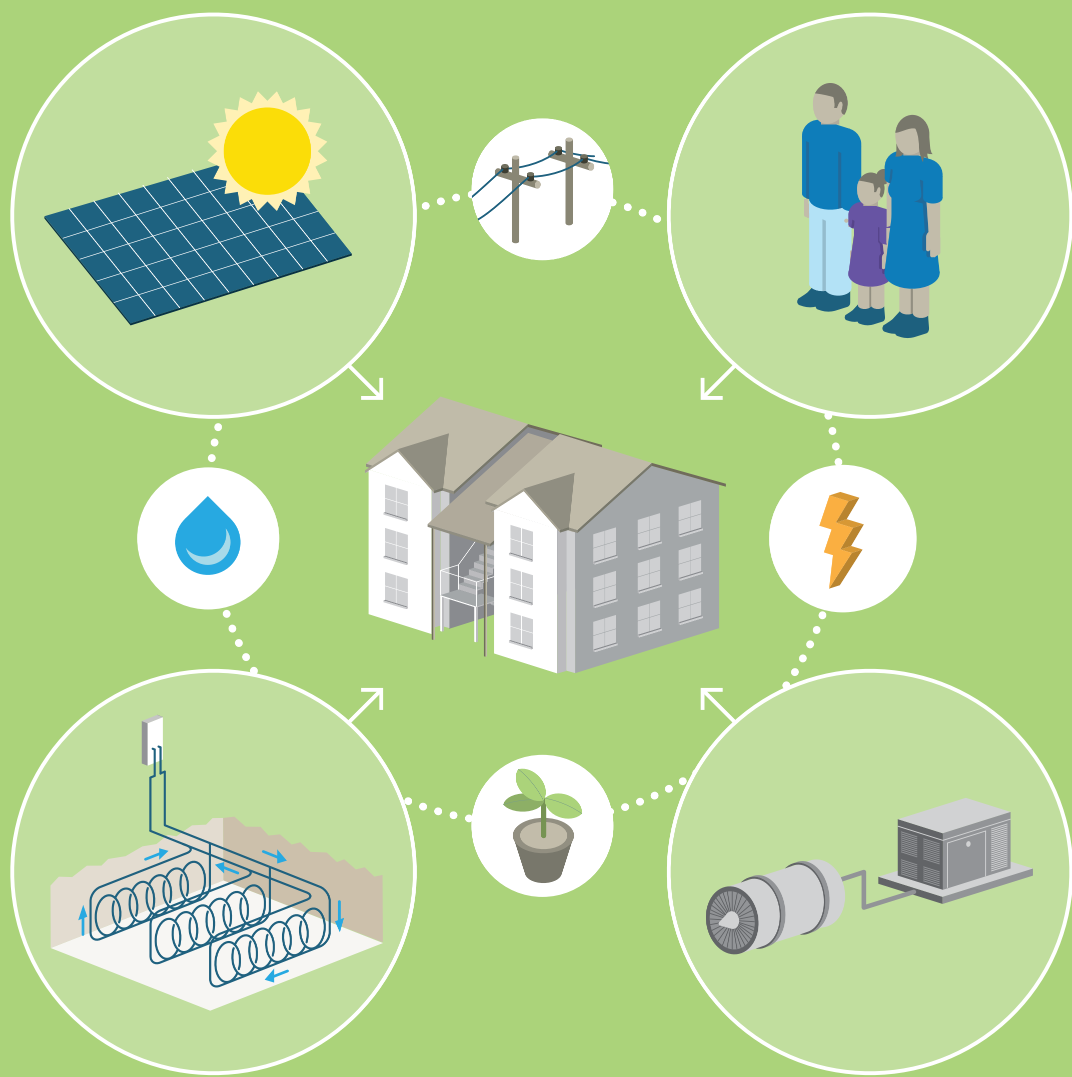


Department of Housing and Urban Development
Community Planning and Development (CPD)

Renewable Energy Toolkit

For Affordable Housing

Making renewable energy a part of affordable housing is clearly vital. How to do it has been less clear.

Now, this toolkit shows you how step-by-step, the knowledge and tools you'll need to integrate renewable energy into your affordable housing project in a way that's efficient, cost-effective and impactful.

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

Contents

Introduction

Housing preservation, lower and more controllable operating costs, resiliency in the face of increasing energy rates and weather events and reduced carbon emissions: these are just a few of the benefits when you integrate renewable energy and on-site generation into your affordable housing projects. As a U.S. Department of Housing and Urban Development (HUD) Community Planning and Development (CPD) grantee, you'll find out how, using this Toolkit.

Renewable Energy and On-site Generation in Affordable Housing.

This toolkit will enable recipients of HUD CPD grants to make renewable energy and on-site generation systems part of their affordable housing development programs under the HOME Investment Partnerships (HOME), Community Development Block Grant (CDBG), Housing Opportunities for Persons with AIDS (HOPWA) or Emergency Solutions Grant (ESG) programs. Integrating renewable energy and on-site generation is vital because it keeps affordable housing affordable, by reducing and regulatizing energy costs, improves operations and maintenance and adds resilience in the form of reliable back-up power.

In addition, renewable energy has significant benefits in reducing the impact of climate change. Renewable energy provides a low- to no-carbon pollution energy source that is necessary if we hope to reduce the impact of human-caused climate change on our environment. As part of The President's Climate Action Plan[1], HUD and other federal agencies have pledged to add 300 megawatts of renewable energy to federally-subsidized affordable housing by 2020.[2]

Renewable energy has become more affordable in recent years, especially solar photovoltaic (PV) panels. The number of U.S. homes with solar systems has increased from 30,000 in 2006 to 400,000 in 2013, according to the U.S. Dept. of Energy. That number could reach 3.8 million by 2020. Once too expensive to be considered, today renewable energy can be a real option for almost any affordable housing project.

The importance of integrating renewable energy into affordable housing may be clear, but the path to get there has been less so. This Toolkit provides a step-by-step process and the knowledge, tools and capacity to integrate renewable energy in an efficient, cost-effective and impactful way.

[1] whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf
[2] hudexchange.info/programs/renewable-energy/

Energy generated on-site reduces the amount of energy that must be purchased from other sources including coal-fired power plants. Although renewable energies do incur upfront costs, if those costs are properly structured, the investment in renewable technologies will, over the life of the building, more than pay for themselves. Over the long term, and with incorporated incentives and subsidies, it is often cheaper to generate energy on-site than to purchase it. In rental housing, this clearly benefits tenants and building owners when tenants pay utilities for their units and building owners cover common area utilities. However, even when tenants do not pay utilities directly, renewable energy helps maintain building affordability.

For many building owners, funds not spent can instead be allocated to more efficient uses such as operations and maintenance. A well-maintained building is less costly to run. Reduced operating expenditures makes it possible to run a building profitably while charging affordable rents to low-income tenants. These benefits extend across the affordable housing sector so while this Toolkit's primary audience is recipients of HUD CPD grants, it can also be used by other affordable housing developers integrating renewable energy into their properties.

How to Use this Toolkit.

This Toolkit is designed for CPD grant recipients. For a comprehensive overview of how a wide variety of renewable energy technologies can be implemented into CPD housing, read this Toolkit from start to finish. Each chapter is also written to stand on its own.

Highlighted text like this with an arrow next to it indicates a clickable link to an online resource. All full link names appear in footnotes at the bottom of the page.

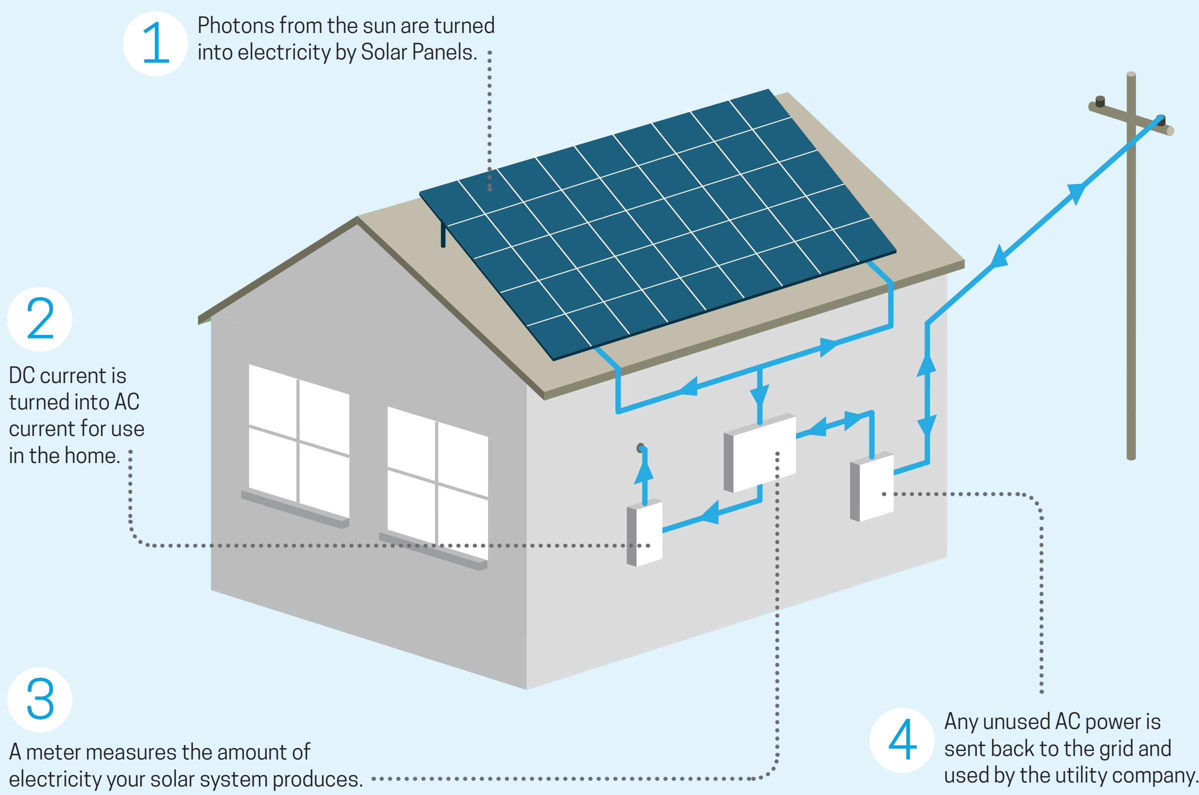
What is Renewable Energy?

Renewable energy means building systems "that rely on fuel sources that restore themselves over short periods of time and don't diminish." Renewable energy includes fuel sources such as the sun (solar thermal, solar photovoltaic), wind (windmills or wind turbines), moving water (hydro, wave power and tidal power), organic plant and waste material (biomass) and the earth's heat (geothermal).

The Toolkit does not cover all renewable energy systems. It focuses on those most commonly used in affordable housing projects today or projected to be used in the future, such as: In-depth explanations can be found in *Phase I: Feasibility Analysis* of this toolkit.

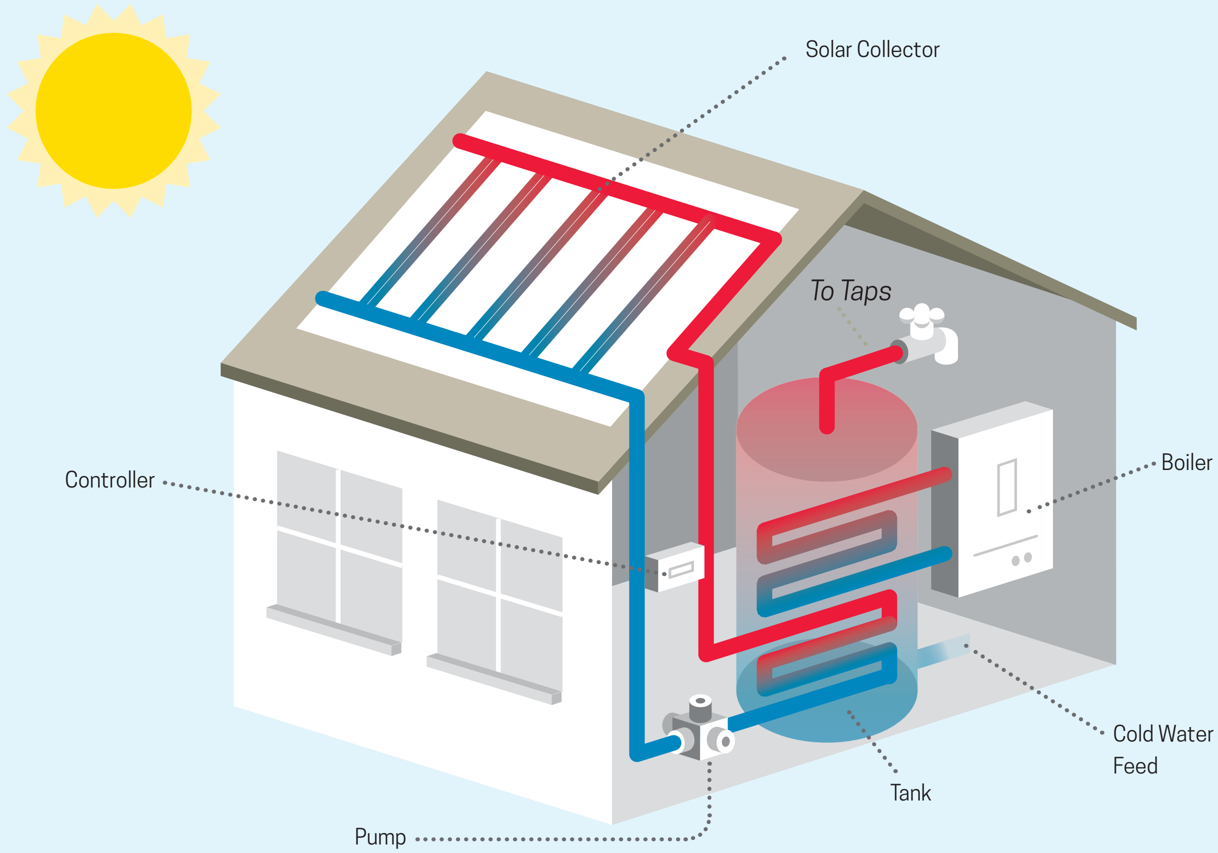
- **Solar photovoltaic (PV).**
- **Solar thermal.**
- **Co-generation.**
- **Geothermal (ground source) Heat Pumps.**

Photovoltaic (PV)



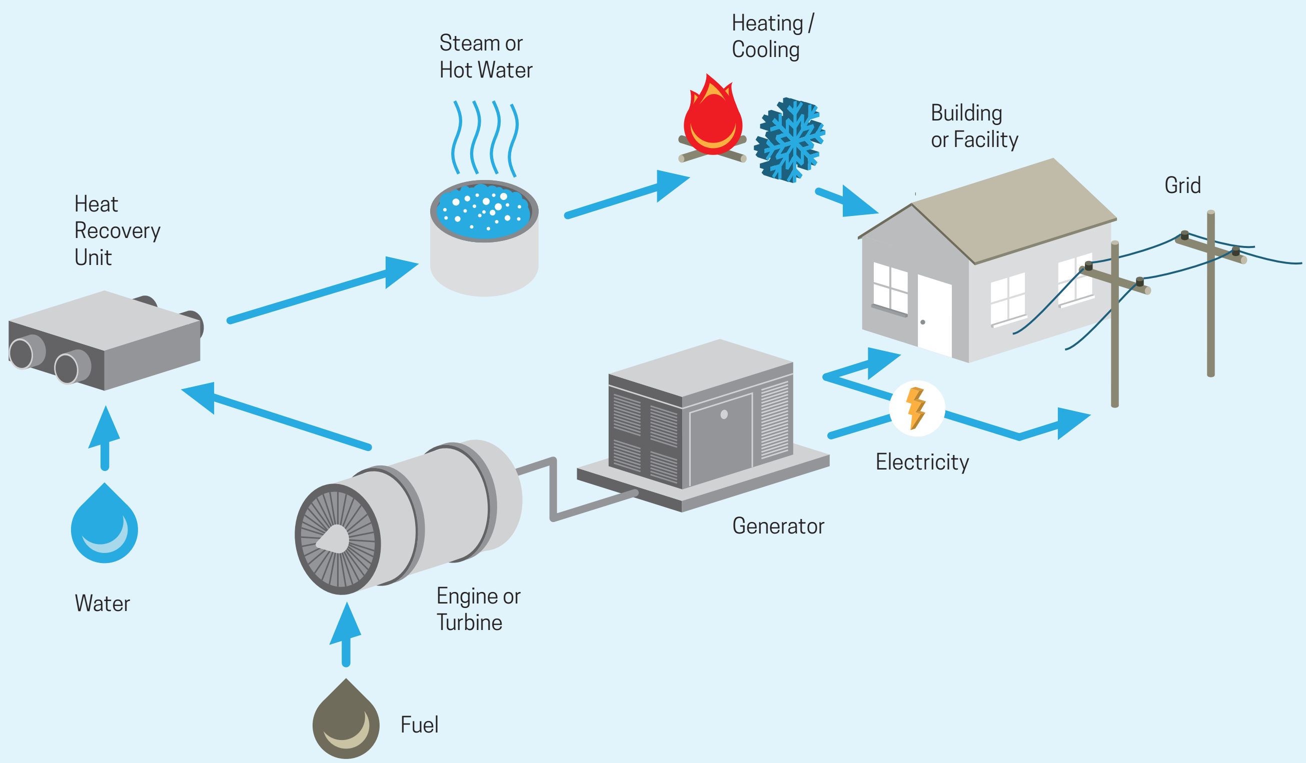
Photovoltaic (PV) materials produce electricity when exposed to the sun. The "photovoltaic" effect occurs when photovoltaic materials absorb photons of light and create a current of electrons. Capturing these electrons generates electric currents that can be harnessed and converted into usable electricity. Grid-connected PV systems are the most common and are designed to operate with the electric utility grid. They convert direct current (DC) power from the PV panels into alternating current (AC) power, then feed it directly into the building and, if there is excess power, into the grid. Stand-alone (off grid) PV systems are much less common and operate independently of the electric utility grid. Stand-alone systems may be powered by the sun, wind or a generator. They require batteries in order to function.

Solar Thermal.



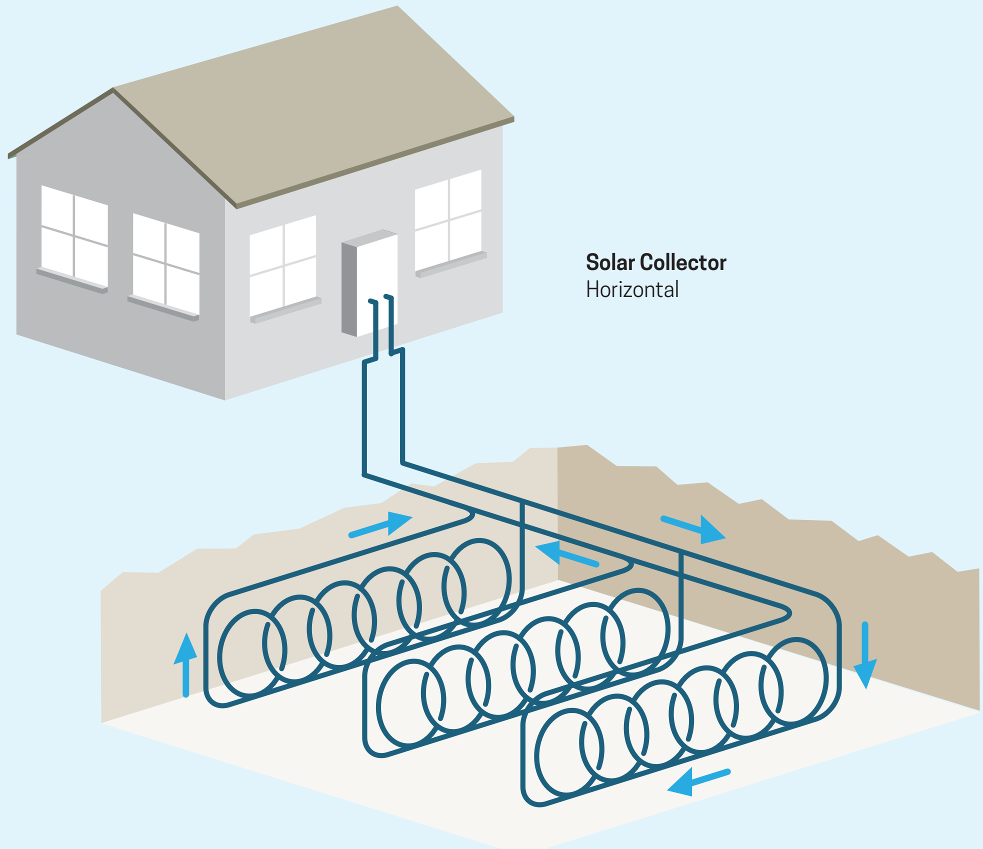
Solar thermal systems use sunlight to heat water. Solar thermal collectors on the roof absorb heat as they are exposed to the sun absorbing as much sunlight as possible and converting it to heat. Solar PV panels, on the other hand, convert sunlight into electricity. Water flows through the solar thermal collectors and becomes hot, then is stored in a tank connected to hot-water plumbing. Storage tanks are typically located in a mechanical room near the hot-water heater. A gas or electric water heater is used to heat the water further if necessary or to supplement the heat at night or during peak periods of hot water use.

Co-generation.



Co-generation – also known as combined heat and power (CHP) – is the simultaneous production of electricity and heat from a single source of fuel, is not technically a form of renewable energy. Co-generation systems use a wide range of fuel sources including natural gas, biomass, biogas, coal, or oil – many of which are not renewable. It is, instead, a more efficient process of energy conversion or power generation. CHP systems use fuel sources to create electricity, a process that creates heat. In ordinary electricity generation, that excess heat is discarded. But in combined heat and power systems, the excess heat is used to heat water that powers heating systems. Currently the fuel most commonly used in combined heat and power systems is natural gas.

Geothermal (Ground Source) Heat Pump Systems.



Geothermal (ground source) heat pump systems (GSHP) are potentially very efficient for building heating and cooling. GSHP are often grouped with renewable energy, but in fact are simply electric heating systems that use the relatively constant year-round temperature of the ground to achieve high efficiencies. In contrast to solar and co-generation systems which may integrate with but don't replace other building systems, a building may consider GSHP systems alongside other options such as condensing gas boilers or air-source heat pumps for building heat.

It is also important to distinguish geothermal heat pump systems (described in this Toolkit) from ***geothermal energy production*** which involves using the heat of magma (underground lava) to generate electricity. Geothermal energy production is a great source of electricity for locations with magma close to the surface such as Hawaii or Iceland but is not a viable technology for use at a single property and is not addressed in this Toolkit.

The Benefits of Renewable Energy in Affordable Housing.

Renewable energy in affordable housing provides a broad array of community benefits from cost savings and economic growth to encouraging private investment and lowering pollution.

Cost Savings

The most tangible benefit of renewable energy is the cost savings. Renewable and efficient methods of energy production help buildings reduce the amount of energy they purchase from utility companies. The principal uses of energy – heat, refrigeration and lighting – are necessities, so the amount that renters spend on energy, varies little with income. That means utility costs consume a much larger proportion of the monthly budget of low–income renters than of higher-income renters. According to Harvard's Joint Center for Housing Studies[3], utility costs represent some 15 percent of income for renters with incomes below $15,000, but just 1-percent for those with incomes of $75,000 or more. Additionally, utility costs can make up a substantial part of a building's operating expenses. Whether these costs are covered by the tenant or the building, renewable energy can reduce these expenses and free up capital for other uses. Public incentives usually exist to help invest in renewable energies, making benefits even more substantial. The Database of States Incentives for Renewable & Energy Efficiency[4] (DSIRE) lists incentives based on geographic location.

Economic Resiliency

Being economic resilient, for affordable building owners and their tenants, means being able to weather and be protected against volatile utility pricing. Many residents and building owners find themselves struggling when utility costs spike. For example in year-over-year data from 2013 to 2014 provided by the U.S. Energy Information Administration (EIA)[5], New England experienced a residential price increase of 9.8 percent. Building owners with limited financial reserves and already stressed low-income renters were faced with utility rate hikes of nearly 10 percent, forcing many to make the difficult choice between keeping the lights on or putting food on the table. Investments in renewable energy give building owners and tenants another fuel choice and protect them from price hikes.

Building Resiliency

In addition to economic resiliency, investments in renewable energy provide physical resiliency, giving buildings the ability to operate during and survive natural disasters. During Hurricane Sandy much of lower Manhattan was without electricity after a transformer blew and the electrical grid shut down. But several buildings at New York University (NYU) remained lit and warm[6] – a bright beacon in a sea of black. NYU had invested in a combined heat and power system which enabled several of its buildings to maintain operations even after the city's grid went down. Depending on the design and the disaster, renewable energy technologies may be able to maintain some if not all of a building's critical functions including heating, cooling, hot water, phones, internet communication, and security systems,

[3] jchs.harvard.edu/sites/jchs.harvard.edu/files/carliner_research_brief_0.pdf
[4] dsireusa.org/
[5] jchs.harvard.edu/sites/jchs.harvard.edu/files/carliner_research_brief_0.pdf
[6] edf.org/blog/2013/11/14/two-technologies-literally-shone-during-sandys-darkest-hours

elevators and other essential equipment. Resiliency to natural disasters is better for the building – and better for low-income tenants. However, not all solar or co-generation systems have worked this way during Hurricane Sandy or other disasters. It is important that the system be installed with "backstart capability," the ability to restore power without relying on external electric system or the grid.

Economic Development

Every year the United States spends billions of dollars on fossil fuels including oil and natural gas from around the world. In 2014, $250 million[7] in crude oil was imported. This drains money from local economies, slows economic development and increases our dependence on foreign powers. Investing in renewable energy, on the other hand, creates local economic activity by generating manufacturing, installation and maintenance jobs. In addition, it keeps dollars in the local economy. For every dollar spent locally, 45-cents are reinvested locally. For every dollar that goes to global businesses, however, only 15 cents is invested locally. Renewable energies help stimulate economic growth at home.

A Cleaner Environment

Much of the conventional power we use comes from intensive extraction of fossil fuels or the widespread disruption of river flows and natural habitats. This is not sustainable. The burning of fossil fuels not only generates greenhouse gas emissions which contribute to global climate change but also diminishes air quality and leads to respiratory diseases like asthma. Using renewable energies means a cleaner, more stable environment.

Certification and Recognition

Installing renewable energy systems can help a project achieve green certification standards by integrating RE with other green features. Some of these green certification standards, such as Enterprise Green Communities Criteria[8] or LEED Homes, can be met without the use of Renewable Energy systems. Net Zero Building Certification, however, cannot be achieved without renewable energy, so it may also be an option for your Renewable Energy project. Certification under any of these standards can help demonstrate your commitment to green building and make your property more marketable.

[7] washingtonpost.com/news/fact-checker/wp/2015/01/29/jeb-bushs-claim-that-the-u-s-annually-imports-300-billion-in-oil-from-countries-that-hate-us/
[8] Google "Criteria for Housing Projects Enterprise Green Communities"

The Pathway to Renewable Energy

Phase 1: Basic RE Feasibility Analysis.

Apply feasibility tools.

The Grantee* reviews the Renewable Energy Toolkit and applies the feasibilty tools to access the suitability of a RE project in the selected building; given annual exposure to sunlight and local utility rates.

Meet with experts and developers.

Armed with performance estimates from the feasibility tools, Grantee staff meet with local renewable energy experts and developers to obtain information.

Phase 2: Prioritizing and Soliciting Projects.

Notice for Funding Announcements.

With input from experts and developers, and a broad understanding of the potential efficacy of a RE system, the Grantee develops a Notice for Funding Announcements (NOFA) with significant public input.

Publish the NOFA.

Grantee publishes the NOFA after the completion of the citizen participation process.

Phase 3: Project Evaluation and Selection.

Obtain NOFA responses.

Developers respond to the NOFA and are encouraged to bring their projects to the Grantee for evaluation.

RE Solar Thermal Scoping Tool.

The Grantee applies the Renewable Energy Solar Thermal Scoping tool to the proposed projects to determine how well renewable energy might work on project-specific sites.

Proposal revisions, as needed.

Using the Toolkit as a reference, the Grantee may advise the developer to make proposal changes to better accommodate RE, such as reducing obstacles on the rooftop or changing the orientation of a roof.

Selection of projects for funding.

Grantee selects the best projects for Office of Community Planning and Development (CPD) funding and may use on-site renewable energy generation as a criteria.

Phase 4: Implementing RE Projects.

Funding contracts signed.

U.S. Deptartment of Housing and Urban Development (HUD) signs CPD funding contract with developer.

Pre-construction meeting.

Grantee holds pre-construction meeting with developer to share best practices.

Construction and installation.

The building is constructed and the renewable energy system installed.

Ongoing operation and maintenance.

Developer follows the guidance outlined in the Toolkit to monitor the system and see it works as planned.

*__Grantee__ – Local or State government entity that is a recipient of HUD's CPD grant funding.

Grantee Basic Feasibility Analysis

Phase 1

This section introduces the CPD grantee to the four main types of renewable energy systems in this Toolkit and assists in determining eligible uses of CPD funding for renewable projects.

CPD Program Feasibility

Housing preservation, lower and more profitable operating costs, resiliency in the face of increasing energy rates and weather events and reduced carbon emissions are just some of the benefits to making renewable energy part of your affordable housing projects. As a first step in assessing the feasibility of RE projects, HUD grantees should evaluate each CPD funding sources to determine whether RE projects are eligible.

Housing-related eligible activities differ across the four CPD entitlement programs, and some programs are better suited for RE investments than others. The tables on the next pages provide a crosswalk of RE systems, the four CPD entitlement programs, the types of eligible activities and properties eligible under each program and key items to consider. They are not meant to cover all regulations for each CPD program, but are a summary of key elements of each program as related to RE funding.

HOME Investment Partnerships Program.

The HOME Investment Partnerships Program (HOME) provides formula grants to states and localities that communities use – often in partnership with local nonprofit groups – to fund a range of activities including building, buying and rehabilitating affordable housing for rent or homeownership or providing direct rental assistance to low-income people. HOME is the largest Federal block grant to state and local governments designed exclusively to create affordable housing for low-income households.

For more specific details regarding incorporating renewable energy into HOME projects, please see *Appendix A – Incorporating Renewable Energy into HOME Projects*.

HOME	Multi-family		Single-family	
	New	Rehab	New	Rehab
Key Eligible Uses	▪ Acquisition ▪ Demolition ▪ Site improvements ▪ Utility connections ▪ Construction ▪ Soft costs	▪ Acquisition ▪ Site improvements ▪ Utility connections ▪ Rehabilitation ▪ Reconstruction ▪ Soft costs	▪ Acquisition ▪ Demolition ▪ Site improvements ▪ Utility connections ▪ Construction ▪ Soft costs	▪ Acquisition ▪ Site improvements ▪ Utility connections ▪ Rehabilitation ▪ Reconstruction ▪ Soft costs
Eligible Property Types	▪ Vacant land (with development) ▪ Mixed-use ▪ Residential ▪ Permanent housing ▪ Group homes/single room occupancies(SROs)	▪ Mixed-use ▪ Permanent housing ▪ Group homes/SROs ▪ Non-residential buildings to be converted to residential use	▪ Vacant land (with development) ▪ Single-family (1-4 units) ▪ Condos ▪ Manufactured housing	▪ Single-family (1-4 units) ▪ Condos ▪ Manufactured housing ▪ Non-residential buildings to be converted to residential use
Applicable RE Systems (Grantee will determine most appropriate system for their property)	▪ Solar PV ▪ Solar hot water ▪ Co-generation (larger buildings)	▪ Solar PV ▪ Solar hot water ▪ Co-generation (larger buildings)	▪ Solar PV ▪ Solar hot water ▪ Geothermal heat pumps	▪ Solar PV ▪ Solar hot water ▪ Geothermal heat pumps

HOME	Multi-family		Single-family	
	New	Rehab	New	Rehab
Key Considerations	▪ Davis Bacon wage requirements increases project costs (12+ HOME assisted units) ▪ Property standards/ codes ▪ Capital Needs Assessment Required (26+ units) ▪ Impact on utility allowances ▪ Maximum per-unit subsidy limit and cost allocation ▪ Project and program rent and occupancy rules/limitations ▪ Project financial sustainability and viability during the period of affordability	▪ Davis Bacon wage requirements increases project costs (12+ HOME assisted units) ▪ Property standards/ codes – property must be brought up to code (“RE only” rehab not eligible) Rehabilitation standards/codes also apply ▪ Maximum per-unit subsidy limit and cost allocation ▪ Capital needs assessment required (26+ units) ▪ Impact on utility allowances ▪ Maximum per-unit subsidy limit ▪ Cost allocation ▪ Project and program rent and occupancy rules/limitations ▪ Project sustainability and viability during the period of affordability	▪ Property standards/ codes ▪ Sales price may not exceed 95 percent of value of median area purchase price ▪ Maximum per-unit subsidy limit and cost allocation ▪ Converts to rental if unsold in 9-months	▪ Property standards/ codes – property must be brought up to code (“RE only” rehab not eligible) ▪ Rehabilitation standards/codes also apply ▪ After rehab property value not to exceed 95 percent median purchase price for the area ▪ Maximum per-unit subsidy limit ▪ Converts to rental if unsold in 9-months.

Community Development Block Grant (CDBG) and Section 108.

The Community Development Block Grant (CDBG) Entitlement Program and state CDBG Programs provide annual grants on a formula basis to entitlement cities, counties and states. The grants develop viable urban communities by providing decent housing and a suitable living environment, and by expanding economic opportunities for low- and moderate-income people. Under the CDBG program, new construction is typically not eligible; however, activities in support of new construction such as clearance and disposition can be.

Section 108 is the loan guarantee component of the CDBG Program. It provides communities with financing for economic development, housing rehabilitation, public facilities and large-scale physical development projects. This flexibility makes it one of the most potent and important public investment tools that HUD offers to local governments. The Section 108 loan guarantee program allows local governments to transform a small portion of their CDBG funds into federally-guaranteed loans large enough to pursue physical and economic revitalization projects which can renew entire neighborhoods. Such public investment is often needed to inspire private economic activity, providing the initial resources and confidence that private firms and individuals need to invest in distressed areas. Local governments borrowing funds guaranteed by HUD through the Section 108 program must pledge their current and future CDBG allocations as security for the loan. It is important to note that all eligible renewable energy activities must meet a national objective[1] as part of compliance with CDBG and Section 108 Programs.

CDBG/Section 108 Programs	Multi-family		Single-family	
	New	Rehab	New	Rehab
Key Eligible Uses	▪ Activities in support of new construction – Infrastructure – Clearance – Acquisition – Disposition	▪ Acquisition ▪ Site improvements ▪ Rehabilitation ▪ Reconstruction ▪ Conversion ▪ Soft costs	▪ Activities in support of new construction – Infrastructure – Clearance – Acquisition – Disposition	▪ Acquisition ▪ Site improvements ▪ Utility connections ▪ Rehabilitation ▪ Reconstruction ▪ Soft costs
Eligible Property Types	▪ Vacant land ▪ Mixed-use ▪ Residential	▪ Multifamily residential ▪ Non-residential buildings to be converted to residential use	▪ Vacant land ▪ Single-family residential (only activities in support of single family new construction is eligible)	▪ Single-family residential ▪ Non-residential buildings property to be converted to residential use

[1] portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/library/stateguide

<table>
<tr><th rowspan="2">CDBG/Section 108 Programs</th><th colspan="2">Multi-family</th><th colspan="2">Single-family</th></tr>
<tr><th>New</th><th>Rehab</th><th>New</th><th>Rehab</th></tr>
<tr><td>Applicable RE Systems (Grantee will determine most appropriate system for their property)</td><td>▪ Solar PV
▪ Solar hot water
▪ Co-generation (larger buildings)</td><td>▪ Solar PV
▪ Solar hot water
▪ Co-generation (larger buildings)</td><td>▪ Solar PV
▪ Solar hot water
▪ Geothermal heat pumps</td><td>▪ Solar PV
▪ Solar hot water
▪ Geothermal heat pumps</td></tr>
<tr><td>Key Considerations</td><td>▪ Homeless shelters and other special-needs housing are considered public facilities under CDBG (though not considered “housing,” RE can be incorporated in shelters/facilities)
▪ 51 percent housing occupancy by low to moderate income</td><td>▪ Davis Bacon wage requirements increases project costs (8+ units)
▪ 51 percent housing occupancy by low to moderate income
▪ No applicable rehab standards – local codes apply
▪ See Appendix D on the Section 108 Program</td><td>▪ HUD recommends obtaining an appraisal to assure cost reasonableness</td><td>▪ No applicable rehab standards – local codes apply
▪ HUD recommends obtaining an appraisal to assure cost reasonableness
▪ See Appendix D on the Section 108 Program</td></tr>
</table>

Emergency Solutions Grants (ESG).

Emergency Solutions Grants (ESG) is a formula grant program. Eligible recipients are generally cities, urban counties, territories and states. ESG funds may be used for five program components: street outreach, emergency shelter, homelessness prevention, rapid re-housing assistance and Homeless Management Information Systems (HMIS) as well as administrative activities (up to 7.5 percent of a recipient's allocation can be used for administrative activities).

ESG	Multi-family New		Single-family New	
	New	Rehab	New	Rehab
Key Eligible Uses	▪ N/A	▪ Rehabilitation ▪ Renovation ▪ Conversion	▪ N/A	▪ N/A
Eligible Property Types		▪ Must be owned by a government entity or private nonprofit organization		
Applicable RE Systems (Grantee will determine most appropriate system for their property)		▪ Solar PV (smaller buildings) ▪ Solar hot water (smaller buildings) ▪ Co-generation (larg-er buildings		
Key Considerations		▪ Cost reasonable-ness ▪ No fees can be charged to partici-pants in ESG-funded emergency shelter projects ▪ Minimum period of use of 10 years required for major rehabilitation and conversion; must be enforced by a recorded deed or use restriction		

Housing Opportunities for Persons with AIDS (HOPWA).

Housing Opportunities for Persons with AIDS (HOPWA) is the only Federal program dedicated to the housing needs of people living with HIV/AIDS. It was established to provide housing assistance and support services for low-income people with HIV/AIDS and their families. Under the HOPWA formula program, HUD makes grants to eligible cities and states. HOPWA funds may be used for a range of housing, social services, program planning and development costs including the acquisition, rehabilitation or construction of housing units facility operations, rental assistance, and short-term payments to prevent homelessness. An essential component is supportive services. HOPWA funds also may be used for services including assessment and case management, substance abuse treatment, mental health treatment, nutritional services, job training and placement assistance and assistance with daily living.

HOPWA	Multi-family		Single-family	
	New	Rehab	New	Rehab
Key Eligible Uses	▪ Construction	▪ Acquisition ▪ Rehabilitation ▪ Conversion ▪ Lease	▪ N/A	▪ N/A
Eligible Property Types	▪ SROs and Community residences only	▪ Vacant land ▪ Existing buildings ▪ Existing facilities		
Applicable RE Systems (Grantee will determine most appropriate system for their property)	▪ Solar PV ▪ Solar hot water ▪ Co-generation (larger buildings	▪ Solar PV ▪ Solar hot water ▪ Co-generation (larger buildings)		

ESG	Multi-family		Single-family	
	New	Rehab	New	Rehab
Key Considerations	Cost Reasonableness ▪ Minimum use period* for structures: – Any building or structure assisted through acquisition, new construction and/or substantial rehabilitation must be used and maintained as a facility for people with HIV/AIDS for a period of not less than 10 years. – Non-substantial rehabilitation or repair is subject to a similar use restriction for 3 years.	▪ Cost Reasonableness ▪ No fee except rent can be charged of any eligible person for housing or services provided. ▪ Minimum use period for structures: – Any building or structure assisted through acquisition, new construction and/or substantial rehabilitation must be used and maintained as a facility for people with HIV/AIDS for a period of not less than 10 years. – Non-substantial rehabilitation or repair is subject to a similar use restriction for 3 years.	N/A	N/A

* Once the minimum use periods are met, the grantee has met the minimum use statutory requirement for the period of use for the original purposes of the building (for HOPWA purposes). There would be no statutory requirement for continued use for HOPWA purposes once that time period is met.

However, if the grantee wishes to dispose of the building after that time period, then the grantee must still follow the disposition requirements set forth in Parts 84, 85, and the OMB circular for grant funds that were provided prior to 2014, and 2 CFR 200 for grant funds provided under the 2014 appropriation and after. This is cross referenced in HOPWA regulations at 574.605. HOPWA has no regulation addressing disposition and as such must follow the instructions laid out in the citations listed above.

Photos courtesy of HUD

Description and Feasibility

Now we'll consider the costs and benefits of renewable energy—Solar photovoltaic panels (PV), Solar thermal water heaters, Co-generation and Geothermal heat pumps—and the feasibility of incorporating them into development projects. While renewable energy has a number of benefits, it's not suitable for every setting.

Their feasibility of RE Systems will be determined by factors including local geographical conditions, a building's lifecycle, local utility rates and incentives and regulations.

Solar Photovoltaic Panels.

What are they?

Photovoltaic (PV) materials absorb sunlight to create a current of electrons which generates electricity.

How do they work?

Grid-connected PV systems are the most common type, and are designed to operate with the electric utility grid. Inverters convert the direct current (DC) power from the PV panels into alternating current (AC) power for immediate use in the building. Any remaining power is fed into the electric grid.

Net metering.

If a solar PV system produces more power than a building could use, the excess power will be diverted into the electricity grid. If a building uses more power than can be generated by the solar PV system, the property will pull power from the electric grid. This process is seamless and does not require any effort from the building operator. A utility company may use "net metering", if permitted, to keep track of how much energy a building puts into and removes from the grid to determine its monthly electricity bill.

Islanding.

A small but increasing number of PV systems can operate as a micro-grid when disconnected from the electricity grid as during a blackout. This is a process called "islanding." These PV systems are increasingly popular especially among critical facilities (government, medical and military) as interest in resiliency grows. They may be powered by the sun combined with a battery storage backup, and may also include power sources such as on-site co-generation, back-up generators and wind.

Where does it work?

Solar PV panels can be installed on roofs, the ground and carports. They produce the most electricity in the Southwestern United States where there is abundant sunshine throughout the year. However, supportive local incentives, high utility rates and net metering can make solar PV panels economically feasible elsewhere. Solar energy is best suited for buildings with large, primarily flat roofs with unobstructed solar exposure. In the northern hemisphere, solar panels are ideal on south-facing roofs; the opposite is true in the southern hemisphere.

Because solar systems have a life expectancy of up to 30-years, the best time to install them in an existing building is during or shortly after a roof replacement. That way, the life cycle of the solar PV panels can be aligned with the lifecycle of the roof. For new construction, architects and engineers can design rooftops that maximize solar energy production and factor in the additional weight of rooftop solar equipment in the engineering of the roof. Solar installations can be timed with construction schedules to increase efficiencies and cost savings.

Main components and costs.

There are three main components in a solar PV system: **Solar panels**, **inverters** and the **Balance of System (BOS)**.

Solar panels.

Solar panels (also called solar modules) are mass produced around the world and have a protective glass layer to encapsulate the solar cells inside. A rigid aluminum frame around the panel gives it strength and allows for mounting. Each panel has a rating in watts that describes how much power the panel will produce during peak sun. For example, a 325 watt panel will produce 325 watts when pointed directly at the sun during the middle of a clear summer day. The panel will produce less power in the early morning and late afternoon hours. Each panel has a positive and a negative connection on the back, and produces direct current (DC) similar to a battery.

Bright Power Inc.

Solar PV panels mounted on a roof.

Types of PV panels include: mono-crystalline, poly-crystalline, and thin film, listed in descending order of performance.

Inverters.

Inverters take the DC current from the PV panels and convert it to alternating current (AC), used in appliances and the electric grid. Grid-tied inverters constantly monitor the voltage and frequency of the grid to ensure that the power they "push" into the grid is in sync with the rest of the grid. In a power outage, the inverter will stop the PV system from operating entirely. This safety feature is required in all grid-connected PV inverters to ensure that the PV system will not continue to feed electricity into the utility grid as it is being repaired, putting repairmen at risk.

SMA America

Grid-Tied Inverter

A **micro-inverter** performs like an inverter, but unlike conventional inverters that works with a series of solar modules that are connected to it centrally or in a string, a micro-inverter works individually for each panel. There are several advantages to this approach. The overall system is not affected by the performance of any individual module, which may be impaired due to shading or debris. Even the complete failure of one module will not reduce the overall output. Micro-inverters are also safer and last much longer than conventional inverters because each handles a smaller electrical load, reducing wear and tear. The main disadvantage is their higher cost and maintenance costs.

Balance Of System.

The Balance Of System (BOS) components consist of wiring, hardware that holds panels on the roofs (that is. racking) and other hardware needed to complete the system.

Racking systems can be ballasted or non-ballasted. Ballasted racking systems use a heavy weight to hold the panel frame down. Unballasted systems use screws to attach the hardware to the roof. Although the risk of leaks is very low because of these roof penetrations, the collective anxiety about roof leaks has caused increasing interest in ballasted racking systems. When deciding between a ballasted or mechanical racking system, considerations should include whether the roof structure can handle the additional weight of ballast (and panels), the type of roof in place, building height and wind speed.

Soft costs.

The Department of Energy (DOE) has found the soft costs of deploying renewable energy can be as high as 64 percent of total costs. Soft costs can range dramatically from project to project. They include expenses like marketing, inspections, engineering, permitting, interconnecting, labor, monitoring and maintenance. DOE has launched efforts to identify and standardize best practices in the market to reduce softs costs to $500 per kW for residential and $300 per kW for commercial installation.

Why is it beneficial?

The only costs of solar PV are hardware, labor and ongoing operating and maintenance costs. The raw fuel – sunlight – is free. And solar PV systems can provide backup power in a blackout if they are designed to do so.

What are the costs?

PV systems typically range from $2 to $7 per watt installed. Larger multi-megawatt (MW) utility scale systems cost less per watt than small residential system because of economies of scale. But though sunlight is free, electricity prices are often low enough that solar PV projects are not always feasible without some form of public subsidy or incentive. Congress created an investment tax credit (ITC) that will reduce the tax liability of the purchaser of the solar equipment by 30 percent of the value of the solar equipment. This tax credit was originally due to expire at the end of 2016, but Congress extended it for five years when it passed an omnibus spending bill at the end of 2015.

Power purchase agreements (PPA) with third party installers also allow building owners to purchase solar power without upfront investment. Monthly PPA rates are usually less expensive than the local electricity rate to provide immediate savings but this is not possible everywhere. Both hard and soft costs continue to decrease as global production increases and people become more familiar with renewable technology.

What to look for and how to evaluate.

In addition to cost, another important consideration is how much energy the solar PV system will produce. This is determined by the location where the solar PV is installed, the tilt angle and the orientation of the panels. A system with a low tilt (~5 degrees) will produce much more power in the summer than the winter because the sun is more directly overhead. A system with a steeper tilt (~30 degrees) will perform better in the winter because the sun is lower. The direction in which the panels face can also be important because it determines when power gets generated by the PV panels. Because utility companies may charge different electric rates during different times of the day and year, it is ideal to orient panels to maximize the capture of energy when electricity is most expensive.

Tracking systems that move the panels to point directly at the sun to increase overall power production may not be appropriate for a rooftop installation. These systems can take up valuable space and the moving parts are costly to maintain.

Solar Thermal Water Heaters.

Rooftop solar thermal collectors in foreground, solar PV panels in background.

Source: John Humphrey

What are they?

With Solar Thermal water heaters, sunlight is gathered to create hot water for domestic use.

How do they work?

Rooftop solar thermal collectors absorb and trap heat from the sun. Water is pumped through the collectors to be heated, then the heated water is stored in a tank for household use. Storage tanks are typically located in a mechanical room near the hot-water heater. Pre-heated water can be fed into a gas or electric water heater where the warmed water is heated to the desired temperature.

In more sophisticated models, heat-transfer mediums other than water can be used between the solar thermal collectors and the heat exchanger. These can include air, glycol-water, oils and refrigerants. The preferred heat transfer medium depends on factors including installation cost, local climate and operating expenses.

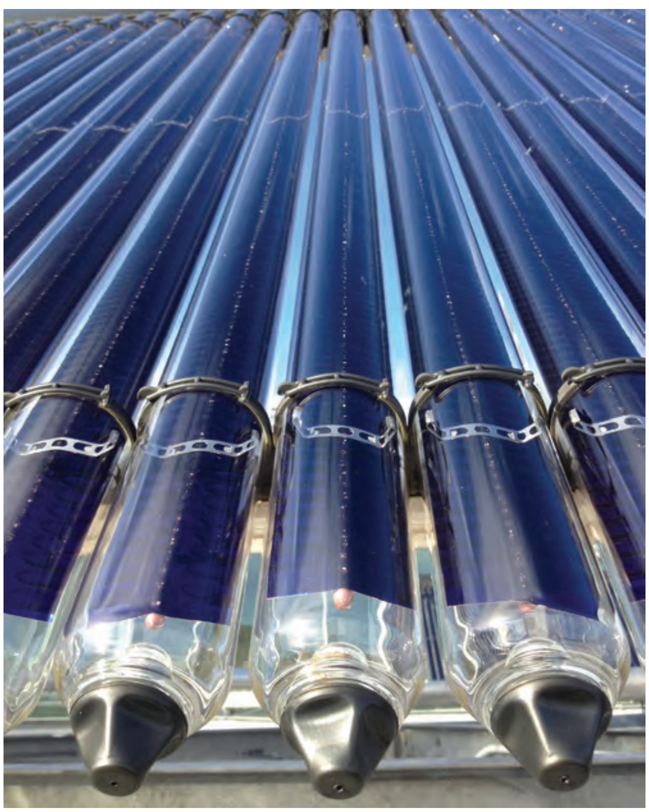
The building should have a year round hot water load to make the best use of this system. In addition to heating water, it can also provide building heating. However, a backup water heater might still be needed to ensure that a consistent hot water temperature can be achieved everyday.

What do they look like?

Solar thermal panels are rectangular and look similar to solar PV panels. But while solar PV panels typically measure 3 by 5 feet, solar thermal collectors can be 4 by 8 or 4 by 10 feet. Solar thermal collectors need to be tilted at a higher angle to maximize heat collection, and so are more visible than solar PV panels. They are heavier too.

Where do they work?

Solar thermal systems work best in climates with ample sunlight and buildings with large, primarily flat roofs with unobstructed southern exposures. Most roofs remain sound for 20 years, and solar thermal system can last for up to 20 or even 30 years, so solar thermal systems work best on a new roof or in new construction where the life cycles of the solar equipment and the roof are aligned. It would not make economic sense to install a system only to remove it later when the roof needs to be replaced. In new construction, architects and engineers can design a roof that is aesthetically pleasing, that maximizes the capture of solar thermal energy, and accommodate the additional weight of the rooftop equipment.



Why are they beneficial?

According to the US Dept. of Energy, domestic water heaters account for 17 percent of all energy used at home – more energy than all other household appliances combined. Solar thermal systems use free solar energy from the sun, so they can significantly lower household hot-water costs.

What are the costs?

Even though sunshine is free, installation, operating and maintenance expenses can still be quite high, so solar thermal projects require some form of public subsidy to be economically feasible. The 30 percent investment tax credit (ITC) can be used to lower costs.

Third party financing options are available for solar thermal systems, but not nearly as many as for solar PV. To reduce costs, installation at a new building should be timed with the broader construction schedule, making for cost savings. For installations at existing buildings, a property owner should budget additional funds to verify that the roof can support the added weight of a rooftop solar thermal system and additional funds for engineering and constructions if the roof needs to be shored up.

Co-generation.

What is it?

Co-generation, also known as combined heat and power (CHP), is the on-site production of electricity, heating, cooling and domestic hot water using a raw fuel source. The distributed nature of these systems distinguishes them from the large, offsite generators that provide the majority of energy in the U.S.

Co-generation engine types

Three types of co-generation systems – reciprocating engine, gas turbine and fuel cell – can generate electricity.

- **Reciprocating Engine** A reciprocating engine is simply a large truck engine that has been repurposed to burn natural gas.
- **Turbine** A turbine burns natural gas like a jet engine. The gas is burned efficiently and generates the high-grade heat needed to generate electricity.
- **Fuel Cell** A fuel cell uses an electrochemical process to break apart natural gas molecules, generating electricity in the process. A significant amount of heat is released as a by-product. Because fuel cells do not use combustion, there are no emissions except for water, and it is quiet.

How does it work?

Co-generation generates electricity and captures a portion of the waste heat that is a by-product for reuse, which offsets heating, cooling and household hot-water costs. Backup HVAC systems and boilers are usually still required, but they can be downsized. The electrical efficiency of on-site CHP systems typically range from 25 percent-30 percent, and the reuse of the waste heat can add another 55 percent to the overall system's efficiency, resulting in an overall efficiency of 85 percent for the raw fuel, usually natural gas. In contrast, average gas-fired power plants can have electrical efficiencies that range from 28-47 percent. Their efficiency is lower because they discharge their waste heat into the environment (air, rivers and oceans) as they have no other use for it.

Where does it work?

On-site co-generation is ideal for mid- and high-rise buildings with many units. The property should have a year-round central thermal load in the form of a central heating and cooling system or a central boiler for household hot water. Compact development ensures that the thermal energy generated from co-generation need not travel far before it is used. A compact development also reduces piping and pumping costs. While the environmental and energy efficiency benefits of co-generation are clear, co-generation is economically feasible in areas where the cost of electricity is high and the cost of natural gas is low.

Yanmar America Energy Systems

The Yanmar 10kW microCHP unit generates electricity and hot water by burning natural gas in the built-in reciprocating engine.

Why is it beneficial?

With the right sizing, a building can efficiently generate a significant amount of energy it needs to operate. By using the waste heat from co-generation, a building can reduce the amount of additional energy it uses to produce hot water, heating and cooling. In addition, residents have an uninterrupted supply of electricity, hot water, heating and cooling during an electric grid failure, as long as there is an uninterrupted supply of natural gas to the property and its co-generation unit was designed with a built in black-start capability.

What are the costs?

Co generation systems now come in various sizes and performance levels so building owners can select a system appropriate to the needs of their building and tenants. The costs of these systems can range from $50,000 for a 10kW micro-co-generation system to many millions of dollars for the larger systems used in high-rise buildings, hotels, ships and university and hospital campuses. Because of their cost, these systems are not ideal for single-family homes. They are better suited for medium to large multifamily buildings with a central boiler and large common area electricity loads. These systems can quickly pay for themselves where electricity costs are high and natural gas is inexpensive and plentiful.

Geothermal (Ground Source) Heat Pumps (GSHP).

What are they?

Geothermal energy is heat and cooling from the earth. At most places in the U.S., the upper part of the earth's surface maintains a temperature of between 40° and 70°F (4° and 21°C). Like a cave or a cellar, this ground temperature is warmer than the air above it during the winter and cooler than the air in the summer. Geothermal systems, made up of geothermal wells, a thermal medium (gas or liquid), a heat exchanger, a heat pump and an air delivery system with vents and ducts can tap into this resource to heat and cool buildings. According to DOE, approximately 50,000 geothermal heat pumps are installed in the United States each year.

How do they work?

In the winter, the heat pump removes heat from the geothermal wells, then pumps it into the indoor air delivery system. In the summer, the process is reversed as the heat pump removes heat from the indoor air and injects it into the geothermal wells. The GSHP must be properly sized. If the loop is not large enough, or if soil conductivity is less than estimated, the system might become less effective over time as a heat sink or a heat source.

Where do they work?

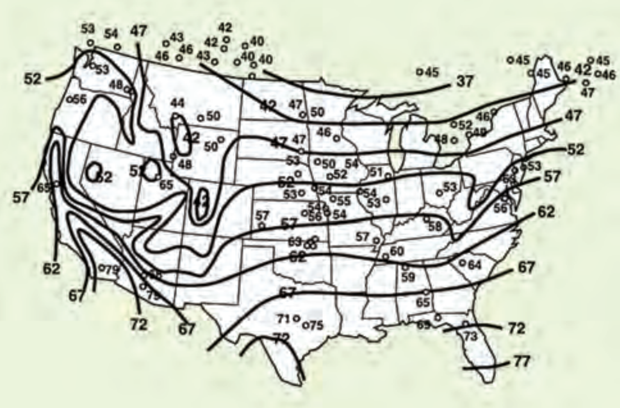
The effectiveness of GSHP technology increases with the thermal conductivity of the soil, which increases with the moisture level. Soil temperatures also play an important role. Hot climates with the highest cooling needs tend to have higher than average soil temperatures, making it difficult to inject heat into the soil. Climates with the highest heating needs tend to have lower average soil temperatures, which makes it difficult to obtain heat from the soil. GSHP systems work best in mixed-climate zones where soil temperatures are moderate, ranging from 50°F to 65°F and where buildings have approximately equal annual heating and cooling loads.

Types of heat pumps:

There are four basic types of ground loop systems. Three of these – horizontal, vertical and pond/lake – are closed-loop systems. The fourth sometimes called pump and dump, is an open-loop system.

In a closed-loop system, water is pumped through horizontal or vertical pipes underground or laid under a body of water. Water is pumped through the geothermal wells to the heat exchanger where the heat is extracted or injected depending on the season and the need. In this system, the water is used over and over again.

In a pump and dump open-loop system, a well is drilled into an underground water source underground water is pumped to the heat exchanger where heat is extracted or injected depending on the season and the need. The water is then sent down a return well to underground water source. Open loops are less common because they require a significant underground water source.



Average soil temperatures in the United States.

Builditsolar.com

Why are they beneficial?

Although installation expenses can be quite high, the long life of GSHP systems may justify their upfront cost. In-house components can last for 25 years, while ground loops can last for 50 years or more. Thermal energy can be extracted from the ground or water without burning fossil fuels such as coal, gas, or oil. Unlike solar and wind energy, geothermal energy is always available.

What are the costs?

The price for a geothermal heating and cooling system can vary significantly depending on the type of loop, underlying geology, the availability of local drilling expertise and equipment and local regulations. According to DOE, average costs range from $20,000 to $25,000 to install a geothermal system in a typical 2,500 square foot home with a heating load of 60,000 BTU and a cooling load of 60,000 BTU. Because of the amount of ground work required, GSHP may only be feasible at new properties.

Benefits and Considerations for Different Types of Energy Sources.

	Benefits	Considerations
Solar PV	Quick and easy to install with minimal disruption to building activities. Solar PV may be able to provide a large of portion of the energy needs in a single-family house. Low maintenance and operating costs. New technological and manufacturing improvements are decreasing the cost of solar panels and increasing their efficiency at converting sunlight into electricity.	Cost savings can be difficult to project due to uncertainty about future utility rates. Tax credits can be difficult to apply without the proper tax liability. In mid- to high-rise buildings, solar power may only supply a small portion of energy needs. The amount of energy that can be generated depends on the amount of unshaded open space available on the property roof. Solar PV panels can be vulnerable to extreme weather (such as hail). Insurance is highly recommended. Incentive programs are subject to political developments and can change year to year. Incentives can be used and hard to keep track of. Some utilities are tightening rules as the popularity of solar PV increases.
Solar Thermal Water Heaters	Solar hot water may provide a large portion of the hot water needs in a single-family house. Systems will pay for them selves during the lifetime of the equipment. Hot water tanks provide some energy storage capacity. More efficient than solar PV at converting sunshine into energy.	More maintenance than solar PV because they have to more moving parts such as valves and pumps. Compared to solar PV, solar thermal water heaters may generate more hot water than can be consumed by building residents. Construction and installation costs are higher than conventional hot water systems. The low cost of natural gas can make solar water heating seem less attractive.

	Benefits	Considerations
Co-generation	Works well in large multifamily buildings with central hot water boilers. Co-generation can offset a large portion of building electric and thermal loads and provide deep cost and carbon savings. Increases the overall efficiency of natural gas from 30 percent to as much as 85 percent. Provides a steadier supply of electricity and hot water than solar PV or solar hot water. Can operate around the clock. If set up properly, can provide back-up power during an extended blackout, for example after a hurricane.	Not appropriate for single-family homes or small buildings. This technology is best suited for large buildings because of its cost and equipment requirements. For optimal operating efficiency, the electricity and thermal loads must be fairly consistent. The technology can be capital intensive. On-site combustion and emissions require proper venting where sited.
Geothermal (Ground Source) Heat Pumps	Can significantly reduce energy costs. Clean. No combustion on site. Low maintenance and long life (50-plus years) for a closed ground loop system.	High upfront capital expense and requires substantial site work during installation. Only works in certain locations. Requires deep drilling.

Standards and Code Feasibility

When attempting to incorporate renewable energy into local projects, it's vital to review the policy and regulatory landscapes of the area. As renewable energy systems expand, state and local policies, codes and standards can promote or hinder them. Grantees need to ask the right questions while pursuing RE strategies, like:

- Is there a clear policy of commitment to, and support of RE?
- What are the state and local codes, ordinances, standards and regulations for RE projects?
- Do special considerations such as historic building codes apply?
- What are the potential incentives or barriers to RE in current codes, ordinances, standards and regulations?
- How will the community support RE projects during the design, permitting and approval processes?
- What are the costs associated with compliance with building codes?

The efficient planning and development of projects incorporating renewable energy features requires a thorough understanding of the policy and regulatory environment of the project. Each state and locality has its own combination of codes that govern the placement, design, construction and operation of RE systems. There are also regulations governing code implementation, permitting, enforcement and associated licensing requirements. These codes and regulations will determine the type and design of systems installed, the licenses, zoning permits or variances required for installation, and building permits, plan submissions and inspections. The costs and timelines of compliance with building codes should be factored into the analysis of project feasibility and planning.

Here is a roadmap for incorporating renewable energy into local projects.

1 Policy and Project Planning.

Applicable policy should permit and empower the incorporation of renewable energy into CPD housing projects and assist in overcoming obstacles to inclusion of renewable energy features.

RE systems are eligible as incorporated into property standards and rehabilitation standards of the participating jurisdiction under the HOME program but are not required, since incorporating RE does not make sense for every HOME project.

Renewable portfolio standards often provide benefits to grid connected systems as well as financial incentives such as tax credits, renewable energy credits and cost recovery incentives which may apply to all solar PV systems.

See the Database of State Incentives for Renewables and Efficiency [2] (DSIRE)for information on incentives and policies that support renewable energy.

SOLAR – Solar thermal systems benefit from financial incentives such as tax credits, renewable energy credits and cost recovery incentives.

GEOTHERMAL – Geothermal systems benefit from financial incentives such as tax credits, renewable energy credits and cost recovery incentives.

2 Understand Codes and Zoning.

Thoroughly research covenants and deed restrictions that may impact renewable energy systems prior to development.

SOLAR – Zoning codes may promote or protect the viability of solar installations via accessory or conditional use, and solar access provisions, or may present barriers in the form of height, locational, set-back or appearance provisions or lack of solar access provisions.

GEOTHERMAL – Zoning codes most often impact small-scale geothermal systems in the nature and location of above-ground equipment, but other regulatory provisions may apply too. (See Renewable Energy Systems Permitting below)

[2] www.dsireusa.org/

3 Understand Renewable Energy Systems Permitting.

SOLAR – For solar thermal and PV systems, permits in compliance with the building or residential code and mechanical, plumbing, fire and electric codes are typically needed. For Solar PV, additional electrical provisions exist. Other permits may be required locally or by project design. Research requirements and verify compliance.

GEOTHERMAL – Permit and compliance requirements for geothermal systems may be quite complex, especially for open-loop systems and those accessing natural geothermal sources. In addition to building code permits typically required under the building or residential code, there may be mechanical, plumbing, fire and electric code, requirements. Other areas of concern include environmental protection, natural resources, ground water protection and well water regulations. For more, see the Energy.gov[3] website

4 Understand Building Code Compliance and Technical Standards.

SOLAR – Solar thermal and solar PV systems are covered by provisions of various building codes which are compiled for easy reference in the 2015 International Solar Energy Provisions of the International Code Council[4]. Additional relevant sources include the International Building Code (ICC) 2015[5], and the International Residential Code (IRC)[6].

GEOTHERMAL – Geothermal systems are primarily covered by building code provisions found in applicable sections of the building or residential code, plumbing code, mechanical code, fire code and electric code.

5 Identify Contractors.

Carefully evaluate and engage contractors with documented experience and proven performance installing the particular type and design of system, You will use, and in your location.
Examples of key questions are in Appendix D – Contractor Proposal Evaluation Questions.

SOLAR – For solar PV systems, verify that electricians bear required additional safety certifications.

GEOTHERMAL – Assure that contractors have experience and licenses and certifications required in your location, especially regarding wells and ground-water projection.

CO-GENERATION – Contractor will need licensed electricians and plumbers to connect equipment.

---

[3] energy.gov
[4] shop.iccsafe.org/media/wysiwyg/material/4751S15-TOC.pdf
[5] codes.iccsafe.org/app/book/toc/2015/I-Codes/2015%20IBC%20HTML/index.html
[6] publicecodes.cyberregs.com/icod/irc/2012/

Renewable energy standards and incentives.

A renewable energy standard, sometimes called a renewable portfolio standard, provides a regulatory requirement promoting increasing production of energy from renewable sources. Utility companies are required to produce a specified portion of distributed power from renewable energy sources. The resulting mandate to purchase renewable energy – sometimes combined with tax credit incentives, renewable energy credits, cost recovery incentives, non-compliance penalties and other incentives – creates a viable marketplace for renewable energy. Most of states and the District of Columbia, have renewable energy standards which vary greatly. More than half the states with renewable energy standards also have solar incentive standards, which may provide additional value for energy from solar sources.

There is not a national renewable energy standard in the United States. Familiarity with the standard in place in the location of a renewable energy project is required to assess the economics of grid-connected renewable energy installations. In addition to state renewable energy standards, there may be local, regional, source-specific or utility-specific standards and incentives to be considered. Funded by the U.S. Department of Energy, the Database of State Incentives for Renewables and Efficiency [7] (DSIRE) provides the most comprehensive source of information on incentives and policies that support renewable energy in the U.S. DSIRE lists this strategic information by state. It is a good starting point for research and analysis of renewable energy standards and incentives applicable to a project location.

Covenants and deed restrictions

Many developments, condominium projects and neighborhood associations may impose covenants, usually agreements or restrictions flowing with the deed to the property. Deed restrictions are usually created at the time of development but may be instituted by the property owner any time to flow with the property upon transfer. Mutual covenants among members of a condominium or neighborhood association often require compliance with the rules of the association and may impose restrictions on the use of property or the type of construction allowed. Features or components of renewable energy systems may often be deemed impermissible. Covenants and deed restrictions may impose a more restrictive use of land than permitted by zoning ordinance. They may include architectural restrictions and could require review and approval by an association. It is necessary to research such covenants and deed restrictions and their potential impact on the renewable energy systems being planned.

Renewable energy and historic properties

For projects listed in or eligible for listing in the National Register of Historic Places, the Standards for Rehabilitation and Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings[8] provide recommendations for incorporating renewable energy into the rehabilitation projects of historic buildings.

[7] www.dsireusa.org
[8] www.nps.gov/tps/standards/rehabilitation/guidelines/

Renewable energy systems permitting.

Installation of renewable energy systems must comply with the building codes applicable to the type and design of the system being installed. Permitting procedures and the submissions which must accompany application for permits vary widely between jurisdictions. Check the online resources and instructions provided by the jurisdiction of the project and meet with code officials for clarification. Some jurisdictions require evidence of zoning approval to be submitted with application for building permits.

Solar PV systems.

Residential solar PV systems typically require permits in compliance with the building or residential code for structural and installation safety compliance and with provisions of the fire safety code. Compliance with the electric code, which has extensive provisions governing PV systems, will be paramount.

Solar thermal systems.

Solar thermal systems typically require permits in compliance with the building or residential code, mechanical, plumbing, fire and electric codes. For some projects, the energy code or swimming pool and spa code may be applicable.

Geothermal systems.

Permit and compliance requirements for geothermal systems, especially those which tap geothermal natural resources such as indigenous steam, hot water and hot brines and open-loop systems require careful research into the ownership of resources, and jurisdictional and environmental requirements which may be complex. For reference, download the PDF: An Introduction to Geothermal Permitting[9].

Geothermal systems will also typically require permits in compliance with the building or residential code and mechanical, plumbing, fire and electric codes. The EPA regulates geothermal wells under the Safe Drinking Water Act, Underground Injection Control Program.

Systems using water wells to exchange heat from groundwater must comply with regulations for water-well drilling, operation/maintenance and abandonment, as well as environmental and natural resources regulations. Closed-loop and direct exchange systems, which circulate the heat exchange medium through buried closed-system piping to draw ambient heat from the earth, incur the least regulatory burden. To investigate the regulatory environment for geothermal heat, download the PDF: Geothermal Heat Pump Systems – Well Construction[10] published by the Michigan Department of Environmental Quality.

Download the EPA Permit Application[11] for geothermal wells, located on the EPA website.

You can also download a PDF of the EPA publication: Manual on Environmental Issues Related to Geothermal Heat Pump Systems[12].

Building codes compliance.

Building codes are the ordinances enacted by state or local governments which specify standards for construction. The building codes most frequently encountered are those from the International Code Council (ICC), which publishes model codes for adoption by local jurisdictions. The ICC Model Code Set consists of 18 code volumes and many other publications. Many of the codes have sections relevant to RE installations. Access The International Codes[13] on the International Code Council Online Library.

For additional information regarding zoning, building code compliance and permitting and technical standards refer to *Appendix B: International Zoning, Building Codes Compliance and Permitting, and Technical Standards Pertaining to Renewable Energy Systems*.

[9] www.geothermal-biz.com/Docs/Intro_to_geo_permitting.pdf
[10] www.michigan.gov/documents/deq/deq-wd-gws-wcu-ghpsguidance_195216_7.pdf
[11] water.epa.gov/type/groundwater/uic/reportingforms.cfm#operators
[12] goo.gl/sCx4QK
[13] publicecodes.cyberregs.com/icod/

Technical standards.

Building codes spell out technical standards for equipment, installation and design each listing the standards applicable to its requirements. Additional standards may apply to components and equipment used in RE installations.

Numerous organizations publish these standards. The International Building Code lists over a dozen pages of standards governed by more than 40 organizations. To locate standards that apply to a particular RE installation, review the referenced standards in the applicable code, refer to the specifications and references in your system design documents and review equipment specifications.

Organizations and standards that are of particular interest to RE systems are listed in *Appendix B: Zoning and Building Codes*.

Contractor performance and industry standards.

The right contractor is essential to the success of a renewable energy systems project for many reasons including quality, safety and the management of schedules and costs. Because renewable energy systems are rapidly evolving, may be quite complex and often require difficult permitting procedures, contractors and installers must be knowledgeable and experienced. They must hold professional trade licenses and certifications as required by the jurisdiction of the installation. Licenses may be required for building and roofing, plumbing, electrical and mechanical. Some codes and jurisdictions may require training, certification or licenses in addition to the electrical, plumbing or other license a contractor holds. For instance, an electrician may be required to have additional certification to install photovoltaic systems because of their complexity. The National Electric Code (NEC) requires additional qualifications for PV electrical installation. The NEC uses the OSHA definition of "qualified", defined in NEC Article 100 as having "received safety training to recognize and avoid the hazards involved." The training must be specific to the type of installation. A licensed electrician may not be qualified to install a specific PV system. Beyond licenses and certifications for the trade categories in which work is to be performed, contractors and installers should provide evidence of professional competence in the type and components of the renewable energy systems being installed.

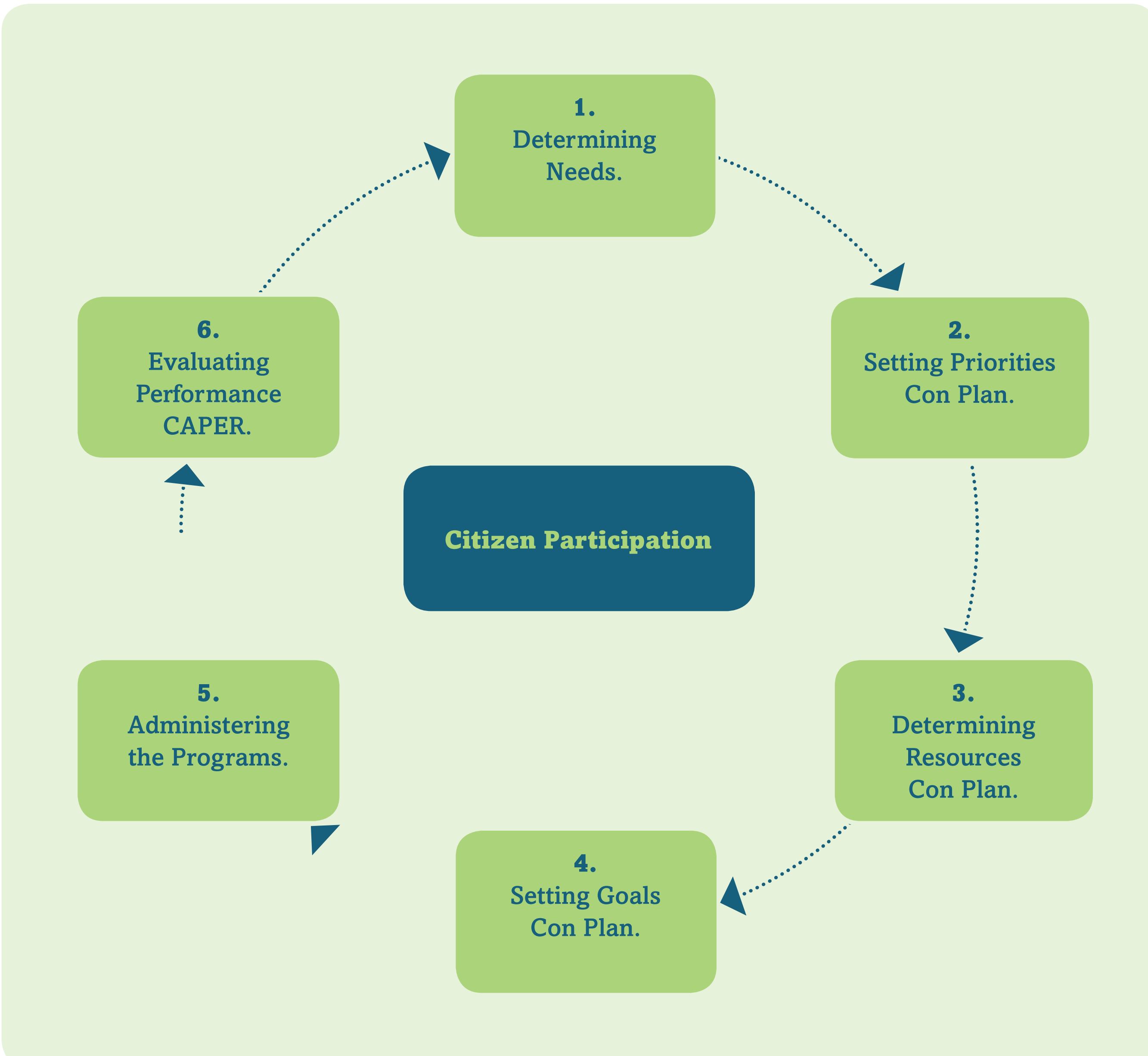
For a list of organizations that provide certificates of competency, refer to *Appendix C—Accredited Certifying Organizations for Contractors*. Solicit proposals from multiple contractors and evaluate their submissions very closely. For a list of sample questions to evaluate contractors and their proposals, see *Appendix D – Contractor Proposal Evaluation Questions*.

Strategic Planning

CPD grantees have several strategic options to use in determining how RE projects are targeted and funded. This Toolkit will focus on two: Establishing RE as a priority of the grantee at the planning stage or soliciting RE projects at the project stage. This section of the Toolkit addresses recommended processes at the planning stage. For a detailed discussion of the project stage, see Phase 3 – Project Evaluation and Selection.

Consolidated (Con) planning process.

This graphic illustrates six phases of the consolidated planning process which CPD grantees follow today. The six-phase model shows how each task in the grants management cycle relates to the others and is part of a larger, cohesive planning process. These phases should be leveraged and modified to include an overall evaluation of the need for RE in the community, while helping to align priorities and funding sources in support of the RE strategy.



Here's how RE specific planning processes can be incorporated into the existing Consolidated Planning process used by CPD grantees.

Determining Needs	Evaluate how existing infrastructure (building types, demand, partners, etc.) support RE projects. Understand the local policy environment and the local, state and federal policies impacting RE projects.
Setting Priorities	Identify and prioritize actions necessary to address the need for RE. Develop a plan that identifies the roles and responsibilities of the agencies and partners involved.
Citizen Participation Consultation	Identify and engage stakeholders. Engage public and stakeholders and ensure their support of RE. Get executive-level approval. Establish a leadership team.
Determining Resources	Use the CPD Funding and Eligible Uses Crosswalk to determine appropriate HUD funding to support RE strategy. Establish funding and financing mechanisms.
Setting Goals	Develop a renewable energy vision (a short-term plan). Develop S.M.A.R.T. goals and objectives to support RE as part of overall housing and community development strategies. Consider the outcomes its impact on the building and the community and not just the outputs (number of units) of the RE strategies.
Administering Programs	Develop the policies, procedures, tools and protocols to support the delivery of RE projects. Clearly communication the vision, priorities, funding options, and evaluation and performance standards to developers and partners through RFPs, NOFAs, etc. Ensure contract or agreement templates incorporate the necessary modifications to compliance, documentation and reporting requirements
Evaluating Performance	Measure and report performance using updating forms and templates, inspection processes and checklists to accurately reflect the RE investment

Determining Needs.

The first step in the grants management process is to determine community needs concerning affordable housing, community development and homelessness. The Consolidated Plan regulations (24 CFR Part 91) list the requirements of the Needs Assessment and Market Analysis. CDBG grantees must also provide a concise summary of the jurisdiction's priority non-housing community development needs.

Setting priorities.

The second step is to draw up priorities. The level of need will always be greater than a community's resources to meet the need. Accordingly, the Strategic Plan must first identify the grantee's priorities – the needs that will be addressed by the goals in the Strategic Plan. This section should make clear the rationale for establishing the allocation priorities. The rationale should flow logically from the analysis in the Needs Assessment and Market Analysis. The housing strategy must indicate how the characteristics of the housing market have influenced grantee decisions to use funds for rental assistance, production of new units, rehabilitation of old units and acquisition of existing units.

Citizen participation and consultation.

A vital part of each phase is citizen participation. To ensure input from a wide range of citizens, providers, advocacy groups, public and private agencies and community leaders in both the development and the implementation of the Consolidated Plan is essential. A Consolidated Plan with "buy-in" from the community is more likely to be successful.

Determining resources.

Before adding the goals in the Consolidated Plan Template, the grantee should complete the Anticipated Resources and Institutional Delivery Structure pages to identify the financial and organizational resources available to address its needs. These resources will be key in determining strategies and goals. Grantees should consider all resources within the jurisdiction's control that may be available, including federal, state and local resources. Federal resources should include Section 8 funds, Low-Income Housing Tax Credits and competitive McKinney-Vento Homeless Assistance Act funds expected to be available to address priority needs and specific objectives identified in the Strategic Plan.

Setting goals.

After priorities have been established, grantees develop a set of goals based on resources, the ability to leverage additional resources and local organizational capacity.

These goals should specifically address the priority needs of the Strategic Plan. They help the grantee track and monitor performance throughout the term of the Consolidated Plan. In order for goals to be an effective management tool, they must be well-written.

Administering programs.

The fifth phase, program delivery, encompasses all of the actions a grantee undertakes a program year. Each year, the grantee will describe the initiatives it plans to undertake with the grant funds on the Projects page of the Action Plan. Each project must address at least one goal described in the Consolidated Plan's Strategic Plan. The project information provided in the Annual Action Plan template carries forward into the other sections of the IDIS Online. Grantees are required to add activity-level data into the IDIS Online.

Evaluating performance.

Within 90 days after the end of its program year, a grantee must submit to HUD a Consolidated Annual Performance and Evaluation Report (CAPER). This reports on the accomplishments of the funded activities within the program year and evaluates the grantee's progress in meeting the one-year goals described in the Annual Action Plan and the long-term goals described in the Consolidated Plan. As of May 2012, the CAPER is integrated into the IDIS Online. With the Consolidated Plan, Action Plan, IDIS and CAPER all part of the same system, it is easier for grantees to compare the goals described in the Consolidated Plan and Action Plan and the outcomes tracked in IDIS and reported in the CAPER.

Photos courtesy of HUD

Prioritizing and Soliciting Renewable Energy Projects

Phase

2

Resources to help the CPD grantee select the most appropriate renewable energy projects to be funded, including additional options and models for financing.

Sample Language for Notice for Funding Announcements

Here, CPD grantees will find relevant language to use in incorporating renewable energy and on-site generation systems into their affordable housing projects.

Sample language on the next page can be inserted into local Request for Proposals (RFPs) or Notice for Funding Announcements (NOFAs) to encourage and solicit RE projects from developers.

Project feasibility.

Proposals should be drawn up using appropriate tools such as the HUD Renewable Energy scoping tool, to include estimates of the potential for on-site power generation, the projected utility cost savings and the project payback period.

Proposals should include a project workplan for the renewable energy project, including a timeline for designing, organizing, managing and carrying out the proposed activities.

Proposals should demonstrate a clear readiness and commitment to proceed within the proposed timeline.

Impact.

Proposals will ideally benefit locations serving low income families (80 percent AMI or lower) and should discuss both direct and indirect benefits for the residents, for example education, reduced rents, reduced utility bill and community benefits.

Operations and maintenance (O&M).

Include a section on how the developer will monitor and verify the energy and cost savings from the renewable energy equipment, such as the vendor or type of monitoring equipment or Data Acquisition System. Proposals should include an O&M plan that will ensure that the equipment remains in working condition including a periodic preventative-maintenance schedule and addressing the handoff between the original installer and who will take over O&M after the warranty and included O&M contract length expires. The proposal should also cover engaging residents to and informing them about the benefits for renewable energy.

Budget.

Proposals should include at least two quotes from installers including purchase price and O&M fees for the first 10 years of service. If the developer chooses to finance the project via a Power Purchase Agreement (PPA) or lease, the proposal should include two financing offers showing any energy price per kWh, yearly escalator, contract term and projected utility savings.

HUD CPD program history.

If your company has received funding in the past through CPD programs such as HOME, CDBG, ESG or HOPWA, indicate this in your proposal.

Financing Renewable Energy and On-site Generation

Various financing models and sources are available to fund renewable energy projects. It is up to the CPD Grantee to determine how to approach financing for the renewable component of a project. Depending on capacity and priorities, a CPD grantee may assist developers upfront by connecting them to financing tools such as the Property Assessed Clean Energy (PACE) or other local incentive. CPD grantees may leave it up to the developer to secure financing and demonstrate the incorporation of renewable energy systems in the proposal response's development budget.

Financing options include outright purchase, leasing, hybrid purchasing-leasing and co-op models. What works best for a specific project depends on geographic location, available incentives and financing, and the type of renewable energy used.

RENEWABLE FINANCING MODELS	Pro	Con
Outright Purchase The property owns the renewable energy system. It may receive grants, rebates and tax credits to offset installation costs and operating subsidies (RECs, SRECs, Feed in Tariffs) to help cover operating expenses. The energy savings and production incentives help offset the cost of debt service on a loan.	▪ Projects can apply for and obtain installation incentives, grants and tax credits as available. ▪ Projects keep SREC income and other production subsidies as available.	▪ The building must operate and maintain the system. ▪ The building owner must secure production credits that are owed. ▪ A 10- to 15-year loan needed to pay the remaining costs.
Power Purchase Agreement (PPA) A third party owns the rooftop system, while the property agrees to host it and to buy from the PPA provider the energy that is produced. The PPA provider keeps the installation and operating incentives and uses it to offset costs so energy can be priced competitively.	▪ No upfront or ongoing costs to the host. ▪ The host gets power at rates often below those charged by the utility company. ▪ The host benefits from a predictable electricity rate. ▪ At the PPA's end, the host keeps the system. ▪ The monthly payment is based on the amount of energy used.	▪ The host is locked into a 10- to 15-year agreement. ▪ The host does not receive installation or production incentives. ▪ Savings depend on whether the electricity price the PPA locks in is less than the cost over the next 20 years.
Leasing The property leases the solar PV system from a leasing company, paying a fixed monthly leasing fee and benefiting by energy savings. The leasing company may assign the operating subsidies to the property and charge a higher leasing fee, or keep the operating subsidies and charge a lower fee.	▪ No upfront costs. ▪ Monthly expenses are predictable. ▪ No loan is needed. ▪ No annual escalators, unlike with PPAs. ▪ The leasing company may assign operating incentives to the property.	▪ A leasing option is not possible for non-profits if the leasing company takes advantage of the 30 percent RETC due to provisions in the tax code. ▪ The lease provider keeps installation incentives. ▪ The monthly expense is not based on the amount consumed.

RENEWABLE FINANCING MODELS	Pro	Con
Power Attributes Purchase Agreement (PAPA) A PAPA is a cross between a PPA and a lease. A third party owns the panels and the property agrees to host them. The property pays the third-party-owner for power based on a rate that is often higher than the market utility rate. However SREC production incentives are assigned to the property to help offset costs.	▪ No upfront costs. ▪ The property gets to keep the production solar credits which can be a significant source of revenue. ▪ The provider may sell the system to the property after 5 or 10 years. ▪ By year 15 when the PAPA ends, the host keeps the system.	▪ The provider keeps installation incentives. ▪ PAPA rates are often much higher than utility rates. ▪ If SRECs are assigned to the property, the property assumes the risk of fluctuating prices in the SREC market.
Co-operative A property agrees to host the co-op's panels. The co-op will sell the rights to the operating incentives and use the proceeds along with installation incentives to cut installation costs. The co-op then sells shares of the solar system to local residents and businesses. Shareholders will be allowed to use their shares to offset their electricity bill in a process known as virtual net metering.	▪ A low-cost platform for a community solar project. ▪ Allows local residents and businesses to contribute their equity for a share of the electricity savings. ▪ Installation costs are often the low-est per watt.	▪ The property cannot benefit from any of the operating incentives.

Direct purchasing models

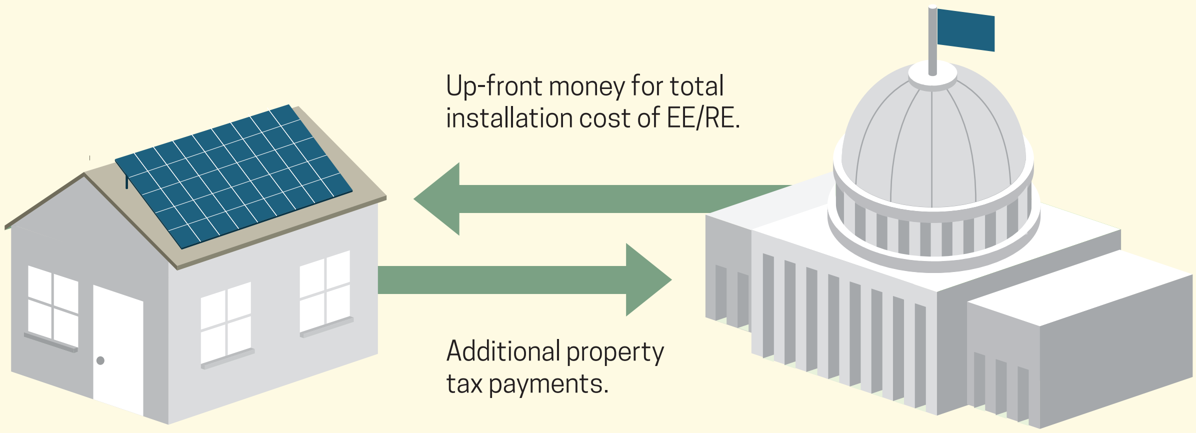
The building owner purchases the renewable energy asset and keeps the benefits, energy savings and operating subsidies. There are a number of financial mechanisms to make direct purchase feasible for property owners, including state and federal incentives, PACE Financing, the Renewable Energy Tax Credits and loans.

Incentives

These typically come either as an installation incentive or an operating incentive. Installation incentives are paid within the first year of installation and are typically based on the system's size or cost. By reducing the initial cost of the purchase, property owners reduce the amount they need to borrow and the amount of debt that needs to be serviced. These incentives may be grants, rebates and more from various sources including foundations, local and state governments, utility companies and more.

BENEFITS OF PACE	
Zero upfront cash investment.	Although renewable energy projects tend to pay for themselves through reduced energy expenditures, property owners may still be unable or unwilling to make the initial cash outlay. PACE reduces an owner's out-of-pocket expenses.
Convenient payment process.	Since PACE financing is applied to the property tax as a special lien, there's no need to worry about keeping track of a monthly bill. Instead, payments are included in the regular property tax bill and paid at the same time.
The loan obligation stays with the property.	If a property is sold with a remaining balance on the lien, the new owner becomes responsible for the loan. The obligation is tied to the property where the renewable energy investment was made.

DRAWBACKS OF PACE	
Limited availability.	As of 2014, only 31 states and the District of Columbia have passed legislation setting up PACE. Only eight states and DC have successfully funded their PACE program.
Risk-averse underwriters.	Due to concerns by mortgage underwriters about the potential effects of PACE mortgages on their lenders, it may be difficult for property owners if they seek to refinance or mortgage the property. State governments are working to mitigate these issues.



Property Owner

- No or low up-front costs.
- Competitive-interest assessment.
- Additional savings from tax-deductible interest.

City or Local Government

- Creates tax assessment district.
- Issues bonds or uses other funding sources.
- Places liens on properties.

Operating incentives are paid out during the operating period and are typically based on the amount of energy that is produced. The operating incentive, combined with energy savings, works to offset the monthly debt service and operating expenses.

Property Assessed Clean Energy (PACE) financing.

PACE is a government-sponsored program that allows investments in energy efficiency and renewable energy (up to 20 percent of the property's value) if the property owner agrees to repay the cost through a special property tax assessment that typically lasts 20 years. PACE financing is still an emerging financing tool with limited availability. PACE Now[1] is one resource to use to determine if PACE financing is a good fit for your project.

Renewable Energy Tax Credits (RETCs).

A taxpaying entity may claim a credit of 30 percent of the qualified expenditures for a renewable energy system. Qualified expenditures include labor costs for on-site preparation, assembly and installation of an original system, and piping or wiring to interconnect a system. For more information see the Residential Renewable Energy Tax Credit[2]. RETCS are not directly available for non-profit organizations that do not pay tax. Non-profits need to enter into a financial partnership with a for-profit, tax-paying entity that would be willing to contribute the investment upfront in return for receiving the tax credit later.

[1] pacenow.org
[2] energy.gov/savings/residential-renewable-energy-tax-credit

Loans.

The most common way to pay for a renewable energy asset is a loan from a lending institution. Some traditional banks offer loans specifically for the financing of renewable projects. CPD grantees can also apply for a loan from the HUD Section 108 Loan Guarantee Program (see next page).

Third-Party ownership models.

Various leasing models support renewable energy projects. The most popular are Power Purchase Agreement (PPAs) and solar leases. In both, the renewable energy equipment is third-party owned, and property owners agree to host it. The agreement period is typically 15 years.

Power Purchasing Agreement

A PPA provider will set up and operate renewable energy equipment for a property owner. In a PPA, the provider sells the host the energy generated from the equipment at an agreed-upon rate. Because the PPA provider tends to be a for-profit entity that can take advantage of the RETC as well as other installation and operating incentives, the electricity rate is typically lower the local utility. However, PPA providers usually build in an annual increase, on the electricity rate, modeled to be lower than the utility company might charge. A more risk-averse approach could be to peg the PPA rate at a discount to the rate offered by the utility. At the end of the PPA period, the equipment is turned over to the host. The host may purchase the equipment during the PPA at fair market value with the provider's agreement.

Solar leases

These are similar to PPAs because the equipment is owned and operated by an outside provider and hosted by the property owner. But instead of paying the provider based on the energy produced, the hosts pays a monthly leasing fee for the duration of the lease period. Lease payments are typically fixed. The installation incentive is kept by the installer, but operating incentives can be assigned to the host because leasing companies are not equipped to take the many steps needed to take advantage of the operating incentives. At the end of the lease period, the equipment is turned over to the host. The host may also purchase the equipment during the lease at fair market value with the provider's agreement. Unfortunately, owing to regulations contained in the Internal Revenue Code, this option is not available to non-profit, non-tax paying organizations.

Power Attributes Purchase Agreement (PAPA)

The Power Attributes Purchase Agreement (PAPA) arrangement is like a PPA but instead of keeping the operating subsidies, the solar provider assigns them to the host. The host pays the solar provider for the electricity generated at a rate that is typically higher than the cost of the electricity from the local utility company. Even with the higher PAPA electricity rate, this arrangement could advantageous because they host receives operating incentives assigned to them from the equipment owner. This arrangement only works in areas where the operating incentives are sufficiently generous to offset the higher third-party electricity rate. At the end of the PAPA period, the equipment is turned over to the host. The host may also purchase the equipment during the PAPA term at fair market value with the provider's agreement.

Community solar.

In this arrangement, community members pool their resources to purchase renewable energy equipment at reduced cost. The generated energy and financial savings from the renewable energy asset are shared by the community. A management company maintains the system and ensures the project operates efficiently.

Co-op Power.

To make a solar program appealing to the community, co-op power uses installation incentives, grants, rebates and the renewable energy tax credit to reduce the final costs and make buying into the solar project as affordable as possible. If there are operating incentives, co-op power will try to sell these to a buyer to further reduce costs. This can cut the cost of solar power by half. The purchaser can pay remaining costs out of pocket or seek a loan.

Section 108 loan guarantee program.

Section 108 is the loan guarantee component of the HUD CDBG Program which provides communities with financing for economic development, housing rehabilitation, public facilities and large-scale physical development projects. This flexibility makes Section 108 one of the most potent and important public investment tools HUD offers to local governments. Under Section 108, local governments receiving CDBG funding – CPD Grantees – can invest in a variety of renewable energy technologies suitable for their projects. Local governments borrowing funds guaranteed by HUD through the Section 108 program must pledge their current and future CDBG allocations as security for the loans. And all eligible renewable energy activities must meet a national objective[3] as part of compliance with the CDBG and Section 108 Programs.

For more information, see Appendix E or please go to Using the Section 108 Loan Guarantee Program to Support Renewable Energy Projects[4]

[3] http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/library/stateguide
[4] hudexchange.info/resource/4508/using-the-section-108-loan-guarantee-program-to-support-renewable-energy-projects/

Project Evaluation and Selection

Phase

3

Tools for investigating and choosing the renewable energy system that's best suited and cost-appropriate for you.

Renewable Energy Scoping Tools

Tools to help determine if renewable energy will work well for your project, including:

- Selection Criteria Scoring Sheet.
- Solar Scoping Tool.
- Solar Thermal Decision Tree.
- Solar PV Decision Tree.
- Co-generation Decision Tree.

Selection Criteria Scoring Sheet

For a customizable Word document go to http://www.hudexchange.info/resources/documents/Selection-Criteria-Scoring-Sheet.docx

When soliciting Renewable Energy projects for funding, CPD grantees should consider these elements. Use this sample project selection criteria scoring sheet to rate the quality and appropriateness of the applications you receive.

SCORING CRITERIA	Possible Points	Awarded Points	Comments
Renewable Energy Project considerations			
Proposed renewable energy activity aligns with the NOFA.			
Feasibility of Project			
Using appropriate tools, such as the HUD Renewable Energy scoping to ol, the proposal includes reasonable estimates of the potential for on-site energy generation, utility and cost savings and project payback period.			
The proposal describes a feasible renewable energy project workplan and a clear timeline for designing, organizing, managing and carrying out the proposed activities.			
The proposal clearly demonstrates a readiness and commitment to proceed within timeline.			
Impact			
The proposal will benefit a project serving the needs of families with low income (80 percent AMI or lower), and spells out whether benefits to residents will be direct or indirect. Possible benefits include education, decreased utility bills and rent, community benefits and more.			
Operations and Maintenance			
Proposed renewable energy activity aligns with the NOFA.			

SCORING CRITERIA	Possible Points	Awarded Points	Comments
Operations and Maintenance			
The proposal includes a section that spells out how the developer will engage residents, making them aware of the value and benefits of the renewable systems to be installed.			
The proposal includes a section specifying how the developer will monitor and verify the energy and cost savings from the investment, including what type of Data Acquisition System will be used to monitor power generated.			
The proposal includes a section that discusses how the property owner will develop, implement and carry out an effective operations and maintenance plan to ensure that the project remains in good working condition. The plan should reference the appendix item O&M best practices checklist.			
Budget			
The proposal includes at least two reasonable quotes from renewable energy installers showing the cost to purchase, install and operate a renewable, clean energy system.			
If the developer opts to do a Power Purchase Agreement (PPA) or a lease instead, the proposal should include two competitive financing offers showing the rate, terms of the agreement and projected savings for the duration of the agreement including rate escalator and assumptions for future utility rate increases.			
Capacity of the Applicant and Relevant Organizational Experience			
The proposal will benefit a project serving the needs of families with low income (80 percent AMI or lower) and spells out whether residents will receive direct or indirect benefits, such as education, utility bill and rent decreases, community benefits and the like.			
The proposal will demonstrate the financial capacity of the organization to manage federal funding and complete the work described in the proposal.			
TOTAL POINTS AWARDED			

Link to download the Excel document: http://www.hudex-change.info/resources/documents/Solar-Scoping-Tool.xlsx

Is Renewable Energy feasible for my project?

Use this tool to check the feasibility of an investment in solar photovoltaic, solar thermal and co-generation technologies at your property.

The tool requires you to input basic information like geographic location, roof area, local utility prices and local installation costs. Taking this information into account, the tool will assess the economic feasibility. Using MS Excel to create this model, we tried to show the underlying calculations most commonly used by renewable energy installers.

This Excel model will show how to assess a project's viability. After using the model a few times, you may be able to do these calculation mentally.

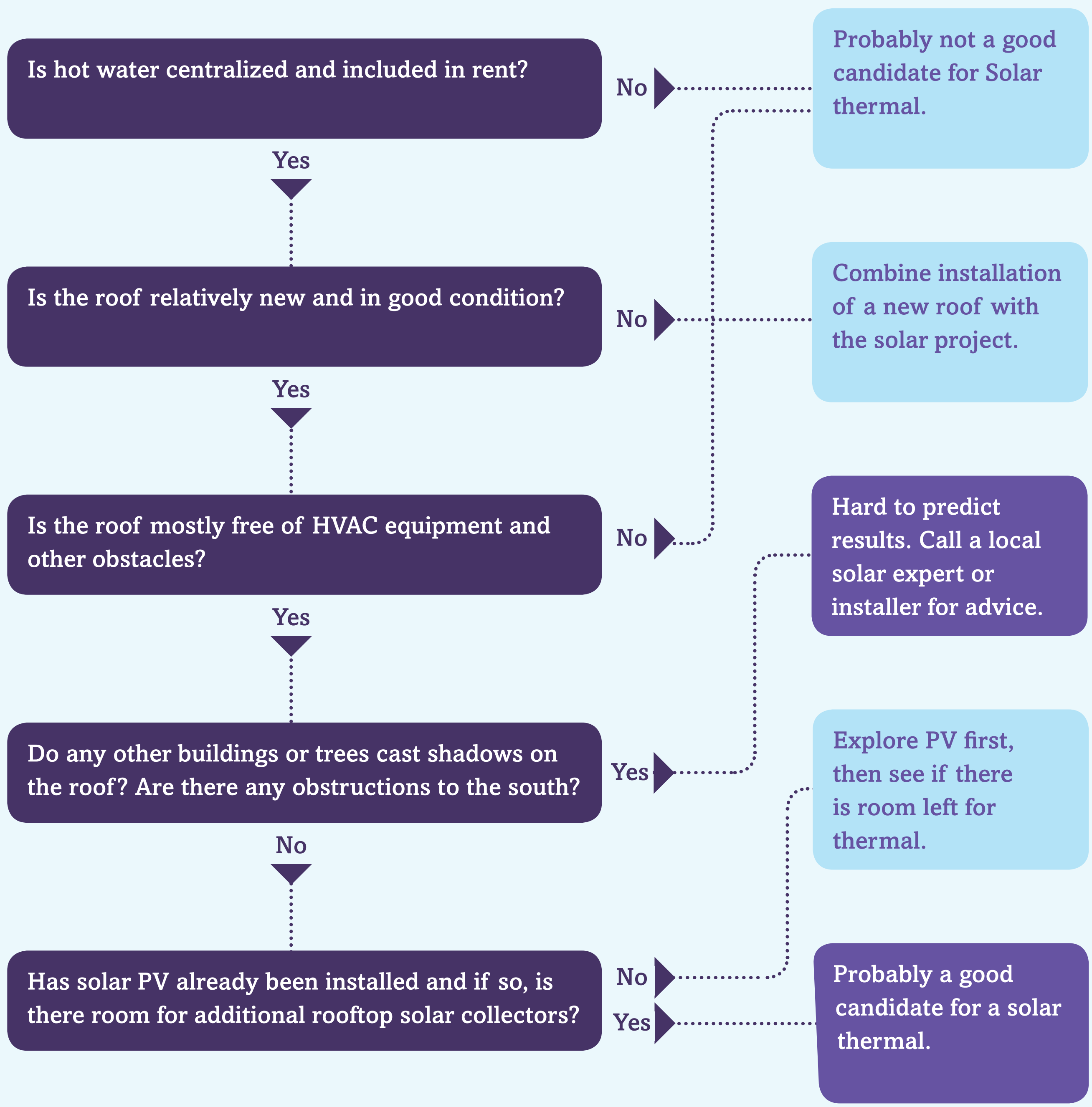
To calculate roof area, please use the tool offered in Appendix F.

HUD Solar PV Electric Scoping Tool

		Units		
	SYSTEM SCOPING	**Units**		
1	Annual Electricity Demand	kWh		4,000,000
2	Solar Installation Area	SQFT		135,000
3	Space for Setbacks (%)		7.0%	9,450
4	Other Obstacles (%)		15.0%	18,833
5	Final Usable Area	SQFT	79%	106,718
6	System size (kW)	1 kW per 100 Square Foot		1,067
	GENERATION			
7	Enter Zip Code	20566	Washington DC	
8	Annual kWh per kW			1,371.43
9	Annual Solar kWh Generation	Per year		1,463,552
10	Solar PV Fraction	Percent		37%
	UTILITY SAVINGS			
11	Electricity Rate	$/kWh		$ 0.120
12	Electricity Value	Per year		$ 176,065
	OPERATING EXPENSES			
13	Tax & Audit & Asset Mgmt	Flat	$ 3,000	$ 3,000
14	Operations and Maintenance	Per kW	$ 15	$ 16,008
15	Insurance	Per kW	$ 23	$ 24,545
16	Reserves	Per kW	$ 20	$ 21,344
17	Operating Expenses			$ 64,896
	NET BENEFIT			
18	Net Benefits (Savings minus Op Ex)			$ 111,169
	USES			
19	Hard Costs per kW		$ 4,000	$ 4,268,700
20	Soft Costs per kW		$ 500	$ 533,588
21	Total Uses			$ 4,802,288

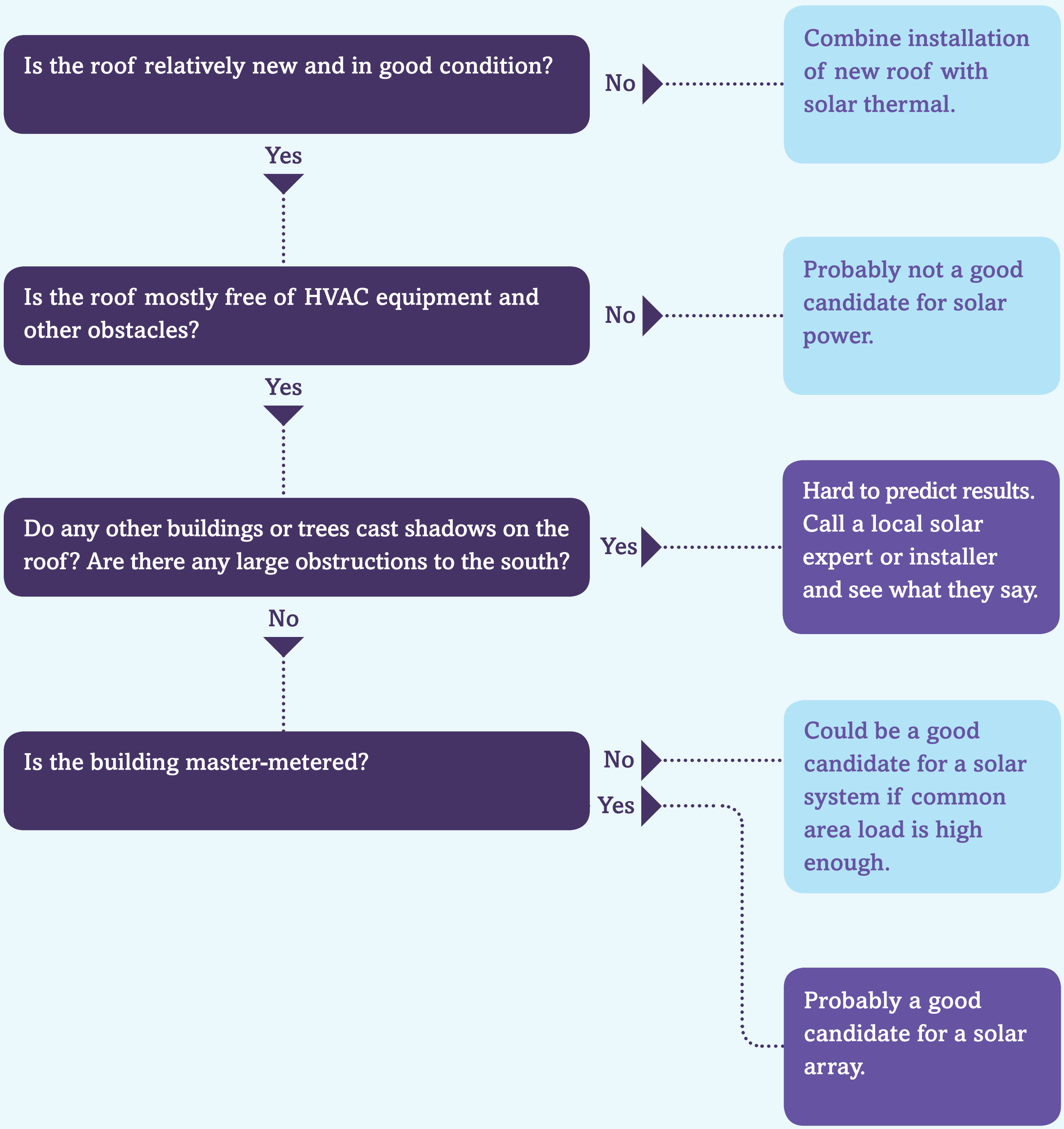
	SOURCES				
22	Investment Tax Credits (ITC)	Yes	30%	$	1,440,686
23	Installation Incentives #1		0%	$	-
24	Installation Incentives #2		0%	$	-
25	Loan Amount		70%	$	3,365,834
26	Equity		0%	$	-
27	Total Sources		100%	$	4,806,521
	USES vs. SOURCES				
28	Surplus or (Deficit)			$	4,233
	DEBT SERVICE				
29	Interest Rate				5.9%
30	Loan Term (Years)				35
31	Loan Repayment (Annual)			$	(227,594)
	OPERATING SUBSIDY				
32	S(RECs) Y/N? And Number of SRECs	Yes	1,464		
33	S(RECs) Average Value	$ 250			
34	S(RECs) Total Annual Value		Annual Value	$	365,888
35	Depreciation Benefits (Y/N?)	Yes			
36	Depreciable Basis	$3,548,357			
37	Deprec Term & Applic Tax Rate	15 Years	35%	$	82,795
38	Total Operating Subsidy			$	448,683
	PROJECT PERFORMANCE				
39	Combined Benefits minus Costs			$	559,852
40	Loan Repayment (Annual)			$	(227,594)
41	Free Cash Flow			$	332,258
42	Debt Service Coverage Ratio (DSCR)				2.46
43	Payback (Years)		Good		6

Is my rehab project a good candidate for solar thermal?



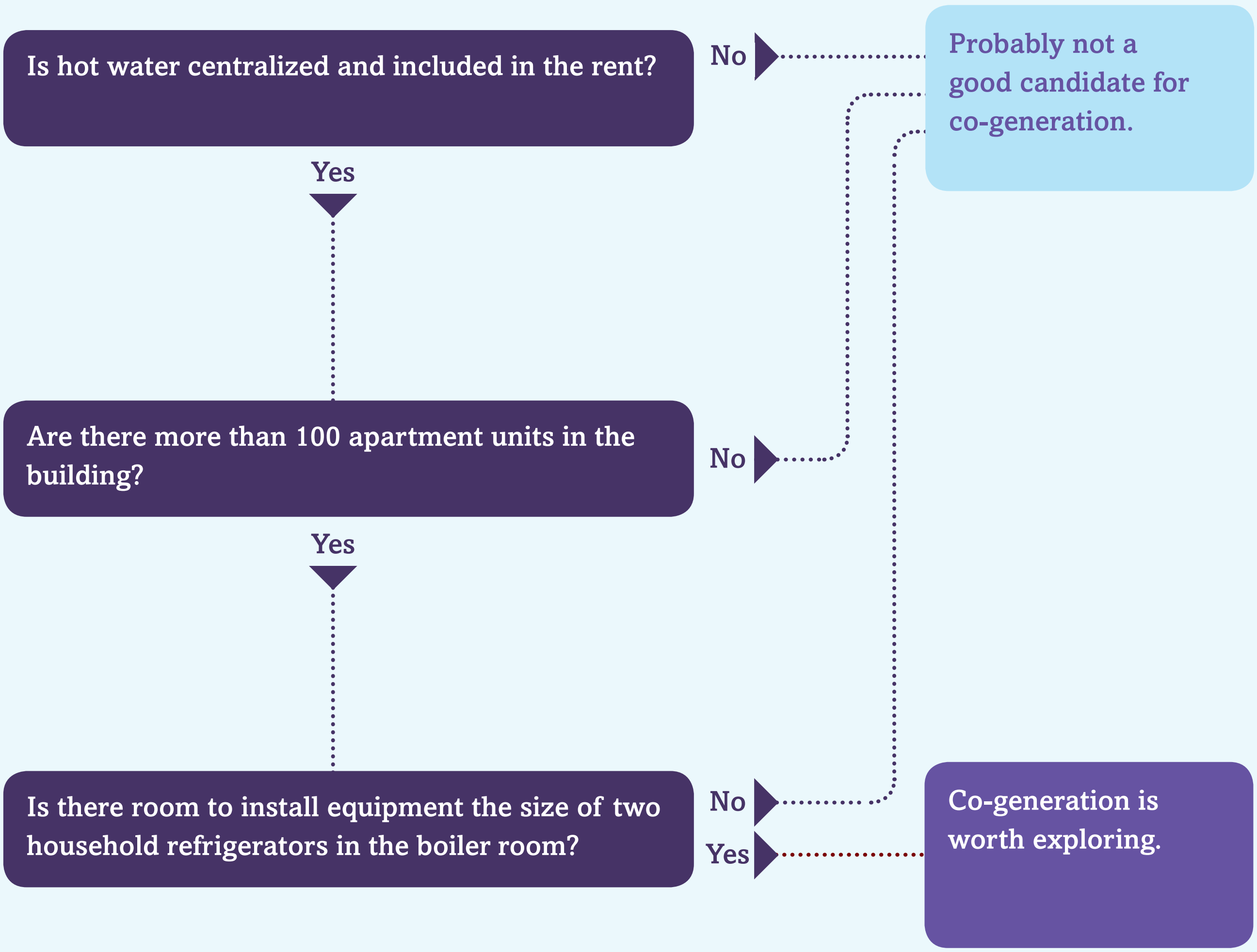
Solar PV Decision Tree

Is my rehab project a good candidate for Solar PV?



Co-generation Decision Tree

Is my rehab project a good candidate for co-generation?



Implementing Renewable Energy Projects

Phase 4

Once an RE project is installed, here are the best practices you'll need to keep the system working well.

System Maintenance and Building Resident Awareness

Informing building residents and the surrounding community about an RE system and its operation is a vital part of its ongoing success. You'll also find advice here on preventive maintenance, reporting and record-keeping and trouble shooting.

Resident engagement.

Making residents – of single-family homes and multi-family buildings – aware of the value that renewable energy systems bring to their homes is a vital element of a project's success. For example, it is important to build anticipation of and knowledge about the ways that installation of solar panels can help owners reduce energy bills and bolster a development's long term sustainability. Resident engagement can dispel common concerns or misconceptions about solar energy and give residents pride in the solar program, with its safe and clean on-site energy generation.

Resident education can help to alleviate accidental damage to solar panels on carports or roofs and encourage preventative and long-term maintenance. Building owners or asset managers can engage residents include distributing information about renewable energy systems (websites and brochures) and holding workshops and discussions. Building owners could also partner with local solar installers to offer tours, demonstrations and presentations for resident groups to build awareness and community acceptance.

Monitoring.

It is simple to monitor solar PV performance because most systems connect to the internet and report their energy production at regular intervals. This monitoring allows the system owner to compare actual energy production to estimates. If the estimated and predicted production levels diverge, technicians can use the data to find the cause. System owners will also use monitoring data to apply for solar renewable energy credits (SRECs), operating incentives that make solar installations more affordable.

Reporting and record keeping.

The system owner must review and keep important documents about the PV system including monitoring reports, incident reports, insurance documents, tax documents, and warranties.

Preventative maintenance.

If the system is producing energy at the anticipated level, an annual preventive maintenance program can help the system maintain that level. This service may be offered by the solar provider, or you may have to find a contractor.

Preventative and long-term maintenance.

On the next page is a sample scope-of-work a system owner could use when contracting for an operations and maintenance contractor to ensure the long-term performance of the system.

Operations and Maintenance Best Practices Scope of Work

Solar PV are specialized systems which the on-site maintenance staff may not be familiar with. To ensure long-term performance of the system, a monitoring and maintenance plan should be in place including a contract with a qualified service provider. Often the installer will offer an ongoing maintenance contract.

This document shows a typical scope for a PV operations and maintenance contract. A similar scope should be offered by a PB maintenance contractor. Ask your maintenance contractor about their schedule of periodic maintenance activities and have them provide a record of checks completed – or adapt the schedule below.

At initial inspection.

Review and compile key data related to the project's equipment including as-built drawings, specification sheets, serial numbers, flash test information, warranties and spare inventories.

Periodic Inspections & Maintenance Tasks

For a customizable Word document go to http://www.hudexchange.info/resources/documents/Periodic-Inspections-Maintenance-Tasks.docx

Date Completed	Check
ANNUAL	
	Inspect modules for signs of physical damage, corrosion, dirt, damage caused by animals, and plant growth.
	Inspect combiner box enclosures for signs of damage, dirt, damage caused by animals, and plant growth.
	Inspect Data Acquisition System (DAS) and associated sensors, hardware, and wiring.
	Inspect inverters for signs of physical damage, failure to perform as rated for environmental conditions due to damage, dirt, damage caused by animals, and plant growth.
	Clean inverter exhaust and intake filters.
	Clean pyranometers and reference cells
	Check shutdown and start-up of inverter to verify timely function of wake-up procedure and maximum power-point tracking.
	Perform any other maintenance tasks reasonably recommended by the manufacturer of the inverter.
	Clean area around inverters to maintain for performance and safety.
	Check all DC fuses and replace any malfunctioning fuses.
	Measure and record the open-circuit voltage ("Voc") and maximum operating current ("Imp") of all DC strings. (IV curve).

Date Completed	Check
ANNUAL	
	Inspect grounding from modules and rack to combiner. Test continuity between modules and rack. Measure resistance and record.
	Thoroughly clean and re-tighten all serviceable electrical connections to manufacturer- specified torque.
	Verify that signage is present and readable.
	Inspect racking and conduit for damage.
	Perform maintenance of the monitoring system according to manufacturer's warranty requirements.
	Inspect wires for damage on exposed conductors.
	Perform inverter maintenance work. Check screens, air filters and fans manufacturer's warranty requirements.
	Inspect site for vandalism.
	Identify and photograph abnormal wear and tear.
	Provide annual variance report of forecast and actual results, with suggestions for updates to the forecast.
	Infra-Red (IR) inspection of switchgear and combiner boxes and any strings or modules that are performing outside of specifications.
MONTHLY	
	Monthly performance reporting and corporate reporting.
	Complete monthly REC or SREC compliance as needed.
ONGOING	
	Actively monitor system performance and production data at the level of the inverter and tracker.
	Diagnose all warnings, alarms or issues.
	Maintain on-site staff access to the monitoring system.

Date Completed	Check
ON-CALL/REACTIVE MAINTENANCE	
	Inverter outage resolution.
	DAS outage resolution.
	Submit and administer warranty claims with providers.
	Monitor DC and AC circuit malfunction diagnostics, including fault situations.
	Monitoring equipment and sensor malfunction diagnostics.
	Repair or replace system components including inverters, PV modules, switchgears and transformers.
	Coordinate unscheduled services.
	Perform warranty eligible repairs.
	Other ____.

Renewable Energy Case Studies

CDP grantees that have successfully incorporated RE systems in their projects and how they did it.

- Stanislaus Apartments, *Solar thermal*
- Rio Vista Apartments, *Solar PV and solar thermal*
- WestTown Single Room Occupancy (SRO) Project, *Geothermal heat pumps*
- Altura Place, *Solar PV*
- Near Zero Energy Home Development, *Solar thermal*
- Stellar Apartments, *Solar PV*
- The Lamb Building, *Solar thermal*

Stanislaus Apartments
Solar Thermal

CPD Grantee: West Rutland, VT
Developer: Housing Trust of Rutland County
Project Type: Multifamily Historic Rehab
RE Type: Solar Thermal
CPD Source: HOME, $315,000 | NSP, $1,248,000
Total Development Costs: $3,834,628
Year Completed: 2011

This historic school served West Rutland's Polish community when it opened in 1924. In the 1970s it was divided into cramped apartments. In 2011, the Housing Trust of Rutland County restored the building and included a deep-energy retrofit. To preserve the building's historic character, solar hot water panels were installed horizontally at a low angle, hidden behind the roof's parapet. The solar installation provides 55 percent of domestic hot water needs. The project won awards for energy efficiency and historic preservation. Funding sources included HOME funds, LIHTC, the 20 percent federal Historic Tax Credit and four Section 8 project-based vouchers.

Keys to Success

» Public support. Residents concerned about volatile fuel prices were willing to embrace unconventional solutions to lower utility bills.

» Renewable energy subsidies. The project received a $165,000 grant from the U.S. Department of Energy.

Lessons Learned

» To adapt renewable energy to the unique needs of an historic building, solar panels were placed out of view to preserve with the historic nature of the building.

Rio Vista Apartments

Solar PV and Solar thermal

CPD Grantee: City of Los Angeles, CA
Developer: Abode Communities
Project Type: Multifamily New Construction
RE Type: Solar PV and Solar Thermal
CPD Source: HOME, $2,542,354
Total Development Costs: $30,675,000
Year Completed: 2011

Rio Vista Apartments is the first joint-use development in Los Angeles county which combined affordable housing with an early education center. Eighty-seven affordable rental housing units will be available for families. To address market need and the projected demand for larger units, the development set aside 40 percent of units as three-bedroom apartments to accommodate families with children. The development is rated LEED® for Homes Platinum and exceeds California Title 24 Standards by 40 percent. Residents were designed and developed by Abode Communities, while the Early Education Center was designed by Gonzalez Goodale Architects and developed by the Los Angeles Unified School District (LAUSD). This innovative and unique urban infill development, a national model, was made possible because of a 66-year ground lease to Abode Communities from LAUSD.

Keys to success.

- An advocate at the city. The developer established a good working relationship with the staff at the department of Housing and Community Development, which made for better communications with other departments so that the developer moved through the permitting process more quickly. Support within city government and open lines of communication between city staff and developers is important to ensure a project's success.
- Tracking PV electricity generation. Using utility monitoring software to track solar electricity generation, the property manager was able to see that the panels were under performing and correct it.

Lessons learned.

- Make RE part of the project's original design. Include a renewable energy consultant in your team early in the design process to avoid problems and project delays later.
- Operating the equipment. Train on-site staff to monitor performance and ensure proper operation and upkeep.

WestTown Single Room Occupancy (SRO) Project

Geothermal Heat Pumps

CPD Grantee: Oklahoma City, OK
Developer: Homeless Alliance
Project Type: Multifamily New Construction
RE Type: Geothermal Heat Pumps
CPD Source: HOME & CDBG, $750,000
Other RE Financing Sources: $12,000 utility rebate
Total Development Costs: $1,444,598
Year Completed: 2015

Twenty chronically homeless, medically vulnerable people will find homes in this Oklahoma City project's 20 studio units each measuring 250 sq. ft. On-site staff access to the services provided by the West-Town Campus will aid residents. The geothermal system will have an excellent SEER rating of 45, 2.5 times more efficient than the best air-to-air system.

Keys to success.

» Team up with geothermal experts. A large and innovative manufacturer of American-made residential geothermal heat pumps donated expertise, labor and supplies to the project so it could pilot state-of-the-art geothermal systems. The project manager for the developer had geothermal experience.

Lessons learned.

» Call in RE engineers. A meeting with renewable energy experts helped to convince engineers who were more familiar with conventional heating systems to try the new approach.

Altura Place

Solar PV

CCPD Grantee: Aurora, CO
Developer: Habitat for Humanity of Metro Denver
Project Type: Single-Family New Construction
RE Type: Solar PV
CPD Source: HOME, $440,000
Other RE Financing Sources: $131,600 | Various grants ($84,000) | Xcel Utility's Solar Rewards Rebate ($41,055)
Total Development Costs: $2,230,692
Year Completed: 2008

Eleven new, single-family homes in Altura Place which were constructed in 2008 in partnership with Habitat for Humanity include a PV system on their roofs. HOME funds were used for the purchase of the solar-energy system. Upon completion, each home was sold. The solar systems varied from home to home depending on the orientation of the roofs and specific home designs. Typical arrangements involved 8 to 11 solar panels which created a system capacity of 2 to 3 kilowatts per home – that is 50% of the power required. The remaining electrical energy is provided by the electrical grid. The system is estimated to offset approximately 42 metric tons of CO_2 each year, the equivalent of planting 1,077 trees, according to EPA calculations. An estimated pay-back period of 5 to 10 years is expected, depending on annual operating and maintenance costs and actual fuel savings.

Keys to success.

- » Renewable energy subsidies. Utility rebates covered 80 percent of the installation costs. Without them, solar installation would not have been financially possible. Check dsireusa.org or local utility companies for current solar incentive programs.
- » Volunteer experts. A retired electrician who was a volunteer at Habitat for Humanity led the solar panel installation, saving the project the cost of a market-rate solar installer.

Lessons learned.

- » Work with the utility company. Foster a relationship with the local utility company by enrolling a utility representative on the board. This can help misunder-standings and costly delays.
- » Discuss funding sources. Clearly explain how the renewable energy project is being funded, especially if donors are concerned that funds are being diverted away from providing housing.

Near Zero Energy Home Development

Solar PV and Solar Thermal

CPD Grantee: Whitley County, KY
Developer: Kentucky Highlands Investment Corp / Southern Tier Housing Corp.
Project Type: Single-family New Construction
RE Type: Solar PV, Solar Thermal
CPD Source: CDBG-DR, $30,000
Other RE Financing Sources: TVA Green Power Providers Program
Year Completed: First homes completed in 2012

Kentucky Highlands Investment Corp. (KHIC) and its affordable housing development partner, Southern Tier Housing Corporation, joined forces for this Near Zero Energy Home Development demonstration project. Partnering with institutions such as the Oak Ridge National Laboratory and the University of Kentucky, KHIC built five single-family houses using the Passive House guide, the industry's highest standard for residential energy efficiency. Solar panels in the houses generate electricity that is sold back to the utility through the power grid. Electricity produced by the panels and purchased by the utility should yield each homeowner several hundred dollars a year for 10 years. KHIC and Southern Tier plan to develop 13 more renewable energy homes.

Keys to success

» Renewable energy subsidies. A 10-year utility rebate agreement with the Tennessee Valley Authority (TVA) helped to make this solar PV installation financially feasible.

Lessons learned.

» Make RE part of the project's original design. Work with the solar installer during the design phase of the project to minimize costs and design flaws. In this development, the solar installer who came late to the project had to install extra bracing under the roof, which could have been avoided if the roof been designed for solar.

Stellar Apartments

Solar PV

CPD Grantee: City of Eugene, OR
Developer: St. Vincent de Paul
Project Type: Multifamily New Construction
RE Type: Solar PV
CPD Source: HOME, $860,000
Other RE Financing Sources: $11,485 utility rebate
Total Development Costs: $10.2 million
Year Completed: 2013

Stellar Apartments in Eugene, OR is a 54-unit LIHTC family housing development with a mix of one-, two-, and three-bedroom townhome-style apartments and flats. Ten units in the complex are reserved for National Guard families, and 4 units are set aside for clients of VetLIFT, which house homeless veterans with families. A 14.4 kW array of solar PV panels on the complex's community building offsets electricity costs, yielding savings of more than $2,000. All units comply with Earth Advantage Certification, including Energy Star® rated appliances, lighting and windows; low VOC paints, finishes, sealants and adhesives; fresh-air ventilation system designed to promote healthier indoor air, and low-flow water fixtures. One 6-unit building is built to Passive House standards, with high levels of insulation and other features that will mean extremely low utility bills for tenants. Stellar Apartments is one of the first multi-family housing projects in the country to use these standards.

Keys to success.

» Leftover contingency funds. When the project started, the developer did not plan on installing solar PV. When construction was completed, however, contingency funds remained, so the developer used $52,000 to purchase solar panels.

» Renewable energy subsidies. A renewable energy rebate from the utility company contributed over $11,000 toward the cost of PV panels.

Lessons learned.

» Make RE part of the project's original design. Contemplating the use of solar power while the project is being designed allows a design optimized for solar power. In this case, PV was only included after construction, so the amount of solar energy production is not optimal because of the way the roofs are angled.

The Lamb Building

Solar Thermal

CPD Grantee: City of Eugene, OR
Developer: St. Vincent de Paul
Project Type: Multifamily New Construction
RE Type: Solar Thermal
CPD Source: HOME, $525,000
Other RE Financing Sources: $21,775, BETCs
Total Development Costs: $7.397 million
Year Completed: 2010

Photos by Marc Mintz

The Lamb Building is a four story mixed use LIHTC project, consisting of ground floor commercial space and 35 one bedroom affordable units. These affordable units are rented to individuals and couples at or below 50% and 60% of the area median income. Each unit features high speed internet and common amenities include a community room, outdoor terrace, and on-site laundry. This project is conveniently located with access to public transportation and in close proximity to shopping, food service, social service programs, and other urban amenities. The Lamb Building is a model of sustainable, environmentally-sound building principles. Energy efficient measures at the Lamb Building result in 32% savings overall, or about $2,850 annually. This includes a high efficiency heating and cooling system, solar water heating, fluorescent lighting fixtures, and EnergyStar appliances. These measures will save tenants money on their utility bills, further enhancing the project's overall affordability.

Keys to Success

» Renewable energy subsidies. Business Energy Tax Credits (BETC) from the State of Oregon contributed $21,775 toward the project's $66,959 solar thermal system.

Lessons Learned

» Find the right type of RE for your climate. Heat pump water heaters may be a better option in a place like Eugene, OR for a place that doesn't receive lots of sunshine since they feed off outside air temperature rather than the sun. They are the same size as a conventional water heater, but cheaper and use less than half the energy.

Appendices

A Incorporating Renewable Energy Features into HOME Projects

Participating jurisdictions who want to incorporate RE features in HOME-assisted rehabilitation or new construction projects should consider all applicable HOME requirements and the potential impact these requirements may have on the project. For instance, incorporating renewable energy features in projects could affect the amount of HOME subsidy required, affecting the applicable per-unit HOME subsidy limits and requiring alternative funding resources to cover exceeding costs.

Especially important is the section of the Rule on Property Standards at 24 CFR 92.251 which covers new construction projects, rehabilitation projects, manufactured housing and existing housing for acquisition and rental occupancy. While this provision of the new HOME Final Rule is not in effect as of December, 2015, it provides parameters for how renewable energy components may be incorporated into HOME-funded projects. Incorporation of renewable energy features into projects involving new or rehabilitation construction or manufactured housing is not addressed, but is certainly allowed within the design parameters of a qualifying project. Of particular interest is the requirement at 24 CFR 92.251 (b)(1) Rehabilitation Standards.

This section will require each participating jurisdiction to establish rehabilitation standards for all HOME-assisted housing rehabilitations. These rehabilitation standards set requirements which housing must meet upon project completion. In addition to setting minimum standards for assisted housing, rehabilitation standards specify features exceeding the minimum standards that are allowed, preferred or mandated by the jurisdiction for a funded project. Rehabilitation standards which a HOME jurisdiction must craft in compliance with this section of the HOME Rule may provide a starting point for incorporating or prioritizing renewable energy features.

As a part of the process for specifying new construction, a jurisdiction will have design standards specifying required and desirable features to be used in a project's design. These design standards for new buildings are appropriate to prioritize renewable energy features.

Participating jurisdictions should consult the HOME Investment Partnership Program Rule, revised July 24, 2013, to review the applicable HOME requirements[1].

[1] hudexchange.info/HOME/HOME-Final-Rule/

B Zoning and Building Codes

Zoning Codes

Zoning codes commonly divide land within a jurisdiction into various zones in which the use of land and structures on it are regulated. Each mapped zone usually permits structures of specified form and specifies uses of property. Numerous provisions in zoning codes throughout the U.S. may determine the eligibility, feasibility and design of RE systems. Provisions allowing renewable energy as an approved accessory use are beginning to be adopted, but most of today's zoning codes including the International Zoning Code, a primary standard zoning code, do not contain such provisions.

International Zoning Code

No sections of the International Zoning Code specifically relate to renewable energy. Installations may be impacted by yard and building dimension requirements and height limitations. Structures exceeding specified heights require approval. Section 804 provisions on projections into required yard space may apply. Section 805 landscaping requirements have no provisions regarding solar.

Principal, Accessory and Conditional Uses

Renewable energy development may be protected and encouraged by zoning ordinances that define renewable energy as an accessory use. Zoning ordinances permit a specific principal use of a property, such as housing. Renewable energy installations have sometimes been disallowed as a secondary commercial use. Such barriers to renewable energy development may be overcome by defining RE as accessory to the principal use. Where renewable energy installations are not protected as an accessory use or for a similar reason, it may be necessary to obtain a conditional use permit or zoning variance.

A conditional use permit is a zoning exception which allows a property owner to use the land in a way not otherwise permitted within the zoning district. A conditional use permit may be granted only when compatible with neighboring uses and may bear qualifying conditions. Because a zoning ordinance cannot account for every situation (such as the popularity of renewable energy installations), the conditional use permit allows the zoning authority to permit prohibited uses benefit the neighborhood. A conditional use permit may also be known as a use variance or special use permit.

Zoning Variances

Zoning variances may be in the form of a use variance or an area variance, also known as a non-use variance. Developers or owners may request area variances to resolve issues in complying with set-back, height or other restrictions. The process for obtaining variances and variances are likely to be granted varies widely. Typically the process involves public and neighbor approval of the request. So, it is vital to document the necessity of the requested variance and its benefit to the neighborhood and community, and to build public support.

Solar Access and Easements

Solar access may be protected by zoning requirements that prevent development on one lot from blocking solar access on adjacent lots. Such zoning is most readily accomplished when a parcel is divided into lots for development. For existing lots, some communities define and allow solar access permits and the provision of solar easements that are recorded to preserve solar access for systems being installed. Other easements recorded against a property may impact planned RE systems. The impact of easements should be thoroughly investigated when planning RE projects.

Overlay Zones

Zoning officials may use to approve renewable energy uses overlay zoning to advance while keeping the existing zoning of parcels in place. The overlay process enables renewable energy features in developments, while avoiding the time-consuming process and uncertain outcome involved in rezoning or seeking variances.

Reference: Planning and Zoning for Renewable Energy American Planning Association Planning Advisory Services Info Packet[2]

International Building Code 2015

The International Building Code (IBC) applies to all buildings except detached one- and two-family dwellings and townhouses of not more than three stories and their accessory structures. Example below are sections of the IBC most likely to be relevant to the design and installation of PV solar systems for buildings with 3 or more units or buildings of more than 3 stories. They include:

IBC 1501	General provisions for design, materials, construction and quality of roof assemblies and rooftop structures.
IBC 1505	Fire classification.
IBC 1507	Requirements for roof coverings.
IBC 1510	Rooftop structures.
IBC 1512	Photovoltaic panels and modules.
IBC 1603	Construction documents.
IBC 1607	Live loads.
IBC 1613	Earthquake loads.

International Residential Code

The International Residential Code (IRC) applies to detached one- and two-family dwellings and townhouses of not more than three stories and their accessory structures. The IRC consolidates and references provisions of other codes by prefixing each section number by a letter referencing the code development committee responsible for the provisions of that section as:

(R) IRC Building provisions
(M) IRC Mechanical provisions
(N) IRC Energy provisions
(P) IRC Plumbing provisions

[2] planning.org/search/?keyword=planning+and+zoning+for+renewable+energy+info+packet

Sections of the IRC that may impact the design and installation of solar thermal and solar PV systems include:

Solar thermal and auxiliary systems	
IRC M2301	Thermal solar energy systems.
IRC P2802	Solar water heating systems.
IRC P2902	Protection of drinkable water supply.
IRC M2001	Boilers..
IRC M2002	Operating and safety controls.
IRC M2003	Expansion tanks.
IRC M2004	Water heaters used for space heating.
IRC M2005	Water heaters.
IRC M2006	Pool heaters.
IRC N1103	Systems.

Photovoltaic systems	
IRC R401	Design criteria.
IRC R324	Solar energy systems.
IRC R902	Fire classification.
IRC R905	Requirements for roof coverings.
IRC R907	Rooftop-mounted PV systems.
IRC R909	Rooftop-mounted PV panel systems.

International Mechanical Code (IMC)

The IMC regulates permanently-installed mechanical systems, equipment and appliances which control environmental systems. Sections most likely to apply, to solar thermal and solar PV systems, and structural, mechanical, plumbing and auxiliary or backup systems subject to the International Building code include:

IMC 301	General.
IMC 302	Protection of structure.
IMC 303	Location of equipment and appliances.
IMC 304	Installation.
IMC 305	Piping support.
IMC 306	Access and service space.
IMC 307	Condensate disposal.
IMC 309	Temperature control.
IMC 312	Heating and cooling load calculations.
IMC 1401	General-solar space, domestic water, swimming pool heating.
IMC 1402	Installation.
IMC 1403	Heat transfer fluids.
IMC 1404	Materials.
IMC 1002	Water heaters.
IMC 1004	Boilers.
IMC 1005	Boiler connections.
IMC 1006	Safety and pressure relief valves and controls.
IMC 1007	Boiler low-water cutoff.
IMC 1008	Bottom blow off valve.
IMC 1009	Hot water boiler expansion tank.
IMC 1010	Gauges.
IMC 1011	Tests.

International Fire Code

The International Fire Code (IFC) is a model code that regulates minimum requirements for fire prevention and protection, safety and hazardous materials. It applies to new and existing buildings. Sections most likely to apply to solar energy systems include:

For buildings over 3 stories	
IFC 605	Electrical equipment, wiring and hazards.

For residential occupancies R2-4	
IFC 605.1.1.1	Roof access points.
IFC 317.3	Rooftop structure and equipment clearance.

International Solar Energy Provisions 2015

The International Code Council (ISEP) has compiled in one document, the complete solar energy provisions of the 2015 International Codes[3]. These cover solar thermal and photovoltaic systems as well as water heaters and heating and cooling systems which may be components of hybrid or backup systems. Following the format of the International Energy Conservation Code, the ISEP separates commercial and residential sections. Commercial provisions apply to buildings over 3 stories, while the residential sections apply to residential group R2, R3 and R4 occupancies.

National Electric Code: NFPA70

The National Electric Code[4] (NEC) is published by the National Fire Protection Association (NFPA) and has been adopted in every state. The NEC addresses commercial, residential and industrial occupancies and applies to all electrical conductors, equipment and raceways, as well as signaling, communications and optical fiber used in RE installations.

The impact of the NEC on PV systems is explained in Understanding the NEC 2014 and Its Impact on PV Systems[5] on the SolarPro website.

Articles of the NEC that of interest in renewable energy installations are:

Photovoltaic systems	
Article 690	Solar Electric Systems.
Article 705	Interconnected Electrical Power Production Sources.
Article 225	Outside Branch Circuits.
Article 230	Services.
Article 692	Fuel Cell Systems.
Article 694	Wind Electric Systems.

[3] shop.iccsafe.org/2015-international-solar-energy-provisions-tm-1.html
[4] nfpa.org/codes-and-standards/document-information-pages?
[5] solarprofessional.com/articles/design-installation/understanding-the-NEC-2014-and-its-impact-on-pv-systems/page/0/1

Compliance with Building Codes

Building codes are a series of ordinances enacted by state or local governments which specify minimum standards for the construction. The most widely-used building codes are those from the International Code Council (ICC), which publishes model codes for adoption by local jurisdictions. The ICC Model Code Set consists of 18 code volumes and many other publications. Many of the international codes have sections relevant to RE installations. The international codes may be accessed at the International Code Council Online Library[6].

The ICC Model Codes are given as examples. A state or local jurisdiction may adopt codes with significant modifications to the chosen model code. It is necessary to know the particulars of all applicable codes applicable to of the RE project. Consultation with the officials of jurisdiction is advised.

Many states and counties use various versions of the National Electrical Code (NEC) for electrical code requirements and the American Society of Civil Engineers (ASCE) code for mechanical and physical requirements related to building rooftop solar arrays.

The NEC is updated every 3 years. It is up to the local jurisdiction to decide when to adopt a new version of the NEC. For example, some counties use NEC 2005 while others use 2008. Many will also amend either based on local differences or if the standard code does not meet their needs.

Ballasted solar arrays often use ASCE (7-05) code sections to calculate the amount of weight needed to hold solar panels on the roof. This depends on which standard the AHJ has adopted.

Model codes published by the National Fire Protection Association (NFPA), International Association of Plumbing and Mechanical Officials (IAPMO) and other organizations will be found in various jurisdictions.

Here is a list of the international codes most applicable to renewable energy systems with the provisions most likely to impact solar energy systems as extracted from the 2015 International Solar Energy Provisions (ISEP). The lists of applicable provisions omit reference to sections on scope and administration and definitions, instead focusing on installation provisions.

For more on codes, see Solar America Board for Codes and Standards[7].

i. Building Permits and Code Inspections

Where building codes are in force, the owner of a building, or the owner's agent of the owner, must obtain required permits before commencing work, except for ordinary repairs. To obtain a permit, at least two sets of documents, must usually be submitted with the application. The submitted construction documents must, be prepared by a registered design professional. The building official is empowered to waive submissions or require additional submissions of documents or data.

[6] publicecodes.cyberregs.com/icod/
[7] www.solarabcs.org/

Because renewable energy technology is new and evolving rapidly, permit applicants often require for additional submissions. Building officials have often not had sufficient information to make their decisions. Guidance from existing codes and standards has not always kept up with the technology, making it difficult for officials to confidently evaluate the safety of the newest systems. Caution on the part of building officials has been reinforced by valid safety concerns.

Solar collectors installed on roofs are one area of this concern. To maximize collection area, panels have often been installed over most of a roof surface without taking into account firefighters' needs for a path across roof surfaces in order to vent the roof to fight a fire. In another example, photovolaic panels remain energized despite the disconnection of the building from the power distribution grid. Not only can we not shut off sunlight to thermal and photovoltaic panels, but testing has shown that artificial light sources, such as floodlights used by firefighters may energize photovoltaic panels. Solar PV systems may supply power at up to 600 volts DC or more in sunlight so systems may present serious electrical shock hazards to firefighters and first responders. It took some time for issues such as maximum roof area coverage, circuit labeling, location and identification of means of disconnection to be addressed in standardized system design, codes and installation standards. It was not until the 2014 electrical code that rapid shutdown of PV systems was required. Code officials have justly been cautious about issuing of permits.

Additionally, many building departments and officials have limited experience in renewable energy systems. When applying for a permit for renewable energy system installation, the required package of submissions to accompany the permit application must be carefully and thoroughly prepared. Submission of required and supplemental information will help the building official to understand safety to facilitate and speed permit approval.

Each jurisdiction may have widely varying requirements for submissions, permits issuance and inspection requirements. It is essential to understand the requirements of the state, county and city code agencies having jurisdiction over proposed projects to assure that submissions meet agency requirements. Project timelines must be consistent with jurisdictional time frames for permit issuance, which may be longer for RE projects. Permit fees may vary greatly with the jurisdiction. Some jurisdictions charge a small flat fee to cover the expenses of plan review and inspection, while others charge a percentage of project value, which will be more substantial.

Permits and approvals that are typically required depending upon the type of RE installation include:

- Conditional use permit or zoning variance could be required in some jurisdictions or zones to obtain building permits.
- Building or residential permit may be required for structural, design, fire resistance materials and methods.
- Electrical permit (all systems using or producing electrical power and controls).

- Plumbing permit (solar thermal and geothermal systems and auxiliary and backup components).
- Mechanical permit (systems with mechanical components).
- Utility connection approval (grid connected systems).

Inspection approvals must be obtained from the of jurisdiction for each permit issued. Inspection approval will be more likely when:

- Code requirements are followed and compliance is documented.
- Pre-engineered or packaged systems with “listed” components are used.
- Inspectors are briefed about the nature and certifications of equipment and approved installation methods.
- Complete plans are submitted with all supporting documentation.
- Only certified and listed equipment is used.
- Documents certify that equipment complies with local code and required technical standards.
- Evidence of licensing, qualifications and certifications of installers is presented.

Many code authorities and industry organizations have inspection checklists for evaluating the performance and compliance of installed systems. These may be helpful to manage and evaluate installations in preparation for inspections and to guide quality control.

Examples:

U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy SERC Solar PV System Field Inspection Checklist[8].

Photovoltaic Information Article 690 from the City of Palm Desert, CA Building and Safety Department[9]

The Energy Star Homes HVAC System Quality Installation Contractor Checklist[10]

For additional information regarding zoning and building zones, please refer to ***Appendix A – International Zoning and Building Codes***.

ii. Expedited Permitting

This is a standardized process, for code and permitting authorities to review and approve defined renewable energy systems. By simplifying and standardizing the permitting process and required submissions, expediting the issuance of required permits and eliminating or reduce the need for costly engineering and design submissions, the permit process can be expedited. Expedited permitting works well and for small-scale RE systems. Systems that are more complex with non-standard design features may require additional submissions or may fall outside the scope of expedited permitting.

The process of expedited permitting is well defined. Review the published report Expedited Permit Process for PV Systems[11] prepared by Bill Brooks, P.E. of Brooks Engineering for the Solar America Board for Codes and Standards.

[8] eere.energy.gov/wip/pdfs/solarpv_checklist.pdf
[9] gov.ca.gov/docs/ec/Palm_Desert_Photovoltaic_Installation_Info.pdf
[10] energystar.gov/ia/partners/bldrs_lenders_raters/downloads/Inspection_Checklists.pdf
[11] solarabcs.org/permitting

Technical Standards

Technical standards for equipment, installation and design are referenced in building codes. Many organizations publish these standards. Here are some examples of particular interest to RE systems.

International American Society for Testing Materials (ASTM)
Standards for photovoltaic electric power conversion[12]

Solar Rating and Certification Corporation (SRCC)
Standards for solar water heating systems[13]

American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
More than 175 standards and guidelines for HVAC, air quality and energy-efficiency. Read-only versions of ASHRAE standards referenced in codes[14]

American National Standards Institute (ANSI)
ANSI oversees the creation and promulgation of many thousands of standards that impact business in every sector. ANSI standards[15]

American Society of Mechanical Engineers (ASME)
ASME serves as a technical publisher of industrial and manufacturing codes and standards. Its advanced energy systems division promotes emerging energy conversion devices and processes. ASME standards[16]

Underwriters Laboratory (UL)
This independent safety science company that tests, validates, inspects and certifies products and components. UL Standards[17] are used to assess products and materials, systems and performance. UL standards evaluate environmentally-sustainable products and renewable energies.

National Ground Water Association (NGWA)
NGWA is a non-profit organization, comprised of U.S. and international ground water professionals that publishes standards to protect ground water resources[18].

North American Board of Certified Energy Practitioners (NABCEP)
The most respected, well-established and widely recognized certification organization for North American solar professionals. NABCEP was founded to support renewable energy and energy-efficiency industries, professionals and stakeholders to develop and implement quality credentialing programs.

For more information, see:
Solar America Board for Codes and Standards[19]

---

12 solarabcs.org/codes-standards/ASTM/index.html
13 solar-rating.org/standards/index.html
14 ashrae.org/standards-research--technology/standards--guidelines/other-ashrae-standards-referenced-in-code
15 ansi.org/
16 asme.org/shop/standards
17 ulstandards.ul.com/access-standards/
18 ngwa.org/Pages/default.aspx
19 http://www.solarabcs.org/about/index.html

C Accredited Certifying Organizations for Contractors

Finding the right contractor is essential to the success of a renewable energy system in many areas: quality, safety and management of schedules and costs. Beyond licenses and certification for the trade categories in which work is to be performed, contractors and installers should provide evidence of professional competency in the particular type and components of the renewable energy system being installed. These additional certifications of competency may come from accredited certifying organizations including:

The manufacturers of equipment installed
–Installer certification

North American Board of Certified Energy Practitioners
Solar thermal installer certification[18]

Building Performance Institute
Building performance certifications[19]

Underwriters Laboratory University
PV Installer Certification[20]

National Roofing Contractors Association
Roof Integrated Solar Energy (RISE) Program Certification[21]

The Electronic Technicians Association
Solar PV and Solar Thermal Certification[22]

International Ground Source Heat Pump Association
Geothermal Heat Pump Installation Certification[23]

[18] nabcep.org/certification
[19] bpi.org/professionals.aspx
[20] lms.ulknowledgeservices.com/common/ncsresponse.aspx?Rendertext=certification
[21] riseprofessional.org/about-rise.shtml
[22] eta-i.org/renewable_energy.html
[23] igshpa.okstate.edu/training/

D Contractor Proposal Evaluation Questions

It is wise to solicit proposals from several contractors and to evaluate their submissions very closely. Among the questions the HUD CPD Grantee may ask in evaluating contractors' proposals are:

- Is the contractor's primary business installing RE systems of the type, or is it principally a general, electrical, plumbing or mechanical contractor?
- How long has the company been in business?
- Is the company properly licensed, bonded and insured?
- What work does the company plan to subcontract and what are the qualifications and certifications of the subcontractors?
- How many systems of the requested type have the installed?
- How many installation crews does the company operate?
- What is the guaranteed time frame for system design, permitting and installation?
- If the contractor will design the system, what are the design criteria and credentials of the designer, and what design documentation will be presented?
- Will the company provide a complete list of specifications for all component products with manufacturer's installation standards?
- Will the contractor handle required permits, interconnections and approvals?
- If there is a rooftop installation, will it preserve the roof warranty?
- What credentials do the installers have?
- Will warranties for all components, equipment, installation workmanship and system performance be provided?
- Will performance monitoring systems be incorporated in the installation?
- Will customer references be provided?
- What is the company's history and standing with the Better Business Bureau, the Contractor Registry, Angie's List and other service evaluation entities?
- Is the contractor or subcontractor subject to any liens or judgments?
- Will systems maintenance be supplied, and what are the arrangements for system maintenance?
- What assistance will be provided in filing for energy tax credits or other subsidies?
- What assistance will be provided with respect to financing, leasing or third-party ownership options?

E Using Section 108 to Support RE Projects

Using the Section 108 Loan Guarantee Program to Support Renewable Energy Projects

Section 108 is the loan guarantee component of the Community Development Block Grant (CDBG) Program. It allows local governments to transform a small portion of their CDBG funds into federally guaranteed loans large enough to pursue major neighborhood revitalization projects These projects are designed to benefit low and moderate income persons, aid in the elimination or prevention of slums and blight, or meet urgent needs of the communities. Local governments borrowing funds guaranteed by HUD through the Section 108 program must pledge their current and future CDBG allocations as security for the loan.

In keeping with national and local goals to ensure the sustainability and resilience of American cities and communities, CDBG grantees are encouraged to consider the potential for generating renewable energy through the installation of on-site technology as part of broader neighborhood revitalization efforts. Well-planned renewable energy projects can create green jobs, reduce utility costs, limit grid demand, support emergency preparedness, minimize air pollution, and alleviate climate change. A variety of renewable energy technologies are available to suit every location, including solar photovoltaic panels, solar water heaters, wind turbines, fuel cells, geothermal heatpumps, and bio/waste-fuel systems. The Section 108 loan guarantee program is available to make these projects a reality.

As part of President Obama's Climate Action Plan, a federal renewable energy target was established to promote and track the installation of on-site renewable energy technology across federally subsidized housing projects – 100 MW of renewable capacity by 2020. In support, HUD's Office of Community Planning & Development is creating a renewable energy toolkit for use when integrating on-site renewable energy technologies into affordable housing development projects. The toolkit focuses on grantees who are utilizing funds from the HOME and CDBG programs, including Section 108, Housing Opportunities for People with AIDs (HOPWA), or Emergency Solutions Grant (ESG) programs. The toolkit will be released in Spring 2016, alongside offerings of technical assistance.

F How to Calculate a Building's Rooftop Area

These instructions are to be used with the **Solar PV and Thermal Scoping Tool** on page 64 of this document. The steps below will help you calculate the following:

1. The roof area of your building to estimate the space available for a solar (PV and thermal) installation.

2. Setbacks to estimate the reduction in roof area to conform to safety codes.

3. Usable rooftop to estimate what sized system you can install.

4. System capacity that can be installed to determine how much energy and thermal heat potential can be generated on site.

5. Annual solar PV electricity production and value to determine estimated savings on electricity.

6. Annual solar thermal heat production and value to determine estimated annual savings on gas.

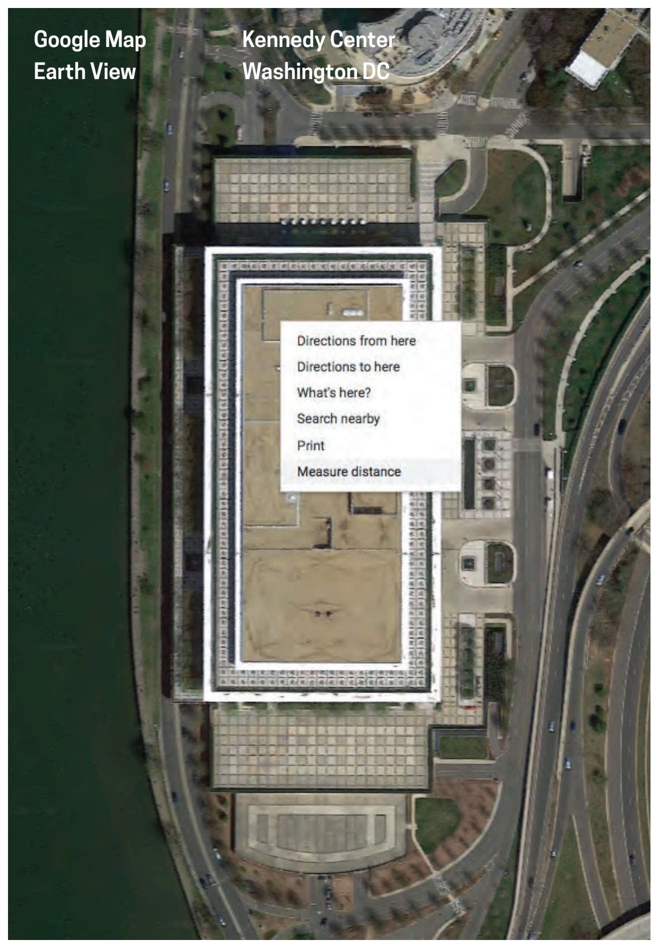
1. Roof area of your building

To estimate how much energy could be generated from the sun on a surface, we first calculate the area to see how many solar panels could be placed on it. There are various rooftop measuring tools online.

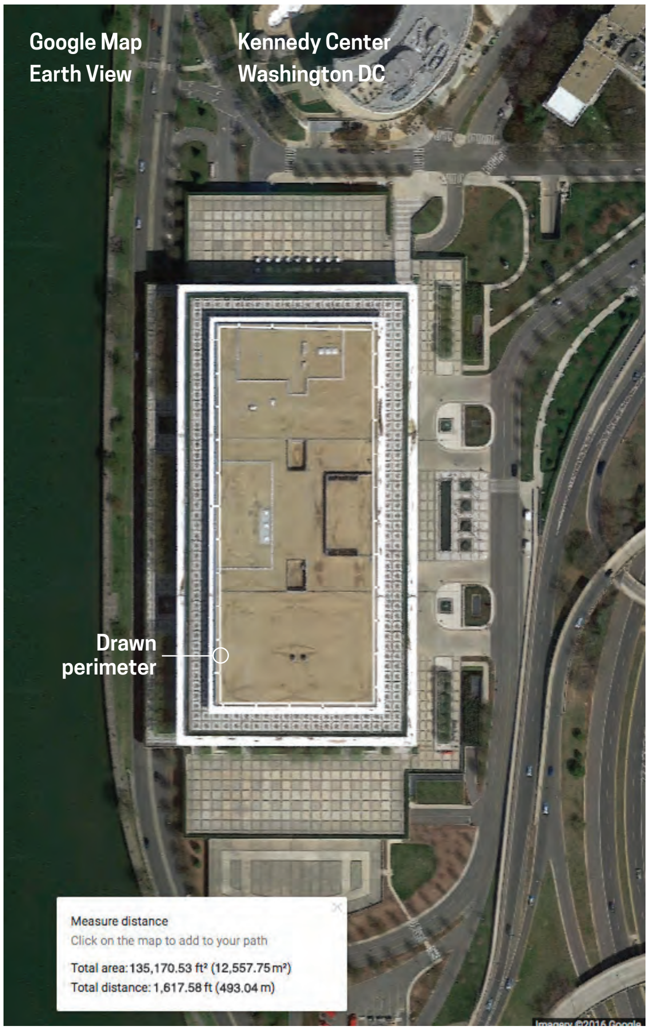
Google Maps provides an area measurement feature. In your web browser, navigate to Google Maps: maps.google.com. To use this feature, be sure you are using the full version of Google Maps and not the "Lite" version. If you see a lightening bolt on the bottom right of your screen, click on it to switch to "Full Maps."

In the search bar enter a building's address, locate your building in "earth view." For the example in this appendix, we will use the Kennedy Center located at 2700 F Street NW in Washington, DC.

Place your mouse on the perimeter of the surface area that you want to measure. Then "Right Click" to reveal the options menu, then select "Measure Distance."



With your mouse, click the corners of the solar installation area. When you have completely drawn the perimeter, Google Maps will automatically provide you with the area of the enclosed space. See the highlighted area below. The roof space of the Kennedy Center is estimated to be **135,170 square feet**.



Note: When using the Google Map "Measure Distance" tool the results will be approximate. Know that each time you calculate the area you will obtain slightly different results.

2. Setbacks

Due to a **4** to **6 foot** fire code setback requirement for solar installations, a portion of the rooftop along the perimeter cannot be used to host solar panels.[1] In the solar PV and thermal scoping tool, this setback reduction is entered as a percentage. We can use Google Maps to calculate the length and width of the roof. The roof area has a width of **240 feet** and a length of **570 feet**.

Therefore, using a **6 foot** setback the setback percentage can be determined by the following formula:

$$\text{percentage} = \frac{1 - [\text{width} - (\text{setback} * 2)] * [\text{length} - (\text{setback} * 2)]}{(\text{width} * \text{length})}$$

$$= \frac{1 - [240 - (6 * 2)] * [570 - (6 * 2)]}{(240 * 570)}$$

$$= -0.07 \text{ Or } 7\%$$

A six foot safety setback along the perimeter of a **135,170 square foot** roof would reduce the usable roof area by **7%** or **9,462 square feet**, leaving **125,708 square feet** of usable space.

[1] No solar panels should be placed within 6 feet of a building's perimeter. However, a 4 feet setback may be used if either a building's length or width is less than 250 feet long.
Source: osfm.fire.ca.gov/pdf/reports/solarphotovoltaicguideline.pdf, page 10.

3. Usable rooftop

For additional accuracy when calculating your usable roof area you can use the "birds eye" view function in Microsoft's Bing Maps: bing.com/mapspreview to get an aerial view of the building from all four directions. This will help you estimate how much of the remaining rooftop is unobstructed.

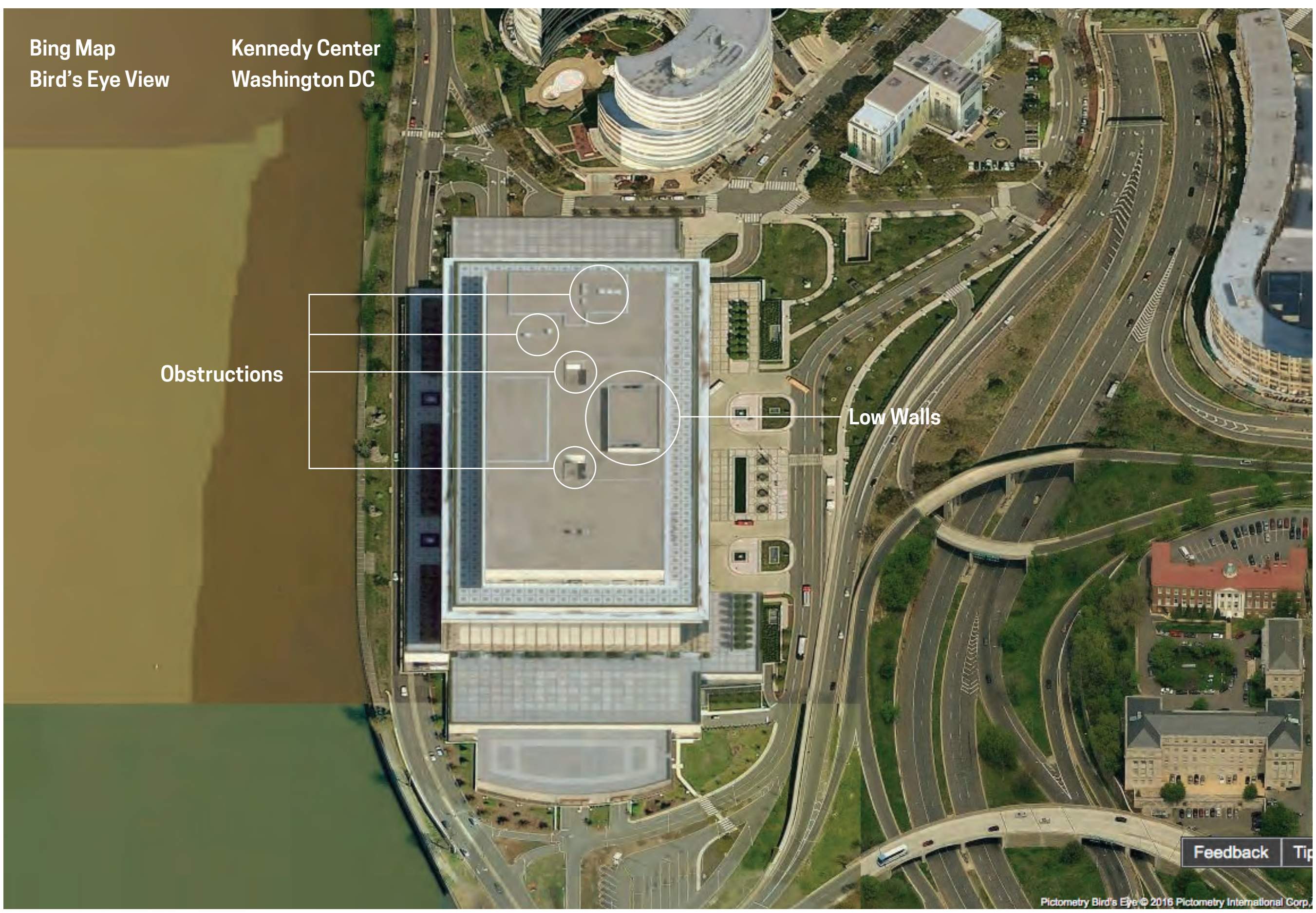
Look for rooftop objects that could be an obstacle for the placement of solar panels. Look for large objects on the roof or in the immediate area that could cast shadows on the roof – and the panels – as the sun moves across the sky from East to West. There also needs to be a **3 foot** wide pathway to any rooftop equipment, like air handlers.

Based on your assessment, use your best judgment to estimate the percentage of the roof that cannot be used because of obstructions. In our example, there are low walls and some objects that could impede solar panel placement. But generally, the roof is fairly clear. We estimate that **15%**, or **18,856 square feet** is unusable for the placement of solar panels. This leaves **106,852 square feet** as usable.

4. System capacity

It takes roughly **100 square feet** of usable rooftop space to install **1kW** of system capacity.

In our Kennedy Center example, we have a usable roof of about **106,852 square feet** (after subtracting **9,462 square feet** for setbacks and **18,856 square feet** for rooftop obstructions). With a system size installation ratio of **1kW** per **100 square feet**, this means that we can install a **1,069 kW** sized system on this rooftop.



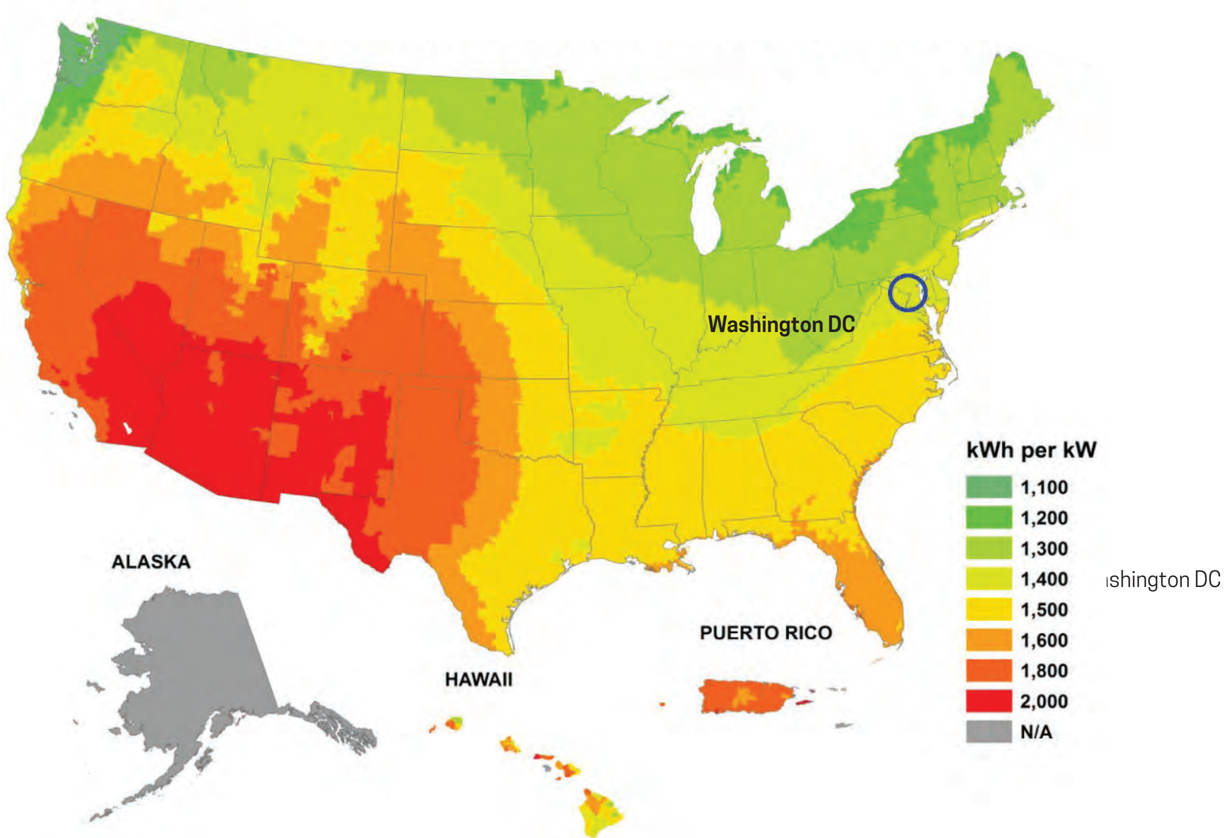
5. Annual Solar PV Electricity Production and Value

To estimate how much energy your solar PV project could generate, simply find its location on the map below. The map color will show the kWh conversion factor for every **1 kW** of installed solar capacity based on its location.

From the map, we see that in Washington, DC it is possible to generate roughly **1,400 kWh** of electricity for every **1 kW** of installed solar capacity. With roughly **106,900** square feet of installable area, we can install **1,067 kW** of solar capacity. And this could generate roughly **1,493,800 kWh** of electricity annually (**1,400 kWh** x **1,067 kW**).

In Washington, DC, the local commercial electricity rate is **$0.12** per kWh. By multiplying the electricity that could be generated annually (**1,493,800 kWh**) by the value of that electricity (**$0.12** per kWh), we estimate that we could reduce the electricity bill by roughly **$179,256** per year.

Annual Solar Electric Generation Factor



[2] Other solar scoping tools exist online like pvwatts.nrel.gov.

6. Annual Solar Thermal Heat Production and Value

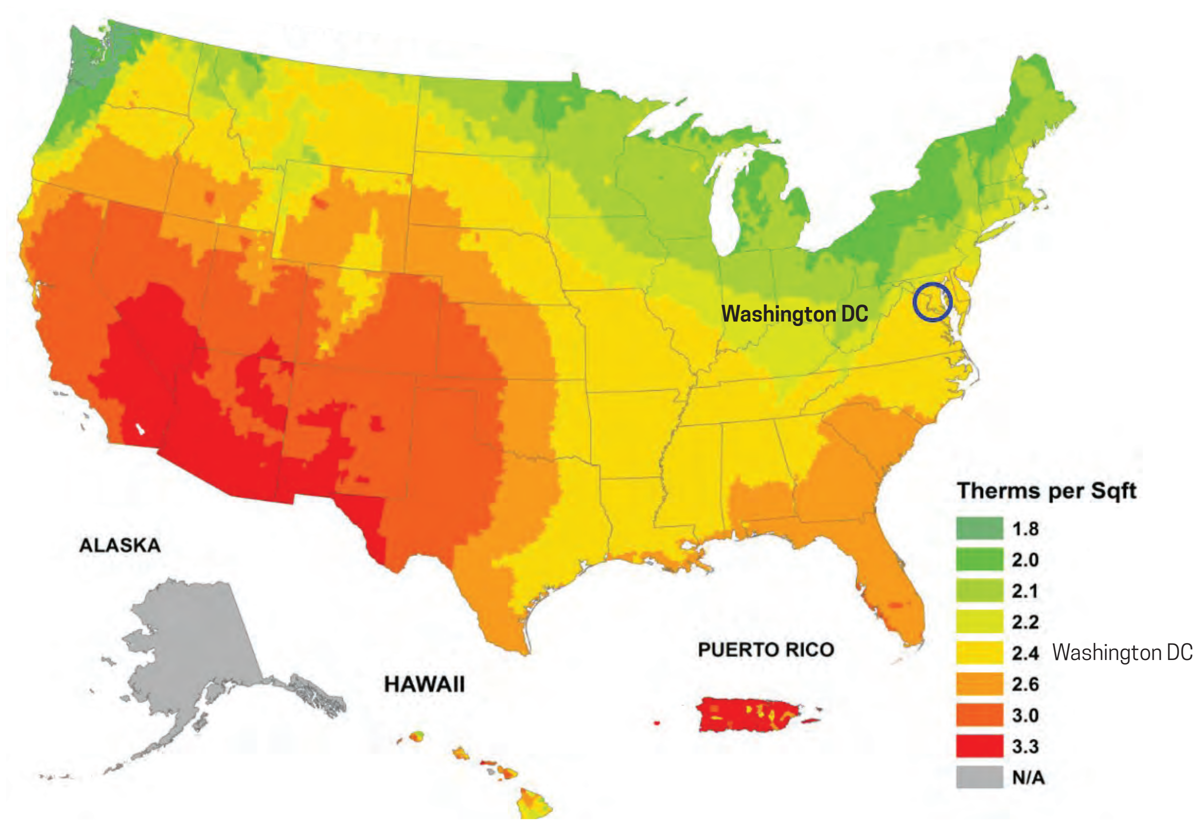
To see how much heat your solar thermal project could generate, simply find its location on the map below. From the map, we can see that in Washington, DC it is possible to generate **2.4 therms** of heat energy for every **1 square foot** of installed solar thermal collector area.

Solar thermal hot water systems are sized to meet a building's hot water demand, and not any larger because the equipment is expensive, and unlike electricity, hot water can not easily be transported offsite and sold.

The scoping tool estimates how many solar thermal collectors would be needed based on the number of housing units in a building and how much sun its gets based on its geographic location.

The hypothetical example in the scoping tool is a **100 unit** housing development in Washington, DC (20566 zip code) with a total gross roof area of **135,000 square feet**.

Annual Solar Thermal Generation Factor



Solar Thermal Example for a 100-Unit Apartment Building

System Scoping

For a **100-unit** apartment building, each unit is estimated to use **38 gallons** of hot water daily, thus the entire building would need **3,800 gallons** of hot water per day. With an average cold water intake temperature of **58 degrees** Fahrenheit, the water temperature would need to be raised by **62 degrees** to reach the **120 degrees** desired for domestic hot water use.

Since it takes **8.34 British Thermal Unit** (BTU)s to increase the temperature of **1 gallon** of water by **1 degree** Fahrenheit, it would thus take **517 BTUs** to increase the temperature of **1 gallon** of water by **62 degrees** (**62 degrees** x **8.34** BTUs = **517 BTUs**. For an entire building, it would take **1,964,904 BTUs** daily (**517** BTUs x **3,800 gallons**). As there are **100,000 BTUs** for every **1 Therm**, it would take **19.6 therms** per day (**1,964,904 BTUs** ÷ **100,000** = **19.6 Therms**). And the building would need **7,172 Therms** per year (**19.6 Therms** x **365 days** = **7,172 Therms**).

Solar Collectors

In the scoping tool, we enter **20566** as the zip code of our hypothetical project to find the average therms received there annually per square foot of collector area (**2.26 therms**) if the panels were tilted toward the sun at the same angle as its latitude. By dividing the total amount of therms needed by the therms available per square foot we find that we would need **3,180 square feet** of collector area (**7,172 therms** ÷ **2.26** = **3,180 square feet**). As each collector is about **40 square feet** in size (**4**' x **10**') it would take almost **80 collectors** to collect the energy needed at the property for hot water (**3,180** ÷ **40** = **79.5**).

Installation Area

The scoping tool will calculate the amount of area needed to install the **80 solar thermal collectors** that would be hypothetically needed while taking account setback requirements for safety, obstructions, and optimal spacing between solar collectors.

Solar Thermal Fraction

This calculates how much of the hot water heating can come from the sun relative to the needs of the building. It provides an important reality check. In reality, there may not be enough space to collect all the heat needed to satisfy 100% of the property's hot water needs.

Water Tank

Domestic hot water is used mostly in the early mornings and evenings, and not when it is being produced, which is during the day. As a result, solar thermal projects need to include a storage tank. The rule of thumb is to install **1.5 gallons** of storage for every **1 square foot** of collector area. In our hypothetical example, we would need a storage tank capable of holding **4,770 gallons** (**3180'** X **1.5 gallons**) or one that is **638 cubic feet** in size to store this much water **(7.5 gallons** per **1 cubic foot**). By taking the cube root of this volume, the storage tank would be roughly **9 feet** in depth, width and length. And it would weigh roughly **40,000 pounds** when full.

The goal of the Department of Housing and Urban Development Community Planning and Development Renewable Energy Toolkit for Affordable Housing is to enable recipients of HUD Community Planning and Development (CPD) grants to integrate renewable energies into their affordable housing development programs under the HOME Investment Partnerships (HOME), Community Development Block Grant (CDBG), Housing Opportunities for People with AIDs (HOPWA), or Emergency Solutions Grant (ESG) programs. Integration of renewable energy into affordable housing is important because it maintains affordability through reduced energy costs, which can facilitate improved operations and maintenance.

In addition, renewable energy has significant, beneficial effects on reducing the impacts of climate change. Renewable energy provides a low-to-no carbon pollution energy source that is necessary if we hope to reduce the impacts of human-caused climate change on our environment. As part of The President's Climate Action Plan, HUD and other federal agencies have pledged to add 300 megawatts of renewable energy on federally-subsidized affordable housing by 2020. This toolkit exists to support these efforts.

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

Thank you to Enterprise Community Partners for toolkit content development, CPD program staff and Office of Strategic Planning and Management staff for review and feedback on the toolkit, and Worldstudio for design of the toolkit. Special thanks to those who contributed case studies for this toolkit, including: Housing Trust of Rutland County, Inc., City of Los Angeles, Homeless Alliance of Oklahoma City, Habitat for Humanity of Metro Denver, Kentucky Highlands Investment Corporation, and City of Eugene. And finally, a special thank you to Promise Energy for help on the solar thermal scoping tool, and to the following companies for sharing cost information on their cogeneration equipment: Unison Energy, ENER-G Group, 2G, Aegis Energy, Tecogen, LC Associates, GEM Energy, and RSP Systems.