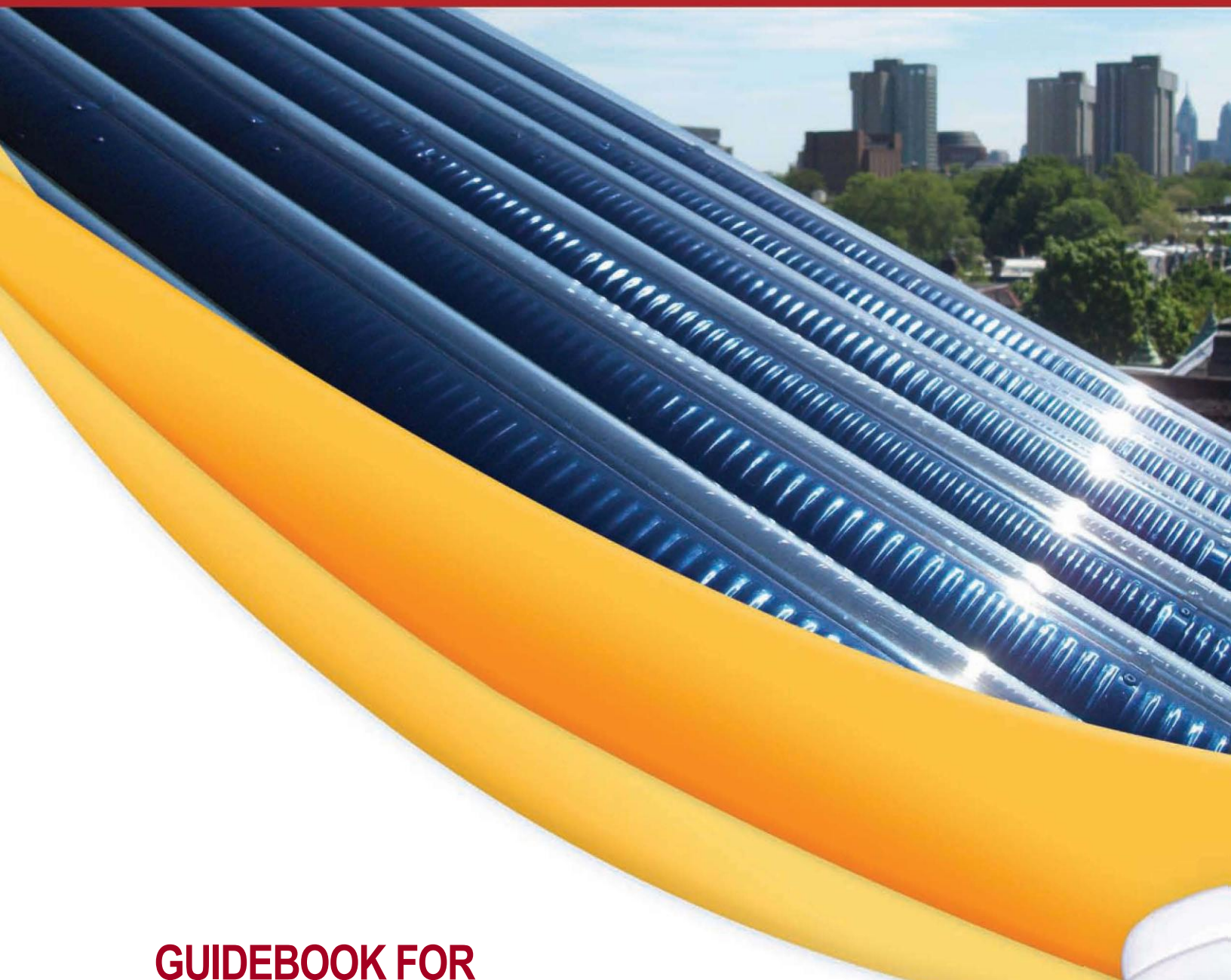

GUIDEBOOK FOR

SOLAR WATER HEATING PROJECTS

IN PHILADELPHIA

December 2011 First Edition

SOLAR AMERICA CITIES

City of Philadelphia
LIFE • LIBERTY • AND YOU™

GREENWORKS PHILADELPHIA

NOTICE

Available electronically at: http://www.phila.gov/green/solar.html.

ACKNOWLEDGMENTS

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Philadelphia's Mayor's Office of Transportation and Utilities

Philadelphia's Mayor's Office of Sustainability

Philadelphia Office of Licensing and Inspection

Philadelphia Zoning Code Commission

Pennsylvania Department of Environmental Protection

Philadelphia's Department of Licenses and Inspections

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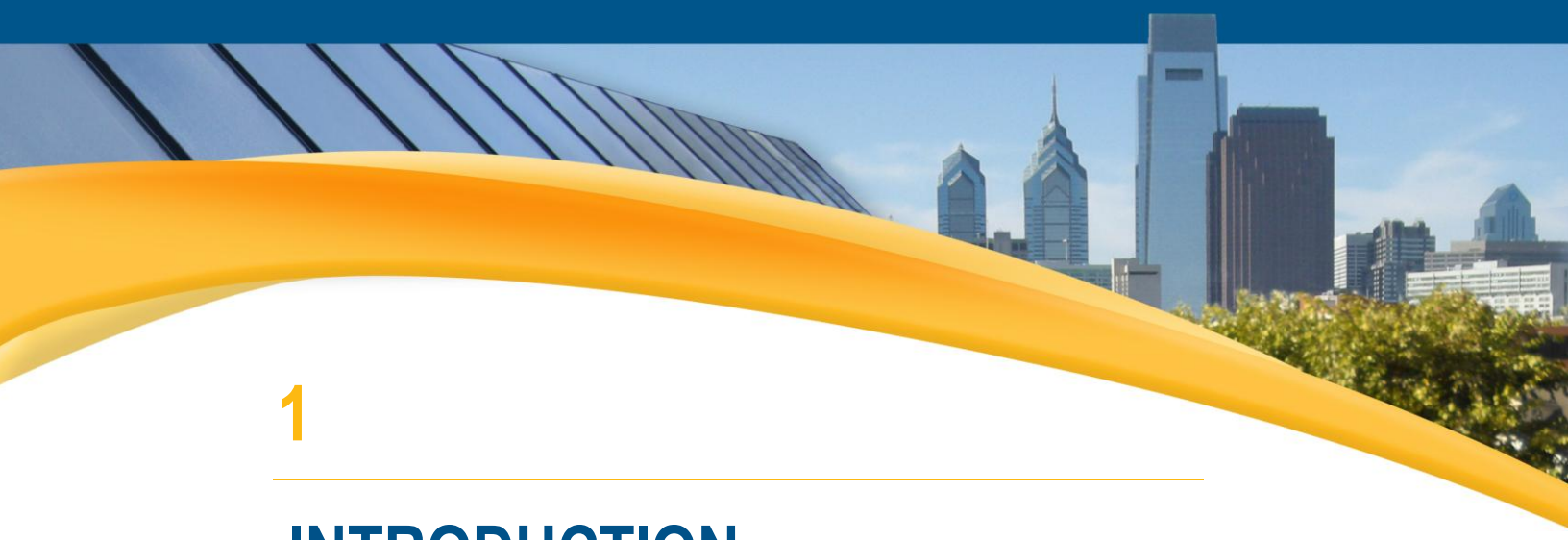


1

INTRODUCTION

A free and abundant resource, solar energy provides homes and businesses with an opportunity to save money and reduce their environmental footprint. The Mayor's Office of Sustainability and the Office of Transportation and Utilities has committed to helping the City of Philadelphia take advantage of the benefits of solar energy. In 2008 the Office began researching municipal sustainability and in 2009 released an ambitious Greenworks Philadelphia plan that sets 15 sustainability targets in the areas of energy, environment, equity, economy, and engagement, with the goal of making Philadelphia the greenest city in America by 2015.

Through the U.S. Department of Energy's Solar America Cities partnership, Philadelphia is one of 25 major U.S. cities working to accelerate the adoption of solar energy technologies for a cleaner, more secure energy future. Through the Solar America Cities partnership, Philadelphia created the Solar Photovoltaic Guidebook. This Guidebook is designed for developers of residential and commercial solar photovoltaic (PV) energy systems and addresses procedures for planning, siting, permitting, interconnecting, metering, and implementing solar installations. Due to funding limitations, the City was not able to include solar water heating systems in this version of the Guidebook.

In the fall of 2011, the City of Philadelphia received funding to create a comparable solar water heating guidebook and to streamline the permit process. The following Solar Water Heating Guidebook is part of this effort. Designed for developers of residential and commercial solar water heating systems, the guide will help you to plan, site, permit, and install a solar water heating system. It also provides helpful additional resources to learn more about the technology.

2

SOLAR WATER HEATING BASICS

This section of the Appendix provides an overview of solar water heating (SWH) technologies and systems.

This section will answer the following questions:

- How does a solar water heating system work?
- What types of solar water heating technologies are commonly installed for residential and commercial buildings?
- What should an installer look for during a site assessment?

2.1 How does a solar water heating system work?

Solar water heating (SWH) systems capture the sun's heat energy and use it to heat water or other liquids. A system collects the sun's energy using a solar collector. That energy is then transferred into a water storage tank, similar to those used by a conventional water heater.

2.1.1 System collectors

There are two common types of solar collectors used for residential and small commercial applications: flat plate and evacuated tube collectors.

Figure 2-1: Solar Water Heating System
Source: U.S. Department of Energy

- *Flat plate collectors* are the most common and cost effective type of collector for domestic solar water systems. These collectors are insulated, weatherproof boxes that hold an absorber plate. The sun heats this plate and transfers the heat to a heat transfer fluid flowing through tubes in or near the plate. Flat plate collectors can typically produce temperatures up to 180 degrees F and in sunny warm conditions can have efficiencies in the 65% to 78% range, but lose effectiveness when it gets extremely cold or cloudy.[1]
- *Evacuated tube collectors* are a parallel series of rows of transparent glass tubes that surround rows of absorbers. The air in the tubes is then removed (evacuated) to form a vacuum. This reduces heat loss and increases efficiency and, as a result, evacuated tube collectors can reach temperatures of up to about 300ºF. Evacuated tube collectors will typically have top efficiencies in the 40% to 55% range, but retain their effectiveness better in extremely cold weather.

[1] More information about the performance of some systems can be found at http://www.solar-rating.org/

2.1.2 Additional system components

In addition to the collectors, SWH systems require a hot water storage tank(s). In a two-tank system, the water is preheated in the solar tank using heat exchangers before entering the original hot water heater. In a one-tank system, the solar heat exchanger is built into a single tank.

A circulating pump circulates the heat transfer fluid from the collectors on the roof via insulated pipes (typically copper) and additional plumbing connectors. Temperature sensors are usually installed in the collector and water tank. These are connected to a controller, which turns on the pump when fluid in the solar collector is approximately 15°F hotter than the water in the tank. Systems may also contain an expansion tank, a safety measure that can relieve excess pressure in the system if it gets too hot. In addition, some controllers can measure the amount of energy being produced by the system.

2.1.3 Types of solar water heating systems

Solar water heating systems can be divided into two categories: active and passive. Active systems use pumps to circulate a heat-transfer fluid through the collectors, while passive systems rely on gravity to circulate water through the system.

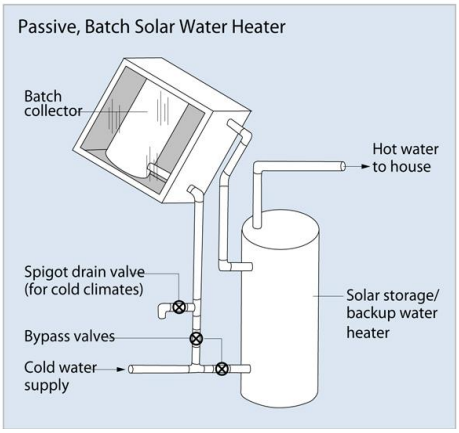


Figure 2-2: Passive solar water heating system

Source: U.S. Department of Energy

Passive systems

Passive SWH systems do not use a pump to circulate water from the solar collector to the water storage tank. In their most simple form, passive systems are usually water storage tanks located inside of an insulated box with a glazed surface. When the sun shines the water in the tank heats up and flows to the solar storage tank via gravity.[2] Although less expensive than active systems, passive solar water heaters are better suited for areas without cold weather, since frozen water can cause pipes to burst.[3]

Active systems

There are generally two types of active solar water heating systems: direct circulation systems and indirect circulation systems.

- *Direct circulation systems* pump potable water through the solar collectors and into the home's water heater. Because the system is pumping potable water into the collectors, they are more appropriate in areas that do not have extended periods of freezing and that do not have hard or acidic water.[4]
- *Indirect circulation systems*, in contrast, are much better suited for cold-weather climates like Philadelphia because they pump a heat-transfer fluid through the collectors. The heated fluid is then pumped through a heat exchanger in an insulated water heater, where it transfers the heat from the fluid to the potable

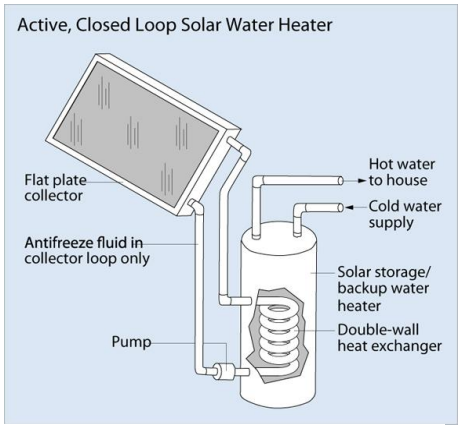


Figure 2-3: Active solar water heating system

Source: U.S. Department of Energy

[2] http://www.eere.energy.gov/basics/buildings/water_heaters_solar.html

[3] For more information on different types of indirect systems, visit the US Department of Energy Solar Basics page: http://www.eere.energy.gov/basics/buildings/water_heaters_solar.html

[4] http://dnr.mo.gov/energy/renewables/solar6.htm

water. Most systems use a non-toxic food-grade propylene mixed with water; in areas where hard freezes are common the mixture contains a high concentration of glycol to prevent freezing. Drainback systems circulate water through the collectors. The water in the collector loop drains into a reservoir tank when the pumps stop. This makes drainback systems a good choice in colder climates. Drainback systems must be carefully installed to assure that the piping always slopes downward, so that the water will completely drain from the piping.

Solar water heating systems almost always require a backup system for cloudy days and times of increased demand. Conventional storage water heaters usually provide backup and may already be part of the solar system package.

The Solar Rating & Certification Corporation (SRCC) is an independent third-party certification organization that administers national certification and rating programs for solar energy equipment. The ratings provide a thermal energy performance rating which provides the energy output under standard test conditions which allows the consumer to compare collectors. All collectors which have been certified by SRCC will bear the SRCC label.

2.2 Solar water heating applications

SWH systems can be used for a variety of residential, commercial or industrial applications, including heating air, water, or generating steam. SWH systems that heat water can be installed in single- or multi-family residences, offices, industrial buildings, schools, hospitals, or wherever there are hot water demands. Systems can also be used to provide hot water for pools, making them a cost effective way to extend the pool season.

2.2.1 Philadelphia case studies

The following are two case studies of solar water heating systems that have been installed in Philadelphia.

PHILADELPHIA SOLAR WATER HEATING CASE STUDY:

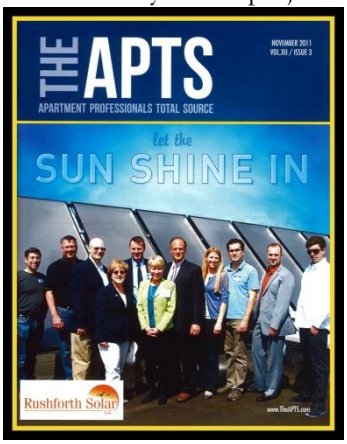
LONGWOOD MANOR

A past president of the Apartment Association of Greater Philadelphia, Alan Lindy knew his three large apartment buildings were a great fit for a solar hot water installation. Each building is oriented on an east/west axis, allowing the panels to face due south and collect the most solar energy. With 40 units in each building, there is a high demand for hot water throughout the day. The panels are highly visible from Roosevelt Boulevard in NE Philadelphia, allowing Lindy to advertise his building's green credentials. The system was installed by Rushforth Solar, a local Philadelphia area solar water heating installer.

The Solar Hot Water project was broken into 2 phases, with the first two buildings installed in May and the third in December 2011. While the gross cost for Solar Hot Water with High Efficiency Heaters was initially $222,400, the 30% federal tax grants of $62,520 and two PA Sunshine Grants totaling $72,940 helped bring Lindy's pre-tax cost to $86,940. Natural gas savings from the combined project should be about 8,400 CCF per year or about 43.5 tons of CO^2 per year. The payback after subsidies but before accelerated depreciation on this system is projected to be between six and seven years. Paybacks that were often five to eight years with the PA Sunshine grants of $35,000 up to $50,000 will be longer, now that the PA grant program has run out of funds.

Project Snapshot

- Three apartment buildings with 40 units in each building.
- 16 solar collectors installed on each building.
- 1,800 gallon storage tank in each building.
- Each system saves an estimated 2,800 CCF (hundred cubic feet) of natural gas a year. Combined, the three systems will offset 8,400 CCF per year!

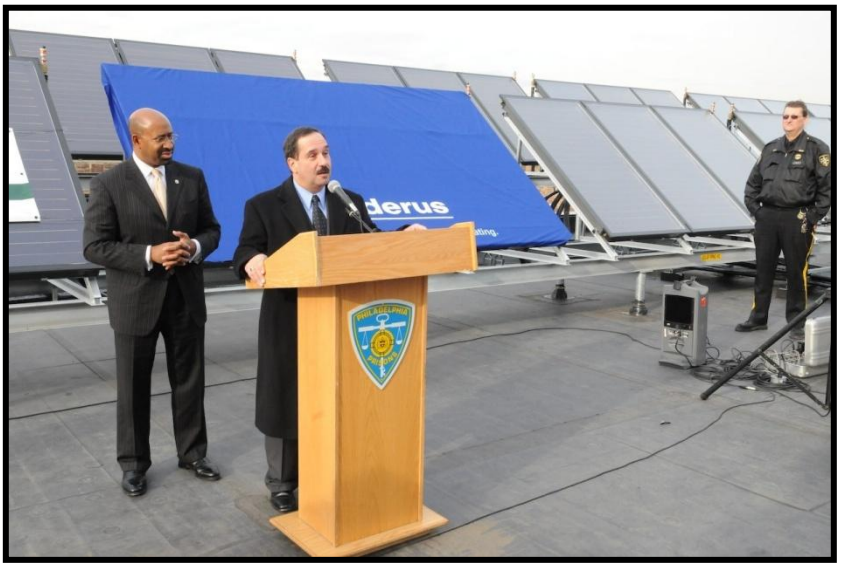


Longwood Manor was featured in the November 2011 issue of *The APTS* (Apartment Professionals Total Source) *Magazine*, which highlighted how solar water heating systems are particularly well suited for apartments with central water heating facilities and large hot water demands. Hotels, nursing homes, assisted living facilities, car washes, and health and fitness facilities are also great locations for solar water heating systems.

Images courtesy of Rushforth Solar, LLC

PHILADELPHIA SOLAR WATER HEATING CASE STUDY:

RIVERSIDE CORRECTIONAL FACILITY



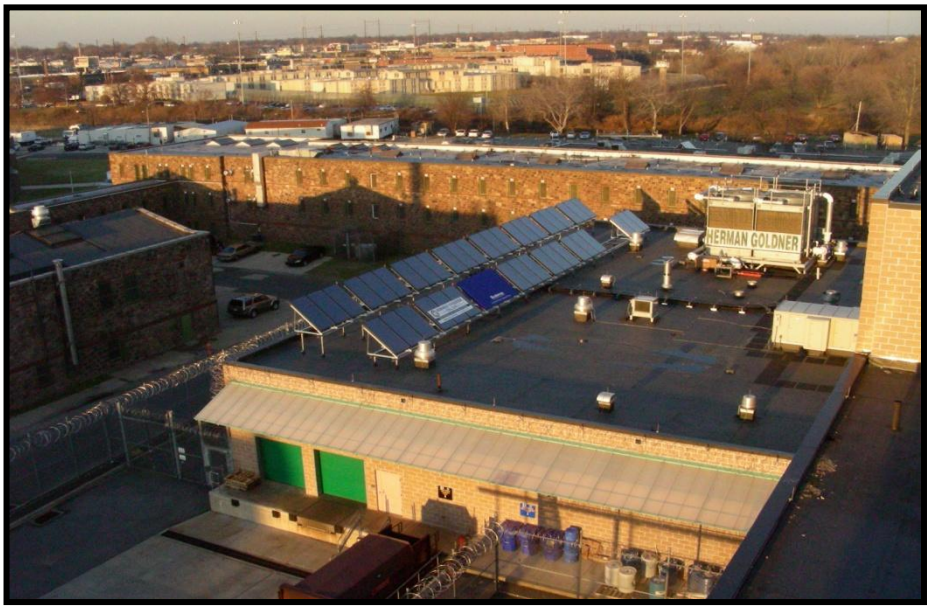
On December 4, 2008, Mayor Nutter unveiled the roof-based solar water heating system at Philadelphia's Riverside Correctional Facility. Estimated to save the facility about $1.1 million dollars over the 25 year lifetime of the collectors, the system will provide a 20 to 25% annual savings on the cost to heat water.

The Riverside Correctional Facility currently supports an average daily population of 800 inmates, as well as provides housing, admissions, diagnostic services, and treatment for all women who are incarcerated in Philadelphia. The systems 45 solar collectors and 15 insulated 105-gallon solar indirect storage tanks allow the facility to better meet hot water demands for laundry, cooking, cleaning, and personal hygiene. They also replace existing inefficient water heating tanks helping the institution save additional money on energy efficiency.

Project Snapshot

- 45 solar collectors
- 15 insulated 105-gallon tanks
- Total cost of $665,000
- Payback period of 9 years
- Total system savings over 25 year lifetime of $1.1 million dollars

Engineers faced a number of challenges when installing the system. Most notably, they had to remove the old water heating system and install the new solar tanks without interrupting the building's hot water supply. They also had to design the systems to fit into the building's existing boiler room, which was very small. Larger solar water heating projects often require additional engineering and design work and some larger solar installation firm often retain engineers on staff.



2.3 Is solar right for you?

Solar water heating systems are an excellent way to reduce heating bills and contribute to local efforts to protect the environment. However, not all homes or businesses are suitable locations for a system. Before committing to an installation it is important to talk to a local installer about your site, where a system could be placed and how it should be sized.

2.3.1 Siting a system

When considering a SWH system, it is important to determine whether a solar system is a good fit for your home or building. Usually an installer or project developer will come to your home and survey your location before providing a bid. The goals of a site assessment are to:

- *Identify the optimal placement for the collectors.* Ideally collectors should be oriented due south plus about 5 degrees (slightly favoring the afternoon sun when it is warmer and the collectors will work slightly more efficiently), although a variation of up to 30 degrees east or west will not dramatically reduce the panel's performance. If the system is sized to match normal summer loads, panels should ideally have a tilt that is roughly equal to the latitude of the region. If the system is oversized to attempt to better heat production in the cold months, a higher tilt is recommended to better scoop up the low winter sun, and to shed some of the excess summer heat (that could otherwise cause overheating). Most solar collectors are flat mounted onto a tilted roof and therefore will have the same tilt as the roof.
- *Determine whether the collector would be shaded during peak sunlight hours.* Peak sunlight hours are usually 9am to 3pm and installers can use a number of tools to identify areas that may be shaded during the day. Common tools include the Solmetric Sun Eye, the Solar Pathfinder, and the Acme Solar Site Evaluation Tool (Wiley Electronics).
- *Determine the best method to mount the collectors.*
- *Identify any structural issues that could impact the cost of the system's installation*. Structural issues may arise if the roof is old or has been damaged in a way that would compromise its ability to support the collectors.
- *Determine where to locate the system water tank(s) and auxiliary equipment*, as well as where to install pipes connecting the collectors to the water tanks.
- *Determine how the system's plumbing will interface with the building's existing plumbing.*
- *Identify any aesthetic or citing concerns the building owner may have.*
- *Confirm that the home or building owner has permission to install a system.* Sometimes a homeowners association may require approval before a resident can install a system.
- *Verify that there are not any existing or proposed uses for the adjoining space that may impact the system's performance.* For example, new construction next to a customer's home may shade the proposed site in the future.

2.3.2 Sizing a system

Solar water heating systems are typically sized based on the number of people residing in a household. Contractors often follow a guideline of about 20 square feet of collector area for the first two family members and 12-14 square feet for each additional person. In practice, two 4 by 8 foot flat plate collectors (64 square feet) usually provide enough heat for the majority of

households. Smaller households may not use all of the heat from the two panels, but the incremental cost of an additional panel is usually justified because it is only a portion of the full cost of installing a system. For active systems, the size of the solar storage tank increases with the size of the collector, typically 1.0 to 1.5 gallons per square foot of collector. Because storage tanks are sized to be 60, 80, or 120 gallons, an installer will select the tank size that best fits the area of the collectors.

A system is typically sized to provide close to 100% of the household's hot water demands during sunny summer weeks. In the winter, less solar heat is generated and a back-up water heater provides the extra energy. Over the course of a year the system may provide between 50 and 80 percent of the household's total hot water usage. While it may be possible to size a system to meet nearly 100% of your household's hot water needs year round, the cost of doing so may make the system prohibitively expensive.

Maintenance Activities and Costs		
Activity	Frequency	Cost
Change antifreeze heat-exchange fluid	Every 3-5 years	$100-$200/ 5 years
Replace pump	After 10-15 years	$100-$300

2.3.3 System maintenance

Once installed, solar water heating systems require minimal maintenance. Over the 30+ year lifetime of a solar hot water installation it is estimated that the homeowner will need to replace the water pump after 10-15 years, at a cost of $100-$300. Additionally, excess heat can cause the glycol mixture in indirect systems to deteriorate and corrode system components. Homeowners should have their glycol checked and changed (if necessary) every 3-5 years. This typically costs about $100-$200 per visit.[5] Drainback systems typically will not use glycol allowing this periodic glycol check to be skipped.

2.4 Purchasing a solar water heating system: a guide for customers

When considering a solar water heating system for your home or business it can be helpful to know what to expect from your solar installer. You can make sure you are getting the best installation by asking potential installers the following information:

- *What will the system cost? What is the payback period for the system?* A system's payback is the number of years it will take for you to earn back your investment in the upfront cost of the system. Once you've earned back the cost of your system, you're basically heating your water for free!
- *Does your company provide financing opportunities?* Some solar installers can offer financing or other payment options to help make your system more affordable.
- *Is my system eligible for any incentives?* Your solar installer should know if you are eligible for any local, state, or federal tax credits or incentives. You can also visit www.dsireusa.org to learn about incentives.
- *What type of system will be installed?* Your installer should provide information on the type of solar collectors and the solar storage tank. Some systems will connect to your existing water heater, while others will consist of an entirely new solar hot water tank.

[5] http://www.greeninstitute.org/pdf/Solar%20Pioneers.pdf

- *Will my system be under warranty?* It's important that you purchase a new system that is under warranty by the manufacturer. Installers should also provide a warranty on installation labor.
- *Is my system a good fit for Philadelphia's climate?* You want to make sure your solar installer chooses a system that has adequate freeze protection in the winter.
- *What type of heat transfer medium will the system use?* The heat transfer medium takes the energy collected by the system's panels and delivers it to the solar water tank. It is usually either water or a food-grade glycol mixture. Systems designed for areas with freezing weather typically use a glycol mixture to prevent freeze damage. If your system uses water as a heat transfer medium the system will need to be drainedwhen the weather is cold.
- *Where will the system be installed?* It is important that systems are located away from any nearby trees or structures that could shade the collectors and reduce their efficiency.
- *How will the system be attached to my roof?* Installers should be sure any installed collectors can withstand a wind load of up to 85 mph. The proposed system design should also provide enough information to clearly verify the size, type and spacing of all fasteners.
- *Who will be doing the installation work? What is their experience with solar water heating?* It is important to find an installer who is experienced with solar water heating technologies and can install your system safely and efficiently. Installation teams usually include a licensed plumber and possibly a licensed electrician.
- *What type of maintenance is required?* The contractor should verify that the system is operational after installation and provide the owner with an Operating Manual. Periodic maintenance may include inspection and cleaning of the panels every year, replacement of the glycol mixture or addition of de-scaling solutions every few years.

2.5 Installing a solar water heating system: a guide for installers

Installing a solar water heating system correctly is very important. There are many variables in installing systems since there are multiple systems types from a variety of manufacturers. The following is a general guide to the basic steps for installing a closed-loop solar water heating system with a glycol heat exchanger. More detailed information, including asolar water heating installation training course, is available online at www.pasolar.ncat.org/lesson02.php. Additional resources on system installation are listed in Section 5 of this Guidebook.

Basic guide to installing a solar water heating system

1. Mount the solar collectors on the roof.

   When mounting collectors, it is best to penetrate the roof as few times as possible. Mount the collectors on the roof near the edge and then run the piping through a vertical wall.

   Install the solar storage tank and heat exchanger next to the conventional water heater. Ensure that the glycol loop connections and cold and hot water connections can be easily accessed. Install the piping and pump for the glycol loop.

   Within the glycol loop, install the pump at the lowest point and connect into the piping that leads to the collectors on the roof. There should also be a check valve installed at the pump outlet to prevent glycol from flowing backwards through the loop when the pump is turned off.

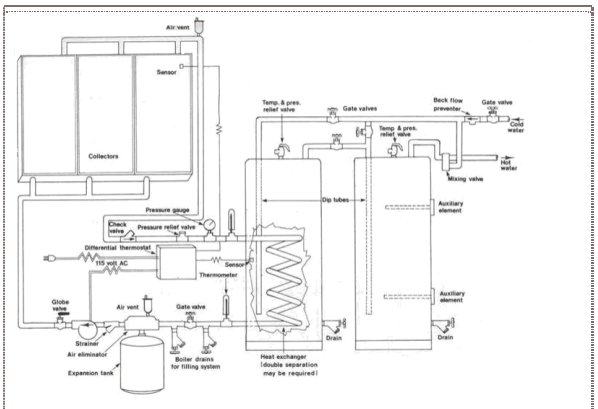


Image courtesy of Pennsylvania Weather Providers

2. Install the water piping.

   Once the glycol loop has been installed, plumb the cold water inlet into the solar storage tank and connect the outlet of the solar storage tank to the inlet of the existing water heater. Include valves and unions on all inlets and outlets.

3. Install the controls.

   When installing the system controls, the differential controller must be able to sense the temperature difference between the water at the bottom of the solar storage tank and the glycol at the top of the solar collectors. The sensors can be attached to the pipes with hose clamps.

4. Fill the system.

   It is important to first fill the closed loop glycol system with water to check for leaks. After filling, let the system stand for eight hours and if the pressure in the loop has dropped there is a leak that must be found and repaired.

5. Insulate the water and glycol lines.

   After the system has been checked for leaks, carefully insulate all of the glycol and water lines. Use standard foam pipe insulation for water piping, but the glycol piping and external heat exchangers should be insulated with fiberglass pipe insulation.

6. Optional additions include: a bypass valve which can be installed to bypass the conventional water heater to provide hot water exclusively from the solar water heater during summer months; a tempering valve installed after the conventional water heater to avoid risks of scalding temperatures, and a high-temperature radiator loop to "dump" energy in case the glycol loop gets too hot.

2.6 Inspecting a solar water heating system: a guide for inspectors

Despite the fact that the number of installed solar water heating systems has increased dramatically in recent years, some code inspectors may be less familiar with the technology. The following checklist can serve as a generic guide for inspectors to better understand the types of things to look for when reviewing a solar water heater installation.

Overall

- Is the system operational? There should be temperature sensors that show the collector and tank temperatures, as well as indicators that the pump is operational.
- Have all the collectors, pumps, and heat exchangers been connected properly and not in the reverse direction?
- Are there any leaks present at intake valves, connection points, along pipes, or at the collector? Are there any leaks or fluid present on the roof?
- Has the owner received a copy of their owner's manual? Does it include information about the system warranty, operation, maintenance requirements, and who completed the installation work?

Collectors

- Do the collectors have a label that indicates the manufacturer and model number?
- Are the collectors well-oriented to take advantage of the sun? The ideal surface orientation factor (SOF) of a collector is 1, which is achieved when a collector is facing due south and tilted at between 35 and 45 degrees. A system that is oriented more than 90 degrees away from due south will not produce the expected level of energy savings.
- Is the system shaded? Ideally the collectors will remain unshaded between 9am and 3pm throughout the year. You can use a Solar Pathfinder or other tool to determine if there will be shading throughout the day.
- Are the collectors positioned so that runoff from the collector surface or liquid from a pressure relief valve will not damage or erode the roof?

Solar tank

- Is the solar tank sized correctly to match the size of the system collectors? For a two tank system, the solar tank capacity should be at least one gallon of storage for every square foot of collector. For a one tank system, the solar tank capacity should be at least 1.25 gallons of storage for every square foot of collector.
- Does the tank temperature exceed the tank's high temperature limit? It is important that tanks do not overheat and that an emergency release valve is present if accidental overheating occurs.
- Does the solar tank have a drip pan with a drain line that can safely drain any excess liquid?
- Is the system equipped with a mixing valve that can prevent scalding water from reaching the end-users?

Piping

- Is all accessible hot water piping insulated? This should include the hot supply line from the auxiliary water heater and all exterior piping.
- Is all piping sloped correctly to ensure the system drains correctly?

Sensors and wiring

- Does all wiring meeting electrical code? Is it properly fastened to protect against mechanical damage?
- Are all of the system's wires, connections, sensors, and pneumatic lines protected? Any sensor wiring should be protected from wind, moisture, temperature, and other factors that could impact their ability to sense information.

Freeze protection

- Does the system have adequate freeze protection for Philadelphia's climate? System suppliers usually specify a temperature limit for each system model (often called a "freeze tolerance limit"). Some systems will have automatic freeze protection, while others will require manual intervention (i.e. draining or changing valve positions). Systems that require manual intervention should have a freeze tolerance limit label that states when and how the owner should take action to prevent freezing. System component and piping that may be subject to freezing should also have insulation and/or fittings and pipe slope to ensure that freezing will not cause damage.

3

SOLAR WATER HEATING INSTALLATION PROCESS CODES AND REGULATIONS

This section of the guide provides information on the installation process and the types of permits required for a residential or commercial system.

This section will answer the following questions:

- What are the key steps in the solar installation process?
- What licensed contractors are required?
- What permits and applications must be submitted?
- What are the applicable codes and regulations?
- What are the L&I permitting processes?

3.1 Solar Installation Process Overview

Once a property has been thoroughly assessed by a qualified solar contractor and has been identified as a feasible site for a solar SWH system, there are five key steps to implementation of the solar project. Each step is briefly described below:

- **Step 1. Assembling the Project Team.** In order to procure all the necessary permits and approval applications that are required to implement a SWH system, a property owner should contract with a solar installer who will subcontract with a licensed Philadelphia plumbing and/or electrical contractor. It is recommended that the solar installer also be an approved member of the Pennsylvania Sunshine Solar Program.

- **Step 2. Preparation of Design Plan.** In this step, the solar contractor prepares a design plan that is specific to the building structure and that meets the energy requirements of the property. The plan should include the safe and orderly handover of the unit from the installer to the owner, guaranteeing its operability in terms of performance, reliability, and safety as mentioned in Section 2.4, System Installation, of this guidebook. This plan must meet all applicable codes and regulations as further presented in this section of the guidebook.

- **Step 3. Application Submittals.** For residential and commercial systems, the solar contractor prepares permit applications that must be submitted to:

    - The Philadelphia Department of Licenses and Inspections (L&I) for building and, if applicable, the electrical and plumbing permits. (Note: The contractor should verify zoning permit applicability, as in some cases a zoning permit may also be required. See Section 3.3 for details.)

- In an effort to consolidate permit requirements for SWH systems, the L&I department does not require a plumbing permit and all information must be on the building permit application. The contractor must still use a licensed plumber for all plumbing connections. See section 3.3 *City of Philadelphia Requirements* for details.
- If pursuing a rebate through the Pennsylvania Department of Environmental Protection's (PA DEP's) Solar Sunshine Program, the solar contractor prepares applications that must be submitted to the Program.

- **Step 4. Application Review.** Each agency reviews the applications that are submitted, assesses the appropriate fees, and issues a permit. Once *all* the permits/approvals have been obtained, installation can begin.

- **Step 5. Installation and Inspection.** The solar contractor installs the SWH system and arranges for:
  - Building inspection (which includes a plumbing inspection). The following sections explain the permitting and approval process that all solar water heating installations must follow with the City of Philadelphia's Department of Licenses and Inspections (L&I).
  - If applicable, and if pursuing a rebate and randomly selected, inspection by the State Solar Sunshine Program's 3rd party inspectors.

3.2 Licensing and Codes Requirements

Codes regulating SWH installations include the construction code (Uniform Construction Code for the Commonwealth of Pennsylvania) and the zoning code (The Philadelphia Code). The City of Philadelphia maintains its own Plumbing Code and all installations must meet the requirements of the Philadelphia Plumbing Code. The Pennsylvania State and Philadelphia City Electrical Codes are incorporated within the UCCCP and are based on the NEC, with some differing or additional requirements particular for Philadelphia. While there is a specific section (Article 690) of the NEC that is dedicated to PV systems, the majority of the remainder of the NEC is also applicable to solar water heating systems.

3.2.1 Licenses/Registrations Required in Philadelphia:

- **State Home Repair Registration** (by the State Attorney General's Office) for projects on 1-2 family dwellings and for contractors who perform at least $5,000 worth of home improvements – *State Requirement.*

- **Business Privilege License** (by L&I) for all companies associated with any project within the city of Philadelphia – *City Requirement.*

- **Contractor's License** (*City Requirement* by L&I) for all projects that are:
  - Not performed by an electrical or plumbing contractor.
  - Performed on all projects other than 1 and 2 family dwellings.

- **Electrical Contractor's License** (by L&I) for all projects involving electrical work – *City Requirement.*

- **Plumbing Contractor's License** (by L&I) for all projects involving plumbing work – *City Requirement.*

- **Approved List of Solar Contractors** (by the PA DEP Solar Sunshine Program) recommended for all projects, required for projects pursuing state rebates – *State Rebate Requirement.* Contractors must meet insurance requirements as determined by L&I.

The Commonwealth (through the PA DEP Solar Sunshine Program) develops and maintains the Approved List of Solar Contractors for projects that pursue rebates through the program. (Even if a project does not pursue a rebate, it is highly recommended to use a contractor from this List because it provides some level of assurance to a property owner that the contractor has met certain eligibility requirements and has had proper training and/or certification.). The Solar Contractor applies for building permits. As part of the building permit application, the City requires the solar contractor to provide evidence that they are on the Approved List and registered with the Attorney General's Office. (Note: Pennsylvania law requires that all Contractors who perform at least $5,000 worth of home improvements per year are registered with the Pennsylvania Attorney General's Office.)

3.3 City of Philadelphia Requirements

The Philadelphia Department of Licenses and Inspections (L&I) evaluates the need for zoning and grants zoning, electrical, plumbing and building permitting for SWH systems. In an effort to consolidate the permitting process, a plumbing permit will not be required for SWH systems in most cases. A building permit will be required and a licensed plumber must provide oversight of the plumbing installation. The need for zoning permits will be decided upon review (see Section 3.3.3.2 Zoning Requirements for more details) but rooftop solar installations will not require a Zoning permit. Fire Department safety requirements that enable safe emergency response need to be incorporated into the design. The requirements for each permit are discussed separately in this guidebook.

To facilitate the preparation of the various L&I permit applications, this guidebook contains checklists, process flow diagrams and worksheets summarizing the requirements for electrical, building, zoning and plumbing permits (see Appendices C, D, E and F respectively).

3.3.1 Electrical Permit

Electrical permits are required for SWH installations that involve electrical work. A simple plug into an existing outlet will not require an electrical permit. If the electrical work is on a 1-2 family dwelling or is simply the replacement of an electrical fixture (outlet receptacle), then only an EZ permit application is required. All other electrical work including all solar PV-powered pumps will require a standard electrical permit. See Appendix C for the information required to apply for an electrical permit.

3.3.2 Building Permit

Building permits are required for all SWH projects. In an effort to consolidate the permitting process, a plumbing permit will not be required for SWH systems in most cases but a licensed plumber must be used for all plumbing connections. Within the review for building permits, zoning and fire requirements are evaluated. The following three subsections discuss these three requirements.

3.3.2.1 Building Requirements

Standard Building Permits are required for SWH installations. Building permits for the installation are regulated by the Philadelphia Building Construction and Occupancy Code (BCOC). A Standard Permit will require a full plan review and will require 20 business days for review of commercial systems and 15 days for residential systems. A Standard Permit will also require additional calculations to be submitted for review. Appendix D contains the information required to apply for a building permit.

3.3.2.2 Zoning Requirements

Presently, solar installations are allowed in all zones within the City; rooftop systems will not need a zoning permit. However, if a SWH should be ground-mounted it may need to obtain a zoning permit. See Appendix E for the Zoning Permit Checklist for ground-mounted systems. Ground-mounted systems should comply with the setbacks required in the property base zoning designation as noted in The Philadelphia Code. If during the building permit review, a project triggers a zoning review or is in conflict with the zoning code, then L&I will review the permit application, determine that the limitations are exceeded, issue a refusal, and advise the contractor to obtain a zoning variance. The contractor must then apply for a zoning variance from the Zoning Board of Adjustment (ZBA). A ZBA review includes a public hearing and may range in time from several weeks to several months. Zoning restructuring is currently underway, but will not be finalized soon. For further direction on zoning a ground-mounted system, contact the Program Director for Renewable Projects listed on the Mayor's Office of Sustainability webpage.

3.3.2.3 Fire Department Requirements

The Fire Department does not require permits. However, L&I provides comments on SWH systems related to the ability of the fire department to respond to emergencies safely as part of the building permit review. SWH systems shall meet the following fire department requirements:

- Provide four (4) foot clearance around fire department connections.
- Provide three (3) foot clearance around other roof top equipment.

3.3.3 Plumbing Permit

Plumbing permits are not required for SWH installations unless specifically directed by L&I after the Building Permit application has been submitted. However, all installations must be supervised by a Philadelphia licensed plumbing contractor. If a Plumbing Permit is required, the information required to apply for a Plumbing Permit is provided in Appendix F.

4

INCENTIVES FOR SOLAR WATER HEATING SYSTEMS

4.1 Database of State Incentives for Renewables and Energy Efficiency (DSIRE)

The North Carolina Solar Center and the Interstate Renewable Energy Council maintain a database of state, local, utility, and Federal incentives and policies that support renewable energy and energy efficiency efforts. Information is organized by state and is a useful resource when trying to determine if a solar water heating project is eligible for incentives. Visit the site at www.dsireusa.org.

When considering a solar project, make sure to check the DSIRE site to identify if a project is eligible for any local, state, or Federal incentives.

4.2 Federal Incentives

Solar systems are currently eligible for a Federal Investment Tax Credit (ITC) for Consumer Energy Efficiency that allows for a 30% credit on federal income tax returns. The credit is based on the complete cost of the installation before any utility or state rebates are taken. The credit can also be combined with other energy improvements, including the purchase of ENERGY STAR™ appliances.

US Tax credit allows for a 30% credit on federal income tax returns based on the entire installation cost, not just the incremental cost after the Sunshine Program rebate.

Businesses can also recover their investments in solar water heating systems by taking advantage of the federal Modified Accelerated Cost-Recovery System (MARCS). Renewable technologies are typically classified as five-year property under MARCS and businesses can depreciate the value of the system in that time period.

4.3 Pennsylvania State Incentives

The State of Pennsylvania has established the PA Sunshine Solar Program, to encourage solar power to create jobs, promote business development, and stimulate energy independence. The program has made $100 million available through the program to provide loans, grants and rebates to cover up to 35 percent of the cost of installing solar technologies. However, the program is currently (as of August 2011) in the "wait list phase." Customers can continue to reserve rebates for their system but they will not be guaranteed to receive a PA Sunshine rebate.

The Department of Community and Economic Development (DCED) and the Department of Environmental Protection (DEP), under the direction of Commonwealth Finance Authority (CFA), are also administering $80 million for grants and loans for economic development projects in the solar sector. The program will offer support for solar technologies in the form of loans, grants, and loan guarantees. Businesses, non-profits, economic development organizations,

and political subdivisions (e.g. local governments, schools, etc.) are eligible for the funding. Continue to check the websites for future updates.

4.4 City of Philadelphia Incentives

In addition to purchasing green power for city-owned buildings, Philadelphia has developed several incentives to encourage property owners to invest in green power. Currently, Philadelphia offers several incentives:

- **Reduced permit fees:** The City recently passed bills to reduce permit fees for solar energy systems. When electric or building permit fees for commercial solar energy systems are calculated based on the 'construction value', the cost of the solar equipment will not be included in the 'construction value' and fees will be calculated only on the labor costs.
- **Streamlined permit process:** The Department of Licenses and Inspections has consolidated the SWH permit process eliminating the requirement for a plumbing permit in lieu of a building permit.
- **Financing through EnergyWorks Loan Fund:** Homeowners and businesses can apply for low-interest loans through the EnergyWorks Loan Fund. EnergyWorks is a comprehensive energy solutions program which provides an expert building assessment to identify cost-effective energy efficiency improvements in a home or business. Customers can then save energy costs by making these energy improvements at low financing rates.
- **10 year tax abatement**: A 10 year tax abatement on property value increases resulting from solar improvements can be obtained through the City of Philadelphia, Bureau of Revision of Taxes (BRT).

5

ADDITIONAL RESOURCES FOR INSTALLERS

The following is a list of additional resources for installers interested in learning more about solar water heating systems:

- Appendix 6 from FSEC's Solar Water and Pool Heating Manual provides an extensive list of tools needed to install, service, and repair solar water-heating systems.
- The troubleshooting information presented in FSEC's Solar Water and Pool Heating Manual offers methods for diagnosing and correcting problems in solar water-heating system installations.
- Two useful sources from SRCC that provide valuable information on installing a solar water-heating system are OG-300 Solar Water Heating Systems – Installation Guidelines and Training Video for Inspection of Solar Water Heating Systems (the *Outdoor Inspection and Indoor Inspection* segments within this video review system installation from the perspective of an inspector). The transcripts of these segments are available by clicking on the following links:
    - Training Video Indoor Inspection Transcript Training Video Outdoor Inspection Transcript
- Pennsylvania Weatherization Providers offer an online training course to be use as a learning tool for low-income renovation contractors and weatherization providers in Pennsylvania. The course covers solar water heating installation, weatherization, and photovoltaic system installation.

APPENDIX A

GLOSSARY OF TERMS

Azimuth: Azimuth is the horizontal angular distance between the vertical plane containing a point in the sky and true south. The azimuth angle is the location of the sun in terms of North, East, West or South.

Balance of System: The components in a solar water heat system (other than the collectors) that include the auxiliary solar tank, conventional water heater, pump, controller, pipes, and support structure.

Ballasted Mounting: A collector mounting system that holds the collectors to the roof using weights and does not require roof penetrations.

Collectors: An interconnected system of solar water heating collectors that function as a single hot water-producing unit. The modules are assembled as a discrete structure, with common support or mounting. In smaller systems, an installation can consist of a single collector.

Conservation: In the context of energy, using energy resources in such a way as to minimize energy consumption in relation to benefits gained.

Energy-efficiency: The use of a lower level of energy to accomplish the same task.

Life-cycle cost: The estimated cost of owning and operating a solar water heating system for the period of its useful life.

NABCEP: North American Board of Certified Energy Practitioners, the certifying body for solar photovoltaic and thermal installers.

Orientation: A term used to describe the direction that the surface of a solar collector faces. The two components of orientation are the tilt angle (the angle of inclination a module makes from the horizontal) and the azimuth (based on true South, not magnetic North/South).

OSHA: The Occupational Safety and Health Administration. Regulatory body that provides construction standards and are covered in Chapter 29 of the U.S. Code of Federal Regulations, Part 1926, Safety and Health Regulations for Construction. All solar water heating installers should be familiar with OSHA construction standards.

Pennsylvania Approved Solar Contractor: An installer that has been approved to participate in the PA Sunshine Program. A list of approved installers can be found on the DEP website. Installers need to meet certain criteria before being listed.

Sun Chart: A chart denoting the position of the sun in the sky for a particular area with the altitude on the y-axis (typically 0 to 90 degrees) and the azimuth on the x-axis (typically -120 to +120 degrees or East to West). Graphs of the sun's position in the sky can be made at different days of the year and by time of day.

System Commissioning: A quality-oriented process for achieving, verifying and documenting that the performance of a system and assemblies meets defined objectives and criteria.

APPENDIX B

FREQUENTLY ASKED QUESTIONS

Will we need to submit engineering files?
Engineer sealed plans are required for all permits unless the SWH system is a residential systems installed on a non-truss roof. Plans must be hard copy, black and white or blueprint; no electronic or digital files can be accepted.

How long does it take to get the permit/permits?
A standard building permit review can take up to 20 business days (commercial) and 15 days (residential). The building permit must be received before applying for the electrical permit. The electrical permit, if required, could be approved on the same day and typically includes a technical conversation about the installation. It is suggested that the electrical contractor be present for the review. There is always an option for accelerated review of standard submittals for an additional cost.

Who is allowed to pick up the approved permits?
The licensed contractor, licensed electrician or licensed plumber should pick up the permit in case there are any additional questions. Another option is for the licensed contractor to prepare a letter that authorizes another representative to pick up the permit. The representative should bring the letter with them when they pick up the permit.

What are the hours of the L&I department?
The L&I Department is open Monday through Friday from 8:00 am to 4:00 pm. If you'd like to speak with an L&I official, be sure to arrive by 3:30 pm. The L&I building is open until 4:30 pm. The L&I offices close at noon on the last Wednesday of each month.

How do I know if my project will require a zoning permit?
Zoning permits are not required for rooftop SWH systems, but are required for ground-mounted SWH systems.

If I'm NABCEP certified, do I need any other credentials, licenses or registrations to install a SWH system in Philadelphia?
Yes, the City of Philadelphia requires licensing/registration from the following:

- State Home Repair Registration (by the State Attorney General's Office) for projects on 1-2 family dwellings and for contractors who perform at least $5,000 worth of home improvements – State Requirement
- Business Privilege License (by L&I) for projects on 1-2 family dwellings all companies associated with any project within the city of Philadelphia – City Requirement
- Contractor's License (City Requirement by L&I) for all projects that are:
    - Not performed by an electrical contractor
    - Performed on all projects other than 1 and 2 family dwellings – City Requirement

- Electrical Contractor's License (by L&I) for all projects involving electrical work – City Requirement
- Approved List of Solar Contractors (by the PA DEP Solar Sunshine Program) recommended for all projects, required for projects pursuing state rebates – State Rebate Requirement.
- Contractors must meet insurance requirements as determined by L&I.

APPENDIX C

ELECTRIC PERMIT REQUIREMENTS FOR THE CITY OF PHILADELPHIA DEPARTMENT OF LICENSES & INSPECTIONS

EXHIBIT C-1
Electrical Permit Flow Diagram

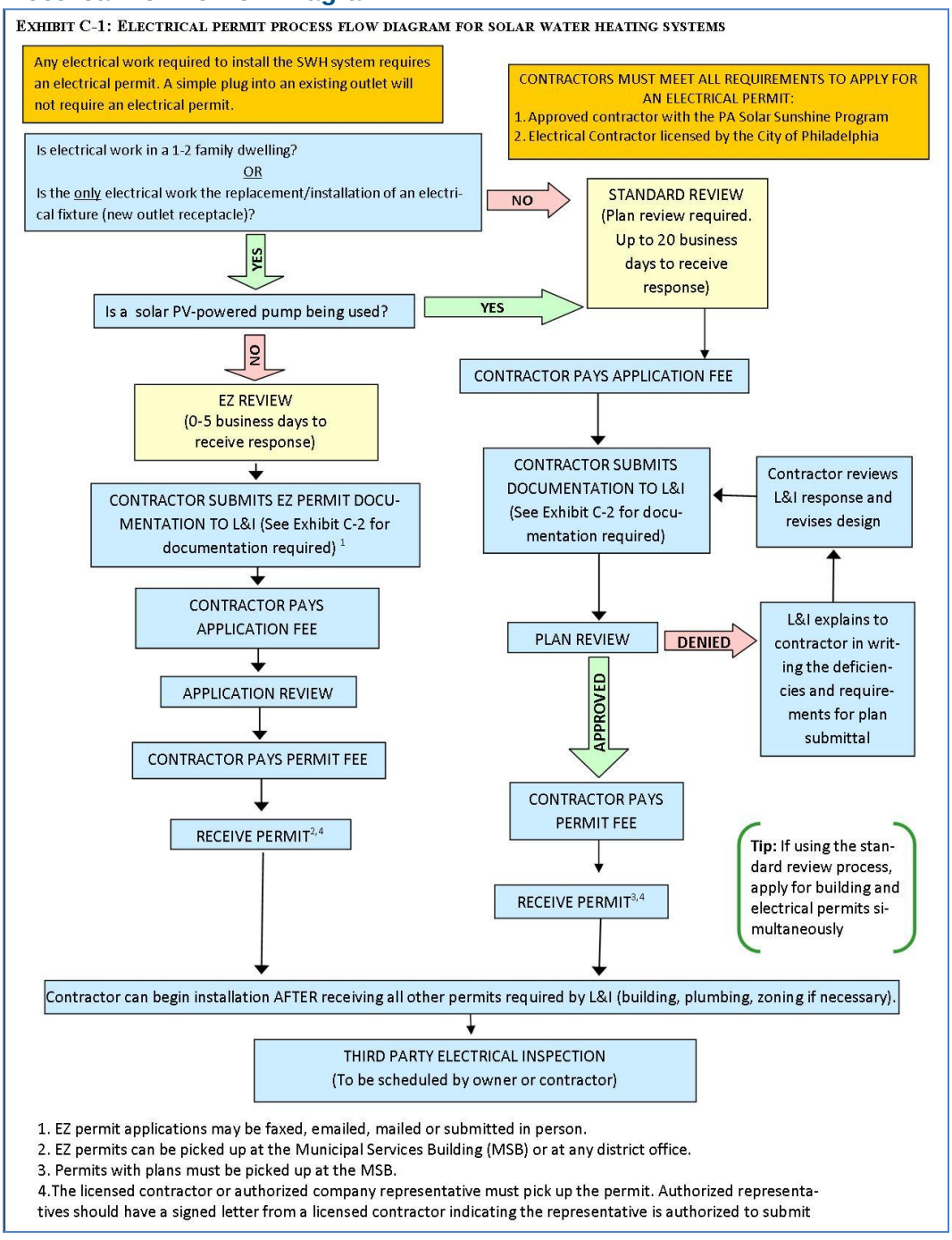


EXHIBIT C-2
Electrical Permit Checklist

Electrical permits may be required for SWH projects if the installation involves any electrical work. The following information must be submitted for EZ Permits and Standard Permits (any exceptions are noted in the requirements).

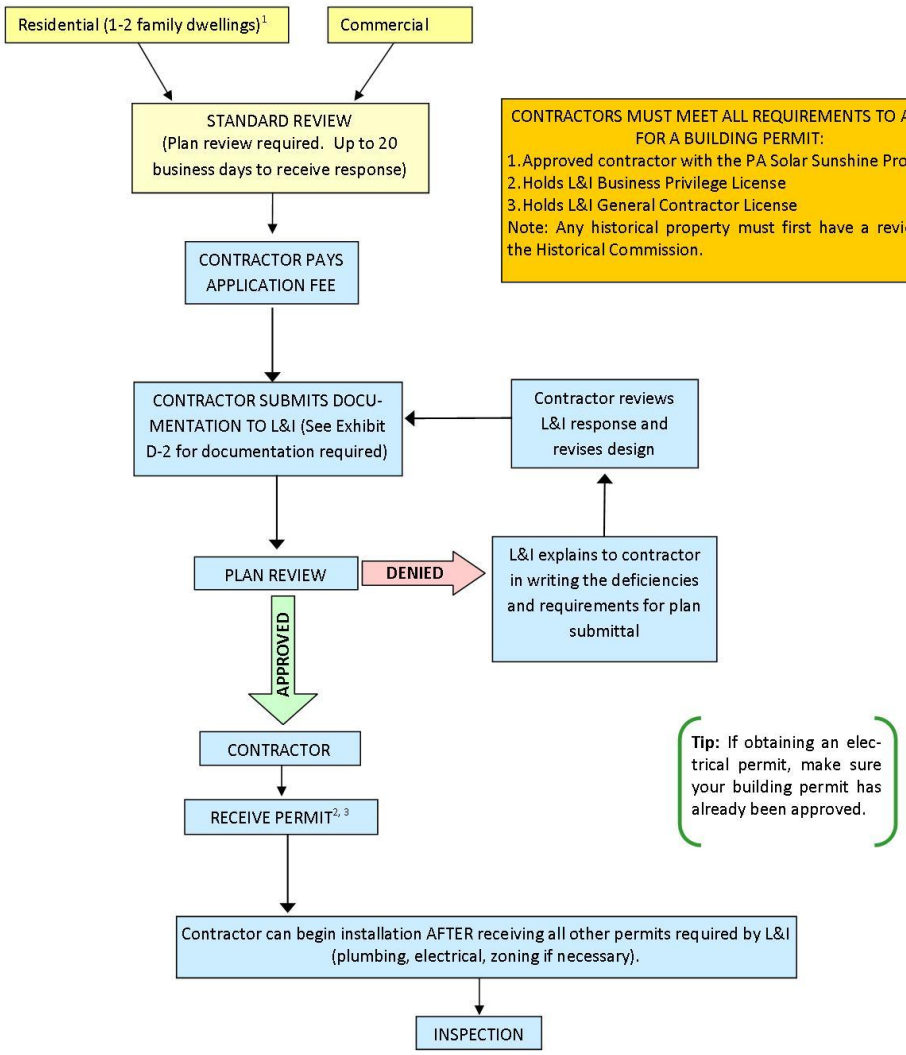
1. You must be a registered licensed Electrical Contractor in order to obtain a permit with the City of Philadelphia.
2. Application for Electrical Permit
    a. Available for download at L&I's Electrical Permit website
    b. Provide the following information on the application:
        i. Location of Property – Provide the house number(s) and street name. [Note: Only addresses issued by the Board of Revision of Taxes will be accepted]
        ii. Explain any alteration or construction [Note: such as added a SWH collector]
        iii. Location of the construction within the building
        iv. List the present use of the existing building.
        v. Provide the name, address, and telephone number of the owner(s), architect, engineer, and the name of the person filing the application. [Note: If you are not the registered owner of the property, you must have the permission of the owner of record to file the application.]
        vi. Electrical Contractor License Number
    c. Standard Permits require more extensive information as detailed in the Electric Permit Checklist on the L&I website.
3. Inspection. Once the permit has been received, the contractor should arrange for a third party electrical inspection.
4. Fees. Fees include filing fees and other applicable fees. A complete listing of the fee schedule is on the website.

APPENDIX D

BUILDING PERMIT REQUIREMENTS FOR THE CITY OF PHILADELPHIA DEPARTMENT OF LICENSES & INSPECTIONS

EXHIBIT D-1
Building Permit Flow Diagram

EXHIBIT D-1: BUILDING PERMIT PROCESS FLOW DIAGRAM FOR SOLAR WATER HEATING SYSTEMS



1. Residential systems do not require sealed plans as long as the collectors are installed on a roof without trusses.
2. Permits with plans must be picked up at the MSB.
3. A licensed contractor or authorized company representative must pick up the permit. Authorized representatives should have a signed letter from a licensed contractor indicating the representative is authorized to submit materials on their behalf.

EXHIBIT D-2
Building Permit Checklist

Building permits are required for all SWH projects. Note that a Plumbing permit is not required for SWH. However, a licensed plumber must provide oversight of the plumbing installation. The following information must be submitted for Standard Permits (any exceptions are noted in the requirements)

1. Application for Building Permit
    a. Available for download at L&I's Building Permit website
    b. Provide the following information on the application:
        i. Location of Property – Provide the house number(s) and street name. [Note: Only addresses issued by the Board of Revision of Taxes will be accepted]
        ii. Explain any alteration or construction [Note: such as added a solar hot water system panel]
        iii. Provide the height in feet and stories of the existing building and proposed panels.
        iv. List the present use of the existing building.
        v. Provide the name, address, and telephone number of the owner(s), architect, engineer, and the name of the person filing the application. [Note: If you are not the registered owner of the property, you must have the permission of the owner of record to file the application.]
    c. A Valid L&I Use Registration Permit and a General Contractor License
    d. Building Plans (3 copies sealed by registered Professional Engineer or Architect). Sealed plans are not required for residential systems as long as the system is installed on a non-truss roof. Otherwise, sealed plans are required. More information on what is required is identified on the L&I website.
        i. Provide the following information:
            1. Drawn to scale
            2. Minimum size is 18" x 24"
            3. Black and White or Blue Prints
            4. Show location of solar collectors on the building/property
            5. Identify roof system
            6. Modifications to existing structure to accommodate solar collector mounting system
            7. Indicate loads that apply to the structure including modification of dead load, uniform distributed live load, concentrated load, roof loads, snow load, wind loads
    e. Design Calculations (2 copies) – for Standard Permit only
        i. Sealed by registered Professional Engineer or Architect
        ii. Calculations shall include all design factors listed in the Uniform Construction
        iii. Code of Pennsylvania – Building Provisions Chapter 16 Structural Design that contributes to the calculations of the loads applied to the design of the structure.
    f. Mounting Hardware Specifications

i. For engineered product designed to mount solar panels, submit manufacturer cut-sheets for mounting hardware. If not an engineered product designed specifically for solar panels, submit details of structural attachment certified by a design professional.

g. Inspections
   i. Once the permit has been received, call to schedule the building inspection. This will also include the plumbing inspection.
   ii. When requesting required permit inspections, specify the permit number, type of inspection, date and preferred time (AM or PM). As an added convenience, Licenses and Inspections District Offices have a customer service standard of inspection within 2 business days for requested permit inspections.

h. Fees
   i. Fees include filing fees, UCC state charges, record retention fees and other applicable fees. A complete listing of the fee schedule is on the website.

i. Backflow prevention - If a backflow preventer is required (see City of Philadelphia backflow prevention requirements), submit the CP-100 form from the Water Department with the Building Permit application. Generally, a backflow prevention device will be required when there is a permanent connection between a potable water and non-potable water/fluid.

APPENDIX E

ZONING PERMIT REQUIREMENTS FOR THE CITY OF PHILADELPHIA DEPARTMENT OF LICENSES & INSPECTIONS

EXHIBIT E-1
Zoning Permit Checklist

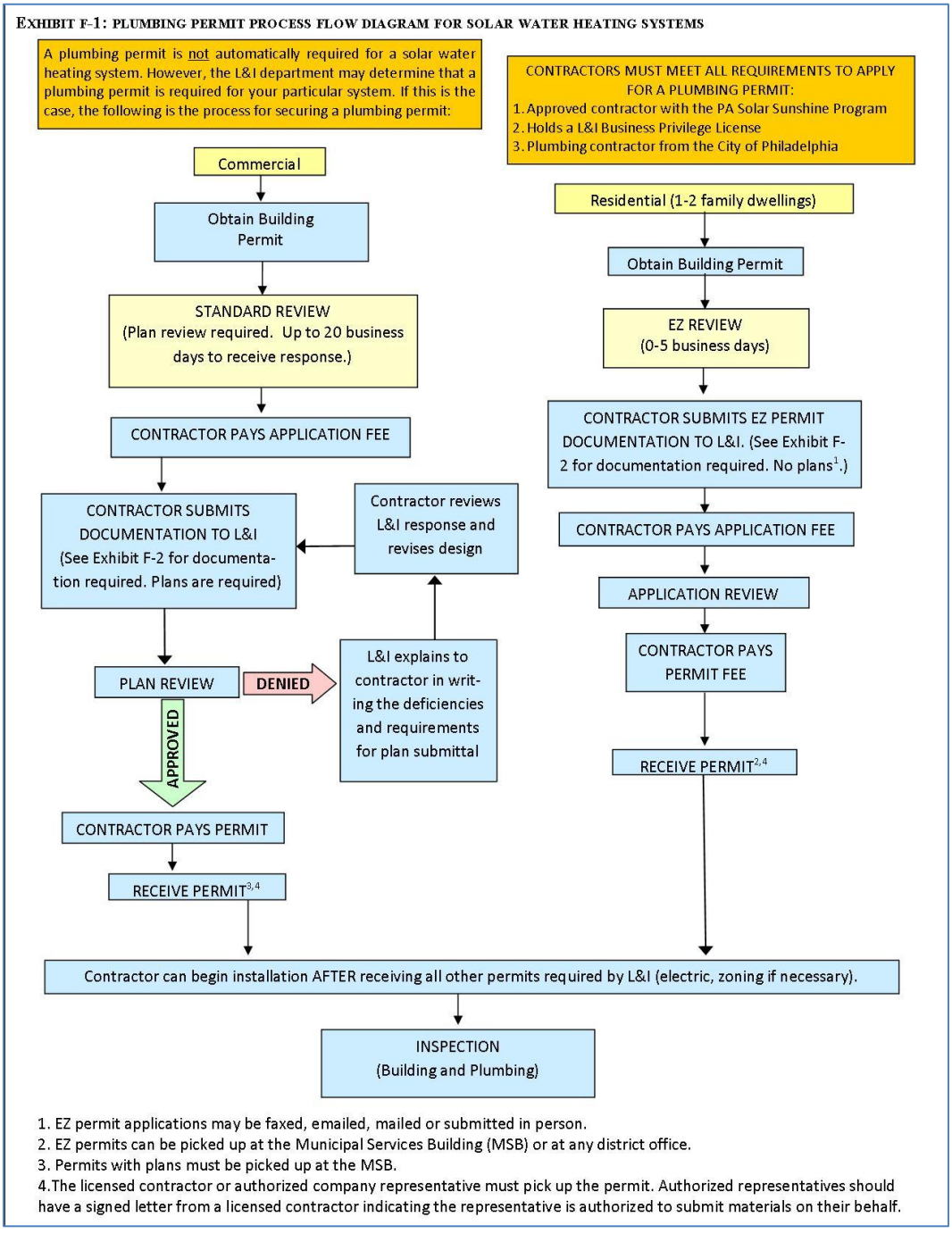
Zoning permits are required for some SWH projects. The following information must be submitted for a zoning permit.

1. Application for Zoning Permit
    - Available for download at L&I's Zoning Permit website
    - Provide the following information on the application:
        - Location of Property – Provide the house number(s) and street name. [Note: Only addresses issued by the Board of Revision of Taxes will be accepted]
        - Explain any alteration or construction
        - List the present use of the existing building.
        - Provide the name, address, and telephone number of the owner(s), architect, engineer, and the name of the person filing the application. [Note: If you are not the registered owner of the property, you must have the permission of the owner of record to file the application.]
        - Prepare a plot plan, which is a scaled drawing of the project, with applicable dimensions. [Note: You must submit six (6) copies of the plan for each individual application form proposing construction]
    - Plot Plan (6 copies)
        - Scale 1" = 10', 20', 40', 50', 60' or 100'
        - Minimum sheet size 11" x 17", Maximum sheet size 24" x 36"
        - Lot lines and dimensions of the property according to the property deed
        - All streets, alleys, or driveways bordering the property
        - Curb lines and their distances from lot lines
        - Exterior dimensions of buildings and structures from lot lines and/or existing and proposed dimensions of other buildings and structures on the same lot
        - Location and dimensions of all driveways and curb cuts, if applicable
        - Name and address of property owner - Signature of applicant

APPENDIX F

PLUMBING PERMIT REQUIREMENTS FOR THE CITY OF PHILADELPHIA DEPARTMENT OF LICENSES & INSPECTIONS

EXHIBIT F-1
Plumbing Permit Flow Diagram



1. EZ permit applications may be faxed, emailed, mailed or submitted in person.
2. EZ permits can be picked up at the Municipal Services Building (MSB) or at any district office.
3. Permits with plans must be picked up at the MSB.
4. The licensed contractor or authorized company representative must pick up the permit. Authorized representatives should have a signed letter from a licensed contractor indicating the representative is authorized to submit materials on their behalf.

EXHIBIT F-2
Plumbing Permit Checklist

In most cases, a Plumbing permit is not required for SWH projects. However, a licensed plumber must provide oversight of the plumbing installation. The contractor also needs to determine whether a backflow preventer is required and if so, supply a CP-100 form from the Water Department. If after submitting the building permit application, it is determined that the plumbing work is more extensive and requires a plumbing permit then the following information would need to be submitted.

1. Application for Plumbing Permit
    a. Available for download at L&I's Plumbing Permit website
    b. Provide the following information on the application:
        i. Location of Property – Provide the house number(s) and street name. [Note: Only addresses issued by the Board of Revision of Taxes will be accepted]
        ii. Provide the name, address, and telephone number of the owner(s), architect, engineer, master plumber completing the work, and the name of the person filing the application. [Note: If you are not the registered owner of the property, you must have the permission of the owner of record to file the application.]
        iii. List the scope of work for the proposed project.
        iv. Explain any alteration or construction [Note: such as added a solar hot water system panel]
        v. Provide the height in feet and stories of the existing building and proposed panels.
    c. A Valid L&I Use Registration Permit
    d. A Valid Plumbing License from the City of Philadelphia
    e. Plumbing Plans are not required for 1-2 family residential dwellings. Write EZ plumbing permit (no plans) on the application
    f. If a backflow preventer is required (see City of Philadelphia backflow prevention requirements), submit the CP-100 form from the Water Department with the Building Permit application. Generally, a backflow prevention device will be required when there is a permanent connection between a potable water and non-potable water/fluid.
    g. Provide Plumbing Plans (3 copies). More information on what is required is identified on the L&I website.
        i. Provide the following information:
            1. Drawn to scale
            2. Minimum size is 11" x 17"
            3. Black and White or Blue Prints
            4. Show location of solar panels on the building/property
            5. Identify all applicable plumbing systems affected by the solar water heating systems.
            6. Plans must be sealed by a Licensed Plumber

2. Inspections

    a. Once the permit has been received, call to schedule the combination building and plumbing inspection. When requesting required permit inspections, specify the permit number, type of inspection, date and preferred time (AM or PM). As an added convenience, Licenses and Inspections District Offices have a customer service standard of inspection within 2 business days for requested permit inspections.

3. Fees

    a. Fees include filing fees and other applicable fees. A complete listing of the fee schedule is on the website.