective, and energy-efficient solar-powered house. The competition, which is sponsored by the U.S. Department of Energy, takes place every two years in Washington, D.C.

Solar easement

A type of solar access law that grants the owners of solar energy systems the right to continued access to sunlight without obstruction from a neighbor's property and limits future property developments that could restrict solar access.

Solar electricity

See photovoltaic system.

Solar energy

Electromagnetic energy transmitted from the sun (solar radiation). The amount that reaches the earth is equal to one billionth of total solar energy generated or the equivalent of about 420 trillion kWh.

Solar farm

Refers to a large-scale solar installation.

Solar installer licensing

Licensing requiring a baseline of quality below which it is illegal to operate.

Solar permitting process

To install a grid-connected PV system, the homeowner or builder must obtain an electrical permit and in some cases a building permit from the local government, followed by an inspection of the installation. Solar water heating systems require a plumbing permit and sometimes a building or mechanical permit, or both.

Solar-ready

A solar-ready home or building is designed as if a solar energy system were going to be installed during construction. Architects and builders take precautions to ensure a viable site for solar technologies by leaving adequate roof space free from vents, chimneys, and equipment; planning landscaping to avoid shading the unobstructed roof space in the future; planning extra space for equipment in mechanical rooms; preinstalling roof mounting systems and conduit; and labeling structural reinforcements and end points of wires or pipes.

Solar resource

The amount of sunlight a site receives, usually measured in kilowatt-hours per square meter per day. See also peak sun hours.

Solar right law

A law or ordinance that furnishes protection for homes and businesses by limiting or prohibiting restrictions (for example, neighborhood covenants and bylaws, local government ordinances, and building codes) on the installation of solar energy systems.

Solar site assessment

An evaluation of a site being considered for a solar energy installation. A trained solar site assessor collects data such as roof or property orientation and slope, dimensions of available installation space, electrical and/or plumbing configuration, and shading on the site location.

Solar thermal

Solar energy conversion technologies that convert solar energy to thermal energy (heat) used to heat water or provide energy for space heating and cooling in active solar space heating or cooling systems.

Spot-market

A market in which commodities are bought and sold for immediate delivery.

Stub-out

The result of preparing a building for future equipment installations. To prepare for solar electric systems, conduits are run through the building so wires can connect a PV system to an electrical panel at a future date. For solar water heating systems, open-ended pipes are placed in an accessible location to connect solar collectors to hot water storage in the future.

Sustainable solar infrastructure

The social, economic, policy, and physical networks and institutions that enable solar energy to be used as a mainstream energy source even in the absence of significant government subsidies.

System benefits charge

A small charge on the bill of utility customers to support public policy initiatives such as renewable energy and energy efficiency programs.

System capacity

The maximum expected energy production from a PV system.

System rating

A rating of the maximum power a solar energy system will produce under standard test conditions (STCs). STCs are a solar irradiance of 1,000 watts per square meter, a temperature of 77°F, and an air mass of 1.5. Solar irradiance is measured in watts per square meter of light incident on Earth.

T

Tariff

A document approved by the responsible regulatory agency that lists the terms and conditions—including a schedule of prices—under which utility services will be provided.

Time-of-use (TOU) pricing (or tariff)

A rate schedule in which the utility customer is charged different amounts for power based on the time of day and season. Typically, peak rates are during summer afternoons. Solar customers who generate power during peak rates are credited by the utility company at those peak rates.

Transmission and distribution loss

The energy lost when transporting electricity over long distances through the electricity grid's transmission and distribution systems from central generation plants to the point of electricity consumption (homes and businesses).

True up

When a utility calculates the "net" consumption versus generation over a given time period (month or year). Compensation for net excess generation is often limited to the amount of electricity used during the true-up time period. Monthly true-up cycles don't capture the true value of a PV system's generation because excess generation in the summer (when PV is producing at its peak) is lost and consumption during winter (when PV systems are producing at their minimum) is charged.

U

Utility energy services contract (UESC)

A contract with a "serving" utility for the utility to provide comprehensive energy and water efficiency improvements and demand reduction services.

Utility renewable electricity service contract (URESC)

A contract with a "serving" utility for the utility to provide electricity from on-site solar electricity generation. As of the summer of 2010, no URESCs had been completed.

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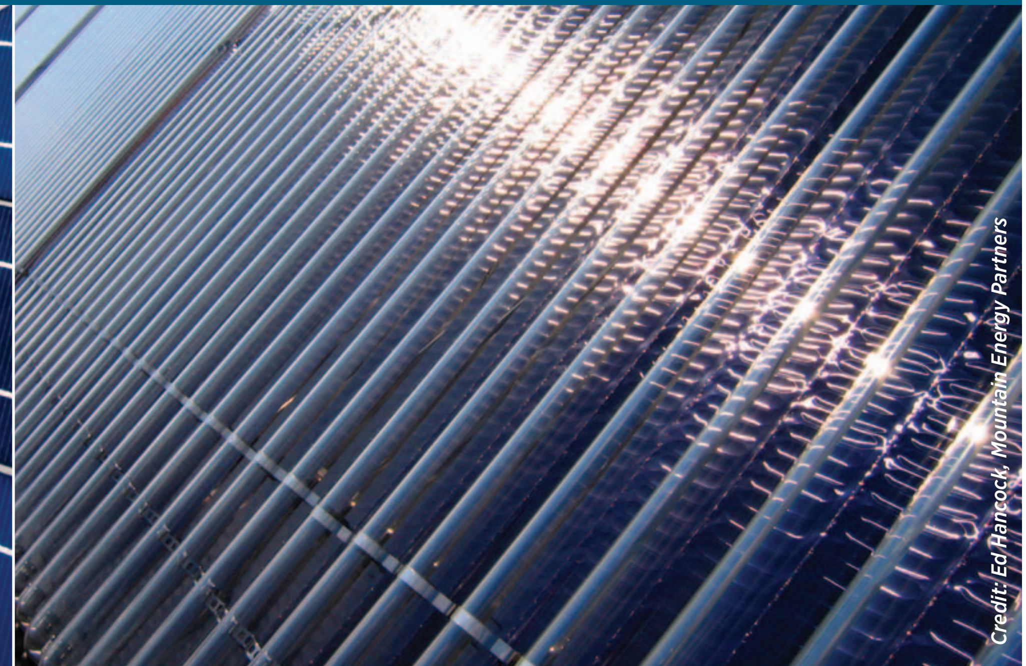


Appendix A

Solar Technologies Overview

Federal site managers need to be smart buyers of solar energy and not necessarily experts in solar technology. The sections below provide a brief technology overview for background information. The focus is on small to medium distributed solar systems.

The solar technologies explained are:

- Photovoltaics
- Solar hot water (both domestic hot water and pool heating)
- Solar ventilation pre-heat

Other topics related to solar energy in buildings include passive solar heating, cooling load avoidance, and daylighting. These topics are not covered here as they are usually part of a larger architectural design of a building rather than a financed project.

Suitland Federal Center PV system, Maryland.
(Credit: Bob Madani for DOE/FEMP. PIX 10726.)

Photovoltaics

HOW PHOTOVOLTAICS WORK AND TYPES OF SYSTEMS

A photovoltaic (PV) system creates electricity when light shines on it, but it needs to be integrated into systems that can power electric machines, appliances, lights, and other electric devices. A PV module creates relatively low-voltage direct current (DC) electricity. PV modules are connected in series and in parallel to create arrays. Series connections increase the voltage of a string, and parallel connections increase the current delivered by the array. Typically the installer defines the maximum DC voltage that the array can produce and designs the series strings to produce close to but below that voltage. The strings are then connected in parallel to complete the PV array. For most grid-connected systems, voltage must be limited to 600 volts direct current (VDC), requiring many parallel strings for large systems. These strings are combined in a combiner box to larger dimensional wires. The exception to this design method is if micro inverters are used, which are explained below.

The three types of PV system designs are grid-connected without storage, grid-connected with emergency battery backup, and off-grid with battery storage.

Grid-connected without storage systems are by far the most common and most likely will be the type to consider for the site. Grid-connected systems without storage consist of two critical parts: PV array and utility-interactive inverter. The inverter changes the DC power and voltage the array produces into alternating current (AC) power at the voltage and number of phases appropriate for the interconnection point. The inverter also senses the utility power frequency and synchronizes the PV-produced power to that frequency. When utility power is not present, the inverter will stop producing AC power to prevent "islanding" or putting power into the grid while utility workers are trying to fix what they assume is a de-energized distribution system.

If the site is connected to the grid and has critical loads that need emergency backup power, a grid-connected with emergency battery backup system is a consideration.

If the site does not have grid power and runs on generators, an off-grid system with battery storage can reduce generator run time and save on operations and maintenance costs.

PV systems with battery storage include a charge controller that is either integrated into the inverter or a separate component. The charge controller controls both the DC voltage that comes off the PV array and the voltage going into the batteries. Batteries require the specific stages of charging produced by charge controllers to help extend their longevity.

All types of PV systems require switch gear and protections as directed by electrical code (e.g., NEC 690) and good system design to protect the equipment. This gear may include DC disconnect; AC disconnect; lighting surge arrestor; ground fault current interrupter; and fuses or breakers and transformers required for higher voltage interconnections. Many utilities require redundant utility-specified relays.

PV TECHNOLOGIES

There are presently two primary technologies that form most of the PV market: crystalline silicon and thin films. Crystalline silicon PV is constructed on wafers of silicon, while thin films are constructed by depositing thin layers on a substrate.

Crystalline modules are the most efficient in converting the sun's energy to electricity. In other words, they produce the most electrical power per area of module. Typical efficiencies for crystalline PV are between 10% and 19% (this is the percentage of the sun's energy that strikes the module and is converted to electrical energy). This type of module tends to be the most expensive per unit of power capacity (dollars per watt) compared to thin film PV technology. Crystalline can be a good match for projects that have limited space and are seeking capacity maximization or where set up costs (i.e., mounting and installation costs) are high.

Crystalline type modules have a lifespan in the 25-30 year range but can keep producing energy beyond this range. They have a proven track record and typically have 25-year power output warranties. On the downside, the modules become less efficient as their temperature rises, and even partial shading can significantly reduce the power output of the strings involved. Crystalline modules presently make up the majority of the market for installed PV.

Thin film PV technologies are the least efficient, with typical efficiencies between 4% and 12%. Some thin film products don't have the proven track records that crystalline PV enjoys and are considered to have a shorter life span, but most come with 25-year power warranties. However, they can be less expensive per watt and are less susceptible to shading and temperature effects. Thin film PV products are designed for several different installation options, but one thrust is for building-integrated installation, especially easy integration with roofs. This type of PV can be a good match for several situations: very large arrays with low set-up cost; large roofs that do not require maximization of production or are structurally insufficient to handle a heavier racked crystalline PV installation; in areas at risk for hurricanes and other extreme weather; near roads where debris can be thrown up by transportation; or ground-mounted systems where earth settlement is an issue.

INVERTERS

There are two types of inverters for grid-connected systems: string and micro inverters. Each type has its strengths and weakness that may recommend them for different types of installations. String inverters are most common and typically range in size from 1.5 kW to 500 kW. Benefits of these inverters are that they tend to be less expensive per watt of capacity, selection includes a large range of output voltages, and possible extended warranties may be available of up to 20 years on larger units. On the down side, if the inverter fails the project could lose a significant part of production during the outage. For larger systems, multiple inverters can be combined in parallel and still produce a single point of interconnection with the grid. Warranties typically run between 5 and 10 years, with 10 years being the current industry standard. Typically, inverters will have to be replaced during the life of the system. Micro inverters are new and are designed to be dedicated to the inversion of a single PV module's power output. Small projects with irregular modules and shading issues typically benefit from micro inverters.

MOUNTING SYSTEMS

PV mounting system can generally be divided into three types: building mounted, ground mounted, and canopy. The type of mounting system will depend largely on the physical site as well as possible secondary goals. If the site is an urban one with no land or parking lots, a building-mounted system will be required. If land is available on the site, considerations may include future plans for the land, possible environmental hurdles to a ground-mount system, desire for covered parking, desired system size, and access restrictions, among others.

Building-mounted PV is primarily either integrated or racked systems on the roof. Integrated systems include PV sunshades for windows, PV in walls, and roof-adhered systems, among other options. Many forms of integrated PV are directed at new construction; however, roof-adhered systems (where the PV is adhered to the roof) are an option for most buildings with a reasonably new roof or those scheduled for a new roof. A roof-adhered system is a thin film PV module that is adhered to a roof surface, ranging from a membrane to a metal roof. This system can be an option when a roof's weight-bearing capacity or aesthetics are an issue.

Roof-mounted racking systems are designed for framed PV modules. The two classifications of roof racking systems are ballasted and attached (roof penetrating). Ballasted racking systems use aerodynamic measures in the design, and the weight of PV modules, racks, and any extra ballast weight calculated to be required to keep the system on the roof during wind conditions. The benefit of this type of system is that roof penetrations are minimized or eliminated, which reduces the possibility of water leaks. Also, they tend to be easier to install. Attached racking systems tend to include multiple roof penetrations. Attached systems can be an option where wind loading exceeds a ballasted system's capacity, where roof-available carrying capacity cannot accommodate a heavier ballasted system, or where an extra safety factor might be required. Another option is to include a small number of attachment points with a ballasted system to give an extra safety factor. Roof-rack systems offer the advantage of tilting PV arrays toward the equator to achieve higher annual energy production. Tilt increases energy production by allowing modules to collect more energy from the sun and by allowing snow and rain to aid in the cleaning of the module face. Typical tilts for these systems are between 5 degrees and 25 degrees.

Ground-mounted systems can be categorized as fixed or tracking. Fixed systems have lower maintenance costs but generate less energy (kWh) per unit power (kW) of capacity. Tracking systems move the PV modules so they are more directly facing the sun as the sun moves across the sky. This increases energy output but also increases maintenance and equipment costs. Single axis tracking, in which PV is rotated around a single axis, can increase energy output up to 30%. With two axis tracking, PV is able to directly face the sun all day, potentially increasing output up to 35%. Tracking is typically used only on systems of 300 kW or larger. Ground-mounted systems typically penetrate the earth, but there are applications such as ballasted tub that do not penetrate the earth and have been used where the earth is subject to settling, such as landfills. Ground-mounted systems usually allow for larger systems and greater design flexibility.

Canopy structures are frequently designed to both host PV modules and provide shade to vehicles. While this structure does provide dual utility, it will likely increase overall system cost due to the cost of the support structure. But in areas where shaded parking is valued and may be built anyway, this can be a good option.

Solar Heating and Cooling

Solar heating and cooling (SHC) technologies vary from the other solar technologies in two significant ways: 1) they produce thermal, not electric energy, and 2) the systems are not utility-scale, but are put at the customer site as distributed energy only. In buildings, SHC provides energy for water heating, space heating, and space cooling. Industrial applications include process heating or cooling for manufacturing, food processing, and other applications; district heating and cooling; and waste remediation/destruction.

This section focuses on the most common end-use applications for federal facilities and military housing. Cost-effectiveness and success depend on a number of variables, particularly the cost of competing fuels, the first cost and payback for the SHC system, incentives, and the presence of market barriers such as unfavorable zoning or building codes. Solar water heating provides the best illustration of these factors, which also apply to a greater or lesser extent to other SHC technologies. Solar thermal sales for space heating are quite small compared to the potential market, but proven products such as solar ventilation pre-heaters are available.

TYPES OF SOLAR HEATING AND COOLING TECHNOLOGY

Solar thermal systems differ by the type of collector used to gather and store solar energy. There are three basic types of liquid collector systems: flat plate, evacuated, and concentrating. Air collectors use air as the working fluid for absorbing and transferring solar energy.

Glazed and unglazed flat plate collectors

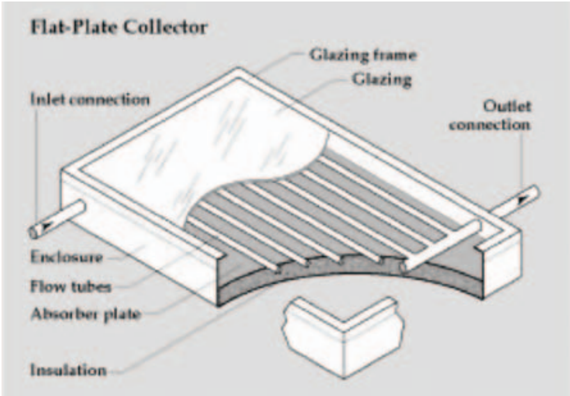


Figure 1. Flat-plate collector
Source: DOE/EERE

Flat plate collectors are the simplest and most common type of collector. They are designed to heat water or another fluid to medium temperatures (approximately 140°F). This collector technology (Figure 1) generally consists of a thin flat-plate absorber sheet that intercepts and absorbs solar energy. The absorber may have a selective coating or it may be chemically coated to increase its solar absorption capacity. Copper pipes or tubes wind back and forth across the absorber and carry fluid through the flat plate collector. Often the pipes are painted black and bonded to the material of the flat plate collector to maximize heat absorption. The collector is covered with glass, or "glazing," that allows solar energy to pass through but reduces heat loss from the absorber. As heat builds up in the collector, it heats the fluid passing through the pipes. "Unglazed" flat plate collectors without the glass covering are best suited for low temperature applications, such as heating swimming pools. While these unglazed collectors capture a larger portion of the sun's energy, they lose a large portion of the absorbed heat because they are not insulated with a covering. These types of collectors are substantially less expensive than glazed systems.

Evacuated tube collectors

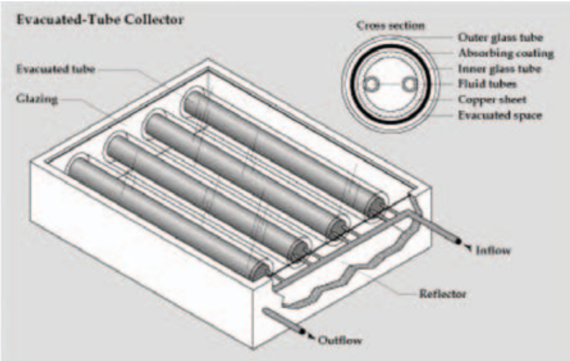


Figure 2. Flooded evacuated tube collector
Source: DOE/EERE

Evacuated tube collectors produce higher temperatures (approximately 300°F). This collector is made of parallel rows of tempered glass vacuum tubes and an absorber surface inside the tube. The absorber is surrounded by a vacuum that reduces heat losses. The glass tubes heat up the solar absorbers and, ultimately, the solar working fluid in order to heat domestic hot water, or provide space heating. Figure 2 is a diagram of an evacuated tube collector.

Air collectors

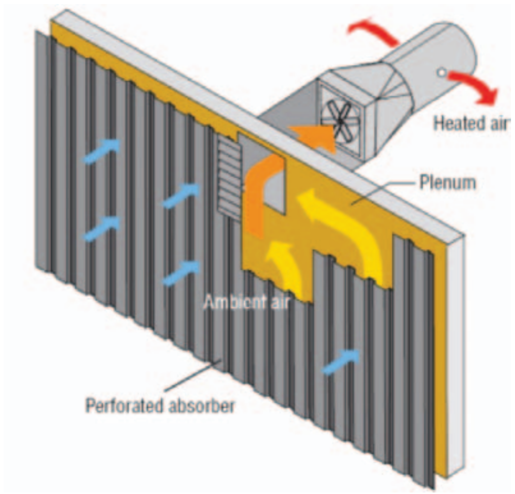


Figure 3. Transpired air collector
Source: Transpired Air Collectors: Ventilation Preheating, NREL, 2006.

Collectors for air heating systems perform the same important function as those for liquid heating systems, although they operate on a much different principle. Figure 3 shows a simple diagram of a transpired air collector. It consists of a dark-colored, perforated façade installed on a building's south-facing wall. These systems operate by using a fan or the building's own ventilation system to draw ventilation air into the building through a perforated absorber plate on the façade and up through the air space between the absorber and the south wall.

Transpired air collectors can preheat intake air by as much as 40°F. Solar roof ventilation systems are also available for both sloped and flat-roof buildings.

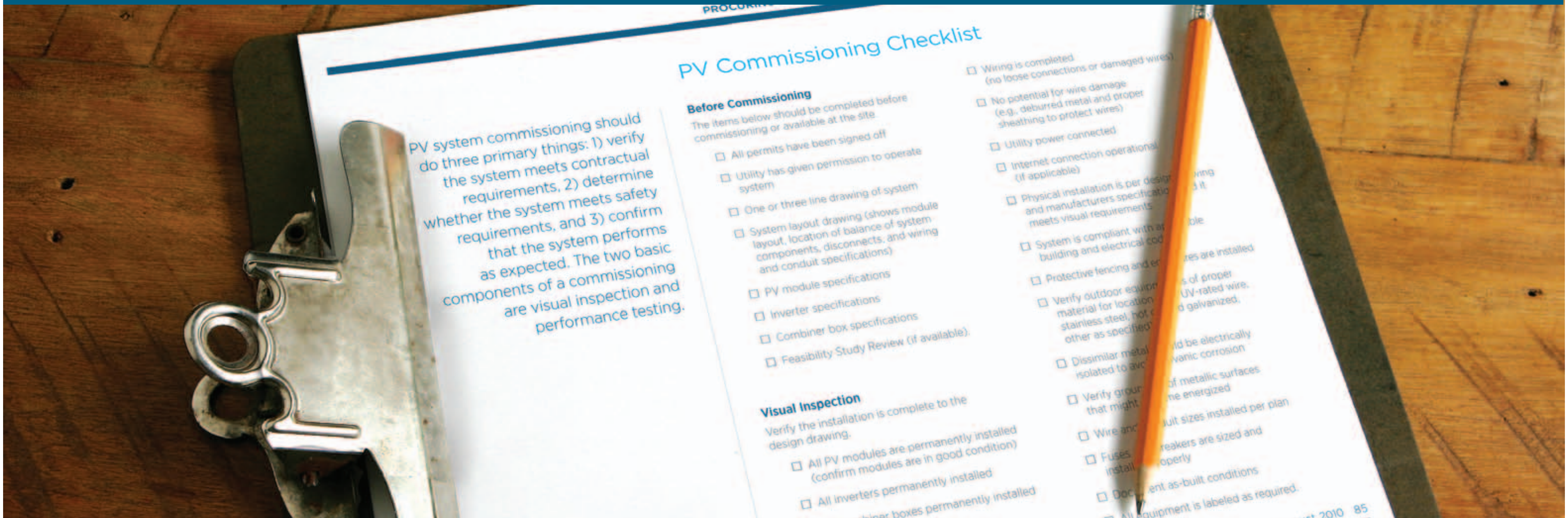
SPACE HEATING

Solar heated air can be used for space heating, either directly or in combination with an air-source heat pump. One application for ventilation air is the transpired solar collector, which draws air through the perforations of a solar absorber, warming the air in the process. This heated air is then collected and used as pre-warmed air to be inputted to a conventional heating/ventilation system. They are well suited for buildings with high ventilation requirements like workshops, hangars, or warehouses. Because of its low cost and simplicity, solar ventilation air preheating using transpired collectors is cost effective in most locations that can use the heat.

COMMON SYSTEM COMPONENTS/ CONFIGURATIONS

For all SHC applications, the primary components are collectors, storage, and balance of systems components. Collectors are such an important component that systems are commonly characterized by the type of collector, as discussed earlier in this section. Other important components include storage, pumps, piping, heat exchangers, and mounting systems.

Water is the most common medium used for heat storage; however advancements in phase change materials could result in a shift away from water, as these synthetics have the potential to store more heat in smaller vessels. Storage tanks utilize either lined/coated steel or stainless steel in their construction. The technology utilized for solar thermal storage is much the same as traditional water heating vessels, although commercial and industrial systems may require significantly larger tanks than domestic systems. The larger the hot or chilled water storage tank, the longer the thermal supply can be considered a firm source of energy. Research is being conducted on chemical means to store heat, such as dessicant/water combinations, so that stored solar energy would be available upon request.



Appendix B

Self-Guided Solar Screening

A preliminary solar energy site screening provides a rough estimate of the solar resource, energy production, and cost of a PV system. It also provides information for a go- or no-go decision to proceed further in the procurement process. A more thorough solar energy site screening may be needed later to better quantify the energy production and costs before proceeding further.

A summary sheet is included at the end of this section to record the data and observations. The summary sheet, along with any drawings or photographs, is needed for the next steps in procuring a PV system. Shooting photographs of the site and equipment is critical, as they allow others to confirm the preliminary estimate or make recommendations without visiting the site.

General Services Administration, Ralph H. Metcalfe Federal Building PV arrays, Chicago, Illinois. *(Credit: Patrick Engineering. PIX 09514)*

Solar Site Screening

PRIOR TO A SITE VISIT

Preview the site using IMBY (www.nrel.gov/eis/imby/) or Google Earth (http://earth.google.com) to identify possible land or roof areas for a PV system.

- Identify roof areas with flat or equator-facing surfaces (e.g., south in the northern hemisphere) with little or no equipment on the roof.
- Identify large, open land areas.
- Print an overhead map of the site and mark these potential land and roof areas on the map for ease of location during site visit.

Use PVWATTS version 1 or 2 (www.nrel.gov/rredc/pvwatts/) or IMBY. Calculate, and print out, the energy production for a 1 kW PV system tilted at 10 degrees, and use the defaults for all other inputs. The monthly and yearly energy outputs for a 1 kW system are useful numbers for scaling to larger systems. For example, a 55 kW PV system produces 55 times the energy of a 1 kW PV system.

WHEN ON-SITE

Access the roof or land area being considered for PV systems. Note the tilt angle and orientation of the equator-facing or flat roof area. Also note the type, condition, and age of the roof. If it is a land area, note the approximate grade and orientation of the land area. Take photographs.

The objective now is to determine the area of the site for a potential solar system as this will allow an estimation of the potential system size. The site needs to be very clear of objects that could cast shadows on the proposed site. While standing on the proposed site, use your thumb and fist to estimate the angle of the object from the horizon to the top of the object. A sideways thumb held at arm's length is about 2 degrees from the bottom to the top of the thumb. A fist held in front of your body is about 10 degrees from the bottom (little finger) to the top (pointer finger) of the fist (see www.vendian.org/mncharity/dir3/bodyruler_angle/). Objects that are less than 20 degrees in height above the site, that are skinny (e.g., power poles), or that can be removed should be ignored for this preliminary estimate. For objects that are on the site, make height-angle measurements close to the roof or ground where the collectors will be placed. Determine the square footage of the site that is not shaded by objects, as determined above. For a preliminary estimate, the distances could be paced off. If available, use a measuring device such as a range finder or a rolling wheel tape measure. Take several photographs that could be used to make a panoramic photograph.

If a roof area is being considered, ask the people on site if the roof leaks, when it was last replaced or repaired, or if they have any concerns about it. Note their answers. Take photographs of the roof and the underside from inside the building if possible. Ask about the roof construction and whether any drawings are available. Make a copy or take a photo of any drawings.

Photovoltaic Specific Assessment

Identify the nearest location for housing the inverters. It is best if this location is shaded or enclosed. Small inverters (6 kW or less) can hang on a wall. Larger inverters (greater than 6 kW) are placed on the ground or floor. Note the distance from the proposed PV system location to the inverter bank. Take photographs.

Identify the nearest electrical panel and record the location and distance from the inverter bank to the electrical panel, voltage at the electric panel (V), the number of phases (1 or 3), capacity of the main breaker (amps), and the capacity of the panel (amps). Take photographs of the equipment, including the circuit breakers.

Energy Production Estimate

Estimate the size of the PV system by multiplying the proposed site area (ft^2) times 9.3 W/ft^2. This corresponds to a fairly typical 14% efficient crystalline PV module. This preliminary solar energy site assessment is for no, or relatively few, solar obstructions. If the solar obstructions become numerous or complicated, then a more detailed solar energy site assessment should be made.

Site Energy Requirements

Prior to a site visit, or while on site, determine the annual energy usage from the utility bills. Ask the site personnel if any energy efficiency changes will be made or if electrical load increases are anticipated.

Determine the annual electrical energy consumption for the building or site. Compare this number to the estimated energy production from a PV system. In most locations there is little economic sense to produce more energy than is consumed. If needed, reduce the PV system size to just meet the annual electrical energy usage.

Divide the estimated PV system production by the annual electrical energy usage. This is the percentage of annual energy supplied by the PV system.

Cost Estimate

A conservative price estimate for a fully installed PV system is $6,500 to $8,000 per kW of PV. Large PV systems (greater than 100 kW) or PV systems on sites with uncomplicated site access or conditions have been installed for less money. This price range is for a simple grid connected PV system without batteries. Systems with batteries can easily double the installed price.

Incentives

Available incentives for solar projects can be critical to the economic feasibility of a prospective project. Look up and list incentives that apply to the project. The DSIRE Web site lists most incentives available for solar projects from federal, state, local, and utility sources. (www.dsireusa.org, accessed July 19, 2010)

Go- or No-go Decision

The information compiled here will form the basis of the economics that will be used for a decision to explore the feasibility of the project further.

Summary of Preliminary Solar Energy Site Screening for Photovoltaics

Name of Location:

Latitude and longitude, or ZIP code:

Assessment performed by:
(include contact information)

Date of Assessment: ______

POSSIBLE SITE ISSUES

Historic building issues?

Structural issues (if rooftop)?

Roof age and condition? Planned replacement?

Area (ft^2)	
Maximum PV system size (kW)	
Estimated annual PV system energy production (kWh/yr) (from PV WATTS or IMBY)	
Building or site annual energy consumption (kWh/yr)	
Percent solar contribution (production divided by consumption [%])	
Distance from PV system to inverter (ft^2)	
Electrical service (voltage and # of phases)	
Total installed price estimate ($)	
Present price of energy ($/kWh)	
Estimated annual energy savings ($/yr) (estimated annual energy production multiplied by present price of energy)	

List available incentives for solar projects on the site:

Comments (use another page if necessary):

Attach drawings, photographs and printouts.

Solar Screening Evaluation Checklist

This is a checklist to review the adequacy and quality of a given solar screening and to determine if a more detailed screening needs to be done. If an applicable element at right is missing from the screening, it is recommended a more detailed solar screening for the site be obtained.

The checklist at right is in two parts. **The first part is for solar screenings** and pertains to financing mechanisms other than agency funded. **The second part is for solar feasibility studies** and includes recommended information *in addition to* the solar screening.

Solar Screening minimum recommended information *(items 1 – 5)*

1. Confirm shading analysis, available square footage and preliminary size estimate:

- ☐ Satellite map view or use of an accurate aerial tool to analyze the potential shading impacts of neighboring buildings, rooftop protrusions, parapets, or vegetation that could block sunlight from a potential solar array and relate these impacts to the available roof or ground area.
- ☐ Satellite or accurate aerial tool measurement of the available square footage or acres
- ☐ Preliminary estimate of the system size.

2. Confirm annual energy production per unit of capacity:

☐ **Electricity production estimates**

__________ (kWh/yr/kW installed)

(available online tools: PV WATTS or IMBY). Inputs for this level of analysis are as follows (unless site conditions preclude, i.e., a steep pitch roof that does not face the equator):

- ☐ 1 kW system size
- ☐ 10 degrees from horizontal-tilt (if you have a pitched roof, enter actual pitch)
- ☐ Local location or nearest location option with similar sun exposure
- ☐ 0.77 derating factor
- ☐ Azimuth (compass orientation—select 180 degrees or 0 degrees so array faces equator or, for a pitched roof, enter the direction that the roof faces)

☐ **Solar thermal**
(available online tool: RetScreen www.retscreen.net/ang/home.php)

☐ **Solar ventilation preheat**
(available online tool: RetScreen)

☐ **Solar pool heating**
(available online tool: RetScreen)

3. Confirm economic analysis:

☐ **Confirm local energy rates**

__________ ($/kWh or $/therm)

☐ **Annual savings**

__________ ($/yr/ kW installed)

☐ **Any available incentives?**

__________ ($/W or $/yr/W)

(i.e. rebates, local Renewable Energy Credits market, other). Check DSIRE: www.dsireusa.org

☐ **Any extraordinary project specific costs?**

__________ ($/W)

Confirm that structural, electrical interconnection, and equipment location issues have been investigated and any additional costs related to these have been estimated.

☐ **Estimated System cost**

__________ ($/W)

☐ **Appropriate economic metric for your decision-making process.**

__________ (SIR, NPV, LCC, other)

(Solar Advisor Model is available online and does some financial analysis.)

NOTE: In general, the estimated cost should not exceed $8 per watt except in special circumstances.

4. If proposed system is rooftop:

- ☐ **Age of roof**

  ___________ (yrs)

- ☐ **Condition of roof**

  ___________ (yrs of expected remaining life)

- ☐ **Roof warranty**

  ___________ (yrs remaining)

- ☐ **Estimated structural capacity available for solar system**

  ___________ (lbs/ft^2)

- ☐ **Estimated maximum weight of solar system**

  ___________ (lbs/ft^2)

5. Confirm other considerations have been addressed:

- ☐ **Historic building issues** (is the proposed system on a historic building or in a historic district?)

- ☐ **National Environmental Policy Act (NEPA)** issues (primarily an issue for large ground-mount systems).

Solar feasibility study minimum recommended information in addition to the Solar Screening information *(items 1-9)*

6. Confirm recommended size

- ☐ **Is the recommended size in assessment reasonable and is there opportunity for a larger system?**

  ___________ (kW or area of collectors)

  In My Backyard (IMBY) is a Web tool that uses aerial maps and a draw feature to estimate PV system size on a site. (Note: IMBY's output for system size is reasonable for a 14% efficient PV module or 100W/m^2.) See www.nrel.gov/eis/imby/ .

7. Confirm shading analysis (recommendations for report)

- ☐ Detailed shading analysis with solar collector exclusion areas marked on the plan view of the site adjacent shading obstructions. Exclusion areas should be indicated to the east, west, and toward the equator (if in the northern hemisphere- to the south) of any shading obstruction.

- ☐ Unless the array is installed with zero degrees tilt (horizontal), need to see some space between rows in the array layout to prevent rows of PV shading each other.

8. Confirm investigation into interconnection issues:

- ☐ Requirements to get utility approval for interconnection (estimated costs if special equipment is required)

- ☐ Recommended interconnection point

- ☐ Confirmation of space for system electrical equipment

9. Confirm annual energy production for site-specific recommended system

- ☐ **Electricity production estimates**

  ___________ (kWh/yr)

  (available online tools: PV WATTS or IMBY).

  Inputs are:

  - ☐ ___________ (kW) system size
  - ☐ ___________ (degrees from horizontal) tilt
  - ☐ ___________ Location
  - ☐ ___________ Derating factor (default is 0.77)
  - ☐ ___________ (degrees-compass orientation) Azimuth

- ☐ **Solar thermal** (available online tool: RetScreen)

- ☐ **Solar ventilation preheat** (available online tool: RetScreen)

- ☐ **Solar pool heating** (available online tool: RetScreen)

PV Project Design Evaluation Checklist

This checklist has been created to assist you in the design phase of the system during the 25%, 50%, and final review stages

Site Layout

- ☐ ____________ (degrees) tilt
- ☐ ____________ (degree) azimuth
- ☐ ____________ (kW or MW) system size
- ☐ Engineer's stamp on PV array mounting design for wind loading
- ☐ Confirm shading analysis has been done and site layout conforms to it.

Rooftop system:

- ☐ Engineer's stamp on roof structural weight carrying capacity for solar system
- ☐ Confirm weight of system is within carrying capacity of roof (lbs/sq ft)
- ☐ What type of roof penetrations, if any, and confirm construction detail to weatherproof penetrations
- ☐ Check PV layout compliance with fire specifications. (Fire Safety Guideline for Photovoltaic System Installations: www.fpemag.com/_pdf/Fire_Safety_Guideline-PV_System_Installations.pdf)

Ground-mount system:

- ☐ ____________ (ft) Height of lower edge of collector to ground. Usually like to see a minimum of 2 feet between the lower edge of the PV modules and the ground. This can be location specific (examples):
  - i. In desert areas where vegetation does not grow tall and could possibly shade the array, the array could be closer to the ground.
  - ii. In areas of high snow fall the array should be higher from the ground to prevent snow building up at the lower edge of the array as it slides off, thus causing the array to be shaded.
  - iii. Some key things to consider regarding location are vegetation, snow, material that may drift around the array, future development, and other possibilities for future shading problems.
  - iv. Decisions around this issue can be a balance between location conditions, O&M costs for periodic removal of shading problems, and specifications for the ground under the array (e.g., weed barriers and gravel).
- ☐ Perimeter fence:
  - i. Confirm the fence doesn't shade the array.
  - ii. It is a good idea to restrict access and keep out tumbleweeds and animals that may damage the system.

For more detailed information see http://irecusa.org/fileadmin/user_upload/NationalOutreachPubs/InspectorGuidelines-Version2.1.pdf

Electrical Design

Based on one-line or three-line diagram:

- ☐ Final electrical design has engineer's stamp
- ☐ ___________ (volts) Check PV string maximum/minimum voltages (extreme weather) and confirm within inverter specifications (most inverters have a "string calculator" on their site, for example: www.aesolaron.com/SolarStringCalc.aspx)
- ☐ ___________ (kW) Check PV array maximum DC power to each inverter (extreme weather-cold and clear) to confirm it is within inverter specifications.
- ☐ PV-each string protected (fuse or breaker)
- ☐ ___________ (% efficiency, configuration & capacity) Transformer specification (recommended minimum efficiency of 97%)
- ☐ Module grounding: confirm there is a specific grounding wire or the rack/module system is Underwriters Laboratories rated for grounding
- ☐ AC disconnects specified and location easily accessible
- ☐ DC disconnects specified and location easily accessible.

Interconnection: Inside building must meet NEC 690

(Sum of PV breaker and panel main breaker less than or equal to 120% of panel rating)

- ☐ ___________ (amps) Panel rating
- ☐ ___________ (amps) Panel main breaker rating
- ☐ ___________ (amps) PV Breaker

Interconnection: Direct tie

- ☐ Is there an acceptable plan?

System Components Specifications

- ☐ System components meet "Buy American" criteria?
- ☐ PV CEC approved?
- ☐ Inverter(s) CEC approved?
- ☐ ___________ % Inverter efficiency
- ☐ ___________ (years) Inverter warranty (recommended 10 year minimum)
- ☐ ___________ PV module warranty (recommended 10 year 90%, 20 year 80% minimum)

PV Commissioning Checklist

PV system commissioning should do three primary things: 1) verify the system meets contractual requirements, 2) determine whether the system meets safety requirements, and 3) confirm that the system performs as expected. The two basic components of a commissioning are visual inspection and performance testing.

Before Commissioning

The items below should be completed before commissioning or available at the site.

- ☐ All permits have been signed off
- ☐ Utility has given permission to operate system
- ☐ One or three line drawing of system
- ☐ System layout drawing (shows module layout, location of balance of system components, disconnects, and wiring and conduit specifications)
- ☐ PV module specifications
- ☐ Inverter specifications
- ☐ Combiner box specifications
- ☐ Feasibility Study Review (if available).

Visual Inspection

Verify the installation is complete to the design drawing.

- ☐ All PV modules are permanently installed (confirm modules are in good condition)
- ☐ All inverters permanently installed
- ☐ All combiner boxes permanently installed
- ☐ All disconnects and switchgear permanently installed
- ☐ Wiring is completed (no loose connections or damaged wires)
- ☐ No potential for wire damage (e.g., deburred metal and proper sheathing to protect wires)
- ☐ Utility power connected
- ☐ Internet connection operational (if applicable)
- ☐ Physical installation is per design drawing and manufacturer's specification, and it meets visual requirements
- ☐ System is compliant with applicable building and electrical codes
- ☐ Protective fencing and enclosures are installed
- ☐ Verify outdoor equipment is of proper material for location (e.g., UV-rated wire, stainless steel, hot dipped galvanized, other as specified)
- ☐ Dissimilar metal should be electrically isolated to avoid galvanic corrosion
- ☐ Verify grounding of metallic surfaces that might become energized
- ☐ Wire and conduit sizes installed per plan
- ☐ Fuses and breakers are sized and installed properly
- ☐ Document as-built conditions
- ☐ All equipment is labeled as required.

For a more detailed description of a similar procedure see http://solarprofessional.com/files/sample/sp2_6_pg34_gleason.pdf.

Performance Testing

Verify the system is performing within acceptable limits.

- ☐ Conductor insulation test using a megohm meter on all homerun wiring to ensure no leakage currents to earth (Pos-to-GND and Neg-to-Gnd resistance > 2 megaohms). This may need to be done during construction while conductors are accessible.
- ☐ Grounding resistance is < 5 Ohms
- ☐ Measure and record open-circuit voltage (V_{oc}) and polarity of each string. (Verifies all strings have the same number of modules.)
- ☐ Measure and record short-circuit current (I_{sc}) of each string.
- ☐ Inverter startup sequence – follow manufacturer's instructions for initial startup.
- ☐ Measure and record maximum power point current (I_{mp}) for each string. (Current measurements for each string should be within a 0.1A range of each other, assuming consistent weather conditions and all string having same tilt and azimuth angle. If a string is outside the range, check for shading or a ground fault.)
- ☐ Confirm inverter's internal power meter and display using independent meters. (Once this is done, inverter-displayed power readings can be used for subsequent reporting.)
- ☐ Confirm the system output under actual conditions meet minimum expected output. Actual performance should be within about 5% of expected, calculated performance. This procedure includes system nameplate rating (kW), solar irradiance measurement (W/m^2) and module cell temperature (C). Procedure is best conducted during consistent weather conditions, where no array shading is present, and solar irradiance is not less than 400 W/m^2.

Appendix C

Agency-Funded Project Case Studies

Agency-Funded Project

U.S. General Services Administration (GSA), Denver Federal Center PV Project, Denver, Colorado, 1.19-MW PV

- This PV system generated 1,726,000 kWh in 2008, 14% more than the contract required (10% of the DFC campus peak electrical load, 2.5% of total Denver Federal Center kWh)
- Collectors at 20 degree fixed tilt
- Requires 6 acres of land
- First cost was $6.9 million ($5.8\Watt), GSA owned
- Incentives - $200K
- REC = 1,525 MWh, $240/MWh for 20 years

More information is available at www.gsa.gov/portal/content/105165

(Photo Credit: Dave Mowers; U.S. General Services Administration (GSA). PIX 17421)

Agency-Funded Project

Social Security Administration, high-temperature hot water project, Philadelphia, Pennsylvania, 54-m^2 solar thermal system

- Reheats recirculation loop
- 360 evacuated heat-pipe collector tubes, 54 m^2 gross area, 36 m^2 net absorber area
- Cost $58,000
- Delivery of 143 million Btu/year estimated
- Installed 2004

More information is available at www.eere.energy.gov/femp/services/yhtp/energy_projects_detail.cfm/id=8

(Photo Credit: Ed Hancock, Mountain Energy Partnership.)

Power Purchase Agreement Case Studies

Power Purchase Agreement

National Renewable Energy Laboratory PV Project, Golden, Colorado, 720-kW PV

- 720 kW (1200 MWh) single-axis tracking, approximately 5 acres
- 20-year power purchase agreement (PPA) contract (utilizing Western)
- 20-year easement
- RECs sold to Xcel Energy for RPS solar set-aside (20-year contract)
- PPA price equal to or less than utility electricity prices (based on EIA projections)
- Operational December 2008
- Additional PV projects in progress.

More information is available at www.eere.energy.gov/femp/pdfs/pfs_mesatoparray.pdf

(Photo Credit: SunEdison, PIX 17423)

Power Purchase Agreement

Fort Carson PV Project, Colorado Springs, Colorado, 2-MW PV

- 2 MW, 3200 MWh in first year (~2% of Ft. Carson's load)
- Fixed, non-escalating energy rate
- 17-year contract, with 3-year option (utilizing Western)
- No-cost, 20-year lease (using 10 USC 2667 lease authority)
- RECs sold to Xcel Energy (20-year contract)
- Ground-mounted, fixed system covering 12-acre former landfill
- First Solar thin film, 25-year warranty
- Came on-line December 2007

More information is available at www.3phases.com/news/news-item.php?id=32

(Photo Credit: U.S. Army Fort Carson. PIX 17394)

Energy Savings Performance Contract Case Studies

Energy Savings Performance Contract

U.S. Marine Corps Base PV Project, Twenty-nine Palms

- 1.1 MW solar energy project
- Army Corps ESPC agreement awarded to Johnson Controls in 2002.
- PV project cost $8.1 million after a rebate of $4.5 million from the State of California
- Annual guarantee of $400,000 in energy cost
- Total savings from the project to date equal $6.9 million.
- The PV system utilizes 8700 modules sited on 6.5 acres.
- The system is tied into the cogeneration plant at 12.47 kV.

More information is available at

http://tonto.eia.doe.gov/kids/energy.cfm?page=solar_home-basics-k.cfm

www.ornl.gov/sci/femp/pdfs/fs-5903_29palms_usmc.pdf

(Photo Credit: Daniel C. Kariuki, Energy Projects Manager, Marine Corps Air Ground Combat Center, 29 Palms, California)

Energy Savings Performance Contract

Phoenix Federal Correctional Institution, Phoenix, Arizona, parabolic trough solar water-heating system

- 17,040 square feet of parabolic trough collectors
- 23,000-gallon storage tank
- Installed cost of $650,000
- Delivered 1,161,803 kWh in 1999 (87.1% of the water heating load)
- Saved $77,805 in 1999 utility costs

More information is available at www.eere.energy.gov/femp/pdfs/33211.pdf

(Photo Credit: Ed Hancock, Mountain Energy Partnership. PIX 09048)

Utility Energy Services Contract Case Studies

Utility Energy Services Contract

Camp Pendleton, North San Diego County, California, PV Project, 75kW PV

- 75 kW PV project with 116,000 KWh/year estimated production (actual production has been higher)
- Bundled with various EE measures
- Total project cost was $11.2 million,
- Simple payback 7.8 years, saving investment ratio (SIR) 1.94
- Contract term is 10 years
- Projected annual savings is 62,377 MMBtus.
- Total projected California solar incentive covers approximately 33% of project costs
- Online since July 2008

More information is available at
www.eere.energy.gov/femp/pdfs/46348.pdf

(Photo Credit: U.S. Marine Corps. PIX 16462)

Utility Energy Services Contract

Joshua Tree National Park, California, PV/propane hybrid

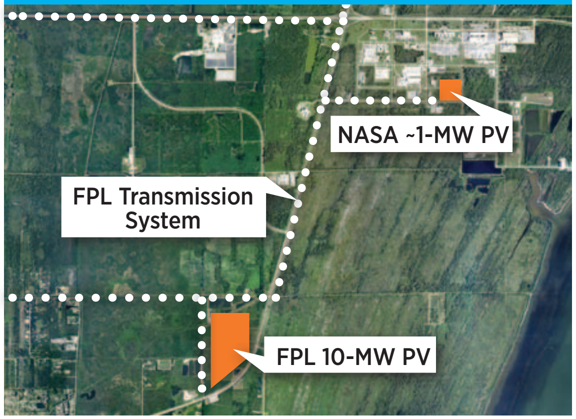
- 20.5 kW PV array
- 613 kWh battery bank
- 35 kW propane generator
- $273,000 cost financed by Southern California Edison under 15-year tariff

More information is available at
www.eere.energy.gov/femp/pdfs/26358.pdf

(Photo Credit: Harry Carpenter. PIX 07260)

Enhanced Use Lease Case Studies

Enhanced Use Lease



NASA Kennedy Space Center/Florida Power & Light Company (FPL), Merritt Island, Florida, 10-MW PV, owned by FPL with in-kind consideration of 990-kW NASA-owned PV

- Partnership between NASA Kennedy Space Center and Florida Power & Light
- EUL signed June 2008
- Phase 1 involves 60 acres; potential phase 2 for additional 40 acres
- 10 MW FPL-owned PV project
  - Construction started; estimated completion date 3/10
  - Output feeds into FPL transmission system
  - Substation expansion required
- In-kind consideration - 990 kW NASA-owned PV
  - FPL construction, O&M
  - Construction started, estimated completion date 10/09
  - Output feeds into NASA-owned distribution system
- 130 mph wind standard

More information is available at www.smartgridnews.com/artman/uploads/1/nasa_space_coast_solar.pdf and www.fpl.com/environment/solar/spacecoast.shtml

(Photo Credit: NASA Kennedy Space Center/Florida Power & Light.)

Enhanced Use Lease

Fort Irwin (in process), Barstow, California, 500-MW solar thermal/PV by 2022

- Notice of opportunity to lease
- Approximately 500 MW at five Fort Irwin sites
- In-kind services equal to or greater than fair market value of land
- Developer conducts NEPA EIS
- Fort Irwin will conduct an environmental baseline study as a part of the lease documents
- Developer selection announced July 30, 2009 – Clark and Acciona Solar Power
- First phase: More than 500 MW solar thermal/PV by 2022

More information is available at http://eul.army.mil/ftirwin/

(Photo Credit: Google maps)

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