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Smart Solar™ from
SYSTEM
2000®



Competitive Landscape

Solar Water Heating Appliances

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About Energy Kinetics' Partner, EnerWorks

EnerWorks is one of North America's leading solar thermal technology providers, developing and manufacturing proprietary renewable energy appliances for residential, commercial and industrial applications. The company's proven, patented technology offers high-quality, reliable, cost-effective solutions.

In the residential market, EnerWorks Solar Water Heating Appliances meet all applicable certifications and complement existing electric, natural gas, propane, or oil water-heating services, providing users with clean energy and a real reduction in energy costs. After space-heating and cooling, water heating is the next largest single demand on home energy consumption. Appliances are distributed through trained plumbing and HVAC dealers, new home and renovation contractors, renewable energy dealers and utility service providers.

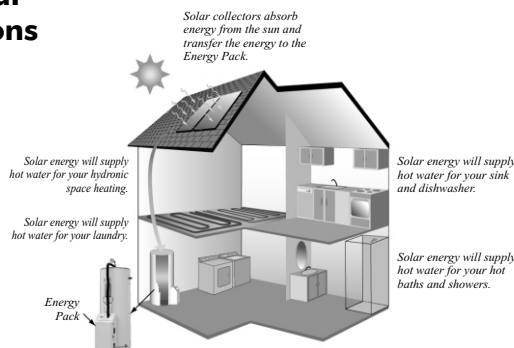
In commercial and industrial markets, EnerWorks is at the forefront of integrated solar thermal solutions. The company works with local project partners to design, install, commission and maintain solar thermal heating systems. Working with local partners to identify and qualify opportunities, EnerWorks takes pride in helping customers move through the sales, design and installation process seamlessly.

EnerWorks is continuously investing in research and development, striving to reduce costs, increase outputs and maximize longevity in markets ranging from food service and hospitality to agriculture to industrial processes.

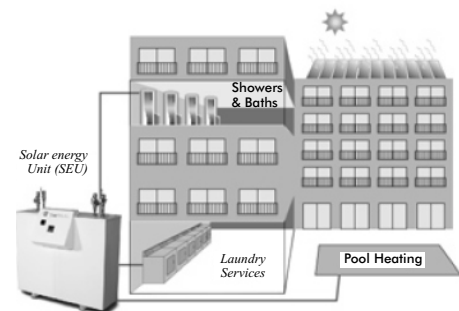
SOLAR THERMAL

The process is relatively simple: the sun's energy is harnessed through solar collector panels, transferred through a heat exchanger to a storage tank, and then available to meet the hot water requirements. The user's existing water heater provides an auxiliary heating source, with the renewable solar-heated water meeting the primary demand—and providing a significant annual energy savings. The Appliances do not affect the quality of hot water produced nor the speed at which the water is heated. They do offer a long operational life, minimal maintenance and an affordable alternative to rising energy costs.

Residential Applications



Commercial Applications



BENEFITS

Solar water-heating is an affordable, cost-competitive, environmentally-friendly and reliable alternative, offering significant energy savings. For homeowners in most of Canada and northern USA, the savings average 50% per year for full-year operation. In southern USA, the Appliance can provide over 80% of annual residential water-heating energy requirements.

A good example of savings to be achieved in a commercial application is Confederation Place Hotel in Kingston, Ontario, Canada. Their installation of 20 solar collectors will pay for itself in just 3½ years and prevent 36 tons of carbon dioxide emissions each year. The Chicago-area William Fremd High School has 100 EnerWorks commercial solar collectors to provide heat for its indoor swimming pool. This is currently the largest solar thermal installation in Illinois. Over the lifetime of the project, the installation will deliver solar thermal energy for much less than the cost of natural gas.

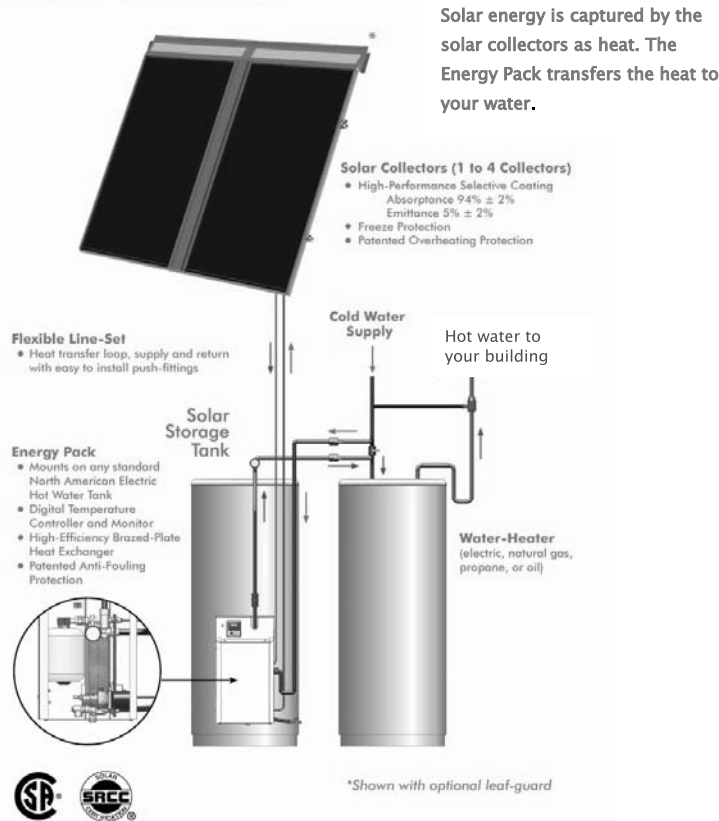
EnerWorks Solar Water Heating Appliances are easy to maintain and provide reliable efficient water-heating. They reduce greenhouse gas emissions by 40-50% and provide clean and secure energy.

Solar thermal technology can offer a significant advantage to builders. The ideal environmental solution, it contributes to green builder certification and leadership and, research indicates, is being enthusiastically embraced by consumers.

With water-heating accounting for 20-25% of a home's energy needs, producing about two tons of carbon dioxide emissions each year, solar water heating appliances are an eco-friendly alternative.

High Performance Solar Water Heating Appliance

HOW IT WORKS



EnerWorks Inc. is one of North America's leading solar thermal technology providers with proven, patented technology offering high-quality, reliable, cost-effective water-heating solutions to the North American market. EnerWorks Solar Water Heating Appliances supply energy for less than the cost of grid electricity. Choosing emission-free, solar energy is a positive step to a clean environment and to saving money.

Sizing High Performance Appliance for Cool Climate (above 37° N*), Residential Application

Individuals in Home	Appliance Size	Solar Storage Tank for Cool Climate Standard North American Electric Tank	
2-3	1-collector	50-65 US gal	180-275 L
3-5	2-collector	80 US gal	275-365 L
5-7	3-collector	120 US gal	365-455 L
7-10	4-collector	120 US gal	455-546 L

For commercial applications, contact your distributor.

Sizing High Performance Appliance for Warm Climate (below 37° N*), Residential Application

Individuals in Home	Appliance Size	Solar Storage Tank for Warm Climate Standard North American Electric Tank	
2-4	1-collector	65-80 US gal	245-300 L
5-7	2-collector	120 US gal	450 L

For commercial applications, contact your distributor.

*guideline only, decision varies with climate, altitude and local conditions

Assembled in Canada from domestic and imported components

Imagine!

- Save money on your energy bill
- A reliable, year-round appliance
- Fast installation by trained professionals



The collectors resemble skylights and can be roof, wall or rack mounted. Overheat protected collectors feature a patented temperature-limiting mechanism that allows hot air to vent, preventing overheating on a hot summer day. The food-grade heat-transfer fluid provides freeze-protection, supporting Appliance operation and continued savings year-round.

The Appliance uses free solar energy to heat water. Solar-heated water is produced during sunny periods. If necessary, your existing water-heater heats the water during periods of low solar radiation and at night so you are never without hot water.

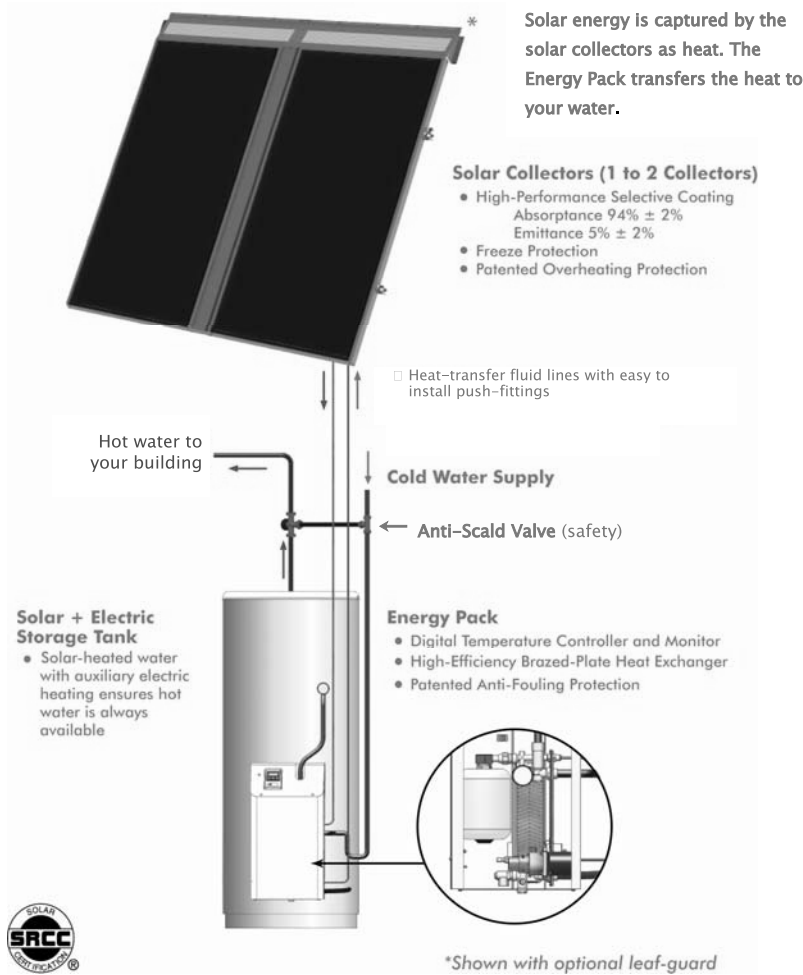
Patented anti-fouling protection prevents clogging of the heat exchanger and ensures optimal performance.

Harness the sun's energy to heat your water—a clean, cost-effective solution!

Space-Saver™ – Solar + Electric Single Tank Solar Water Heating Appliance

For Builder, Utility and Small Commercial Projects

HOW IT WORKS



Imagine!

- Save money on your energy bill
- A reliable, all-season appliance
- Fast installation by trained professionals



The collectors resemble skylights and can be roof, wall or rack mounted. Overheat protected solar collectors feature a patented temperature-limiting mechanism that allows hot air to vent, preventing overheating on a hot summer day. The food-grade heat-transfer fluid provides freeze-protection, supporting Appliance operation and continued savings year-round.

The Appliance uses free solar energy to heat water. Solar-heated water is produced during sunny periods. If necessary, the electric element in the tank heats the water during periods of low solar radiation and at night so you are never without hot water.

Patented anti-fouling protection prevents clogging of the heat exchanger and ensures optimal performance.

Harness the sun's energy to heat your water—a clean, cost-effective solution!

EnerWorks Inc. is one of North America's leading solar thermal technology providers with proven, patented technology offering high-quality, reliable, cost-effective water-heating solutions to the North American market. EnerWorks Solar Water Heating Appliances supply energy for less than the cost of grid electricity. Choosing emission-free, solar energy is a positive step to a clean environment and to saving money.

Assembled in Canada from domestic and imported components

Frequently Ask Questions

1) Who is EnerWorks?

Incorporated in 1999, EnerWorks is a developer and manufacturer of clean, intelligent solar thermal solutions for residential, commercial and industrial markets throughout North America. EnerWorks is venture capital-funded and works with the Queen's University Solar Calorimetry Laboratory to develop innovative and cost-effective water-heating solutions.

2) What do Smart Solar and EnerWorks Products Offer?

Instead of using traditional energy sources, EnerWorks Solar Water Heating Appliances use the sun's energy to provide potable hot water. EnerWorks Solar Water Heating products provide environmentally clean, competitively priced energy solutions for a range of heating applications. EnerWorks Appliances:

- *Cut water heating costs by 50% or more*
- *Reduce the impact of rising energy prices*
- *Offer cost-competitive and environmentally friendly green energy*
- *Offer a practical and inexpensive way for home and building owners to support sustainable, pollution-free energy solutions.*
- *Contribute to a healthier environment by reducing greenhouse gas emissions*
- *Are dependable*
- *Do not affect your hot water use*
- *Require minimal maintenance*
- *Energy Kinetics partnered with EnerWorks to distribute its solar water-heating appliance through Energy Kinetics' dealer network.*

The Appliances are available across North America through distributors and authorized dealers/installers. For dealer information and support in your area, please visit our website at www.enerworks.com.

3) How much electricity does the EnerWorks Solar Water Heating Appliance Produce?

None. However, the EnerWorks Appliance can displace over half of the electricity, natural gas, oil or propane you purchase from your utility company with free solar energy from the sun.

4) Will Heating Water With Solar Energy Save Me Money?

Yes. Depending on the solar collector orientation, in southern Ontario and the northeastern United States, free solar energy will deliver annual savings of up to 60% on a typical household's water-heating bill. In the southern United States and very sunny areas, annual utility savings of over 80% can be achieved.

5) How Much Does The Appliance Cost?

EnerWorks distributes its solar water-heating Appliance through builder channels, utilities and renewable

energy dealers. A variety of options are available, depending on the heating demands, so it's best to have the installed cost quoted by your dealer or installer based on the Appliance chosen and the specifics of the installation site. Your local dealer can determine the installed cost, which is like buying electricity at 6¢ per kWh, based on the best solution for you. Residential customers may have the option of purchasing or leasing the Appliance, while commercial customers may be able to purchase solar energy on a toll basis through third-party power purchase agreements.

6) How Does The Appliance Work?

Solar energy, in the form of heat, is collected by solar collectors. The EnerWorks Energy Pack transfers the heat to your potable water. The Appliance works in all seasons, is freeze-protected and reduces dependence on your existing natural gas, electric, oil or propane water-heater.

7) How Dependable Is The EnerWorks Solar Water Heating Appliance?

The EnerWorks Solar Water Heating Appliance combines the dependability of conventional fuels with free energy from the sun. It has been under development and testing with Natural Resources Canada, the Queen's University Solar Calorimetry Laboratory and leading component manufacturers for the past decade. The Appliance performance has been third-party verified by the National Solar Test Facility at Bodycote Material Testing, a testing facility recognized by the Solar Rating and Certification Corporation (SRCC). The Appliance requires minimal service every 3 years and has an expected lifespan of over 25 years. EnerWorks Appliances are certified under Canadian Standards Association (CSA), Florida Solar Energy Center (FSEC), International Association of Plumbing and Mechanical Officials (IAPMO) Uniform Solar Energy Code (USEC), Energy Star® and SRCC standards.

8) How Do EnerWorks Solar Collectors And Appliances Compare To Evacuated Tube Technology?

EnerWorks Solar Appliances use flat-plate collectors with very low-flow, freeze-protected heat-transfer fluid and high-efficiency brazed-plate heat exchangers. The EnerWorks Overheat Protected Collectors' patented, proprietary overheat protection keeps collector temperatures under 260 °F (125 °C) when the solar hot water tank is fully charged. The result is low system pressures and no degradation of the heat-transfer fluid. Evacuated tubes can reach temperatures of 572 °F (300 °C), which can cause overheating, high system pressures and breakdowns to rubber seals and vacuums, and the degradation of heat-transfer fluid.

EnerWorks collectors have been tested by third parties such as the Florida State Energy Center (FSEC). The EnerWorks Overheat Protected Collector has an FSEC BTU rating of 786 BTU/sq. ft. The leading brand of evacuated tube collector has models with performance ranges of 634 to 785 BTU/sq. ft.

An EnerWorks collector with hook-bracket mounting hardware can be safely positioned on the roof in less than 5 minutes by two people; there are no tubes or parts to sequentially pass up or store on the roof during installation. The EnerWorks collector and flashings are a neutral color and resemble a skylight. The collector is only 3 inches high, just like a skylight curb.

The copper tubing in the EnerWorks collector is a continuous serpentine loop; there are no internal connection points or brazing points to fail. The EnerWorks collector is thermally sealed from the elements. The ambient temperature, winds, etc. have nominal impact on collector performance. As the winter ground water is colder, the Appliances' rate of heat transfer is actually higher in winter than summer.

The EnerWorks collector and flashings present a uniform flat surface across the roof and have no spaces and crevices to hold snow, ice and leaf debris. Rain and snow cleans the glass and slides off.

EnerWorks collectors and Energy Packs are very cost-competitive.

9) What Is The Advantage Of A Closed-Loop Heat Transfer System Versus Drain-Back?

EnerWorks uses and strongly recommends the “closed-loop heat transfer” type systems even in hot climates. In drain-back systems, if mains water is being used as heat-transfer fluid in an unpressurized system, then:

- a) collector tubing will scale and require frequent maintenance or will malfunction; and*
- b) pure water used in a closed, unpressurized loop will eventually breed bacteria and cause bio-fouling.*

Some drain-back installers are trying to counter these effects by using a closed-loop propylene glycol drain-back system. If the glycol is not pressurized and is exposed to oxygen, it will actually degrade even faster. If glycol and a nitrogen blanket are used to avoid oxygen exposure, the system becomes very complex and expensive. Leak-proofing, although crucial, becomes very difficult. In drain-back, all pipes have to be properly sloped for it to work, making the installation challenging and time-consuming.

10) How does the EnerWorks Solar Water Heating Appliance handle the high summer temperatures and solar radiation of a city like Phoenix, Arizona?

EnerWorks's system is designed to avoid the problems associated with stagnation due to overheating, with no user intervention required:

- Each EnerWorks Overheat Protected Collector has a patented temperature-limiting device that sheds excess heat. This is done in a “passive”, mechanical way so that the device is not dependent on a power source; the vent is thermally actuated and works automatically even during a power outage.*
- Fluid in the collector evaporates and the vapors push the rest of the fluid volume out of the collector. Because vapor has a very large specific volume and quite small mass, in effect, only a tiny amount of fluid is exposed to high temperatures. This dramatically slows down fluid degradation.*
- EnerWorks uses only non-toxic, food-grade propylene-glycol that can withstand high temperatures with minimal degradation.*
- Fluid change is recommended at least once every three years in moderate climates, and should be checked more often in hot climates. The last anti-stagnation protection level is provided by a pressure relief valve set at 50 psi.*
- Collector materials are carefully selected to prevent out-gassing and to be able to withstand collector stagnation temperatures (which are lower due to the temperature-limiting device).*

For residential applications in southern states such as Arizona, Florida, Texas, Louisiana, New Mexico, and California, EnerWorks recommends a single-collector appliance for families of up to 5. For larger families, or where solar heat is used for more than just domestic hot water during the summer, a two-collector appliance is appropriate. Extended stagnation is undesirable for both economic and technical reasons. Reasonable episodes of stagnation will not hurt the EnerWorks Appliance, or the fluid; no action is required by the owner (covering the collectors to prevent stagnation is NOT recommended).

11) How Is The Appliance Installed?

In residential applications, one to four solar collectors (4 ft x 8 ft x 3 in) resembling thin skylights are mounted on your roof or a ground-mounted rack. An insulated, flexible fluid line runs from the roof to the hot water tank(s). Once connected, the EnerWorks Solar Water Heating Appliance is quickly ready for everyday use.

The Solar Water Heating Appliances are scaled up to provide the same benefits to commercial users of hot water and other thermal operations like food services, hospitality, multi-family accommodation, car washes, community centers, agriculture, industrial processes and government buildings.

In commercial applications with higher water loads, modules of 10 collectors are sized to fit the heat load and available installation space. Typically, installations are from 20 to 120 collectors. EnerWorks has supplied district heating projects such as Okotoks, Alberta's Drake Landing Solar Community near Calgary, where solar arrays with 800 solar collectors are mounted on the garages of the subdivision. www.dlsc.ca

12) I Am Building A New Home. Is There Anything I Can Do To Make Installation Easier?

During mechanical rough-ins, run a 3 or 4-inch PVC pipe from the basement (or where your hot water tank will be located) to the roof (or where you wish to install the solar collectors). Contact EnerWorks for installation requirements as certain roof positions need to be considered.

Drain-Back vs. Closed-Loop Glycol Summary

1. Background

1.1 Stagnation

There is a valid concern regarding solar thermal systems in “stagnation conditions”, an operating condition where heat is not being removed from the collectors. The collectors being designed for collecting solar heat, they can overheat during stagnation. Overheating has the potential to cause material failures and heat transfer fluid breakdown.

1.2 Closed-Loop Versus Drain-Back

EnerWorks uses and strongly recommends the “closed-loop glycol” type systems even in warm climates. There's another type of system called “drain-back,” which some people believe is better suited to handle overheating. This belief comes from the fact that drain-back systems are designed to automatically drain the collectors when the pump turns off for any reason. With no fluid in the collector, there's no fluid boiling or degradation.

However, drain-back systems have significant issues. If water is being used as heat transfer fluid in an unpressurized system, then:

- a) collector tubing will scale and require frequent maintenance or will malfunction.*
- b) potentially severe pipe corrosion will occur due to simultaneous exposure to oxygen and humidity.*
- c) pure water used in a closed, un-pressurized loop will eventually breed bacteria and cause bio-fouling or present a hazard to potable water. Some drain-back installers are trying to counter these effects by using a closed-loop glycol drain-back system.*

If the glycol is not pressurized then it's exposed to oxygen and will actually degrade even faster. If glycol and a nitrogen blanket are used to avoid oxygen exposure, the system becomes very complex, expensive and leak-proofing becomes very difficult (but crucial). Another negative feature of drain-back systems is that all the pipes have to be properly sloped; otherwise the “drain-back” won't work. This makes those systems very dependent on the skills and level of care of the installer. Even the slightest dip in a pipe, caused by someone stepping on it, for example, can have a catastrophic impact during freezing conditions.

Drain-back systems also require more powerful pumps because they have to pump the water (or glycol) against a “head” equal to the height of the building. By comparison, closed-loop systems can take advantage of the hydrostatic pressure of the return pipe, so their pumps only have to overcome small fluid friction losses. The result is that closed loop systems can operate with lower electricity consumption.

The drain-back tank needs to be located in a heated space but preferably close to the collectors. Depending on the building's layout, it is sometimes very difficult to find a suitable place for them. By contrast, closed-loop storage tanks offer more flexibility.

Traditional closed-loop glycol systems are known to:

- a) blow glycol or water pressure relief valves;*
- b) degrade the glycol in a short period of time due to exposing it to high temperatures for extended periods of time.*

2. Dealing With Stagnation In Closed-Loop Systems

Provided that proper system design steps are taken to deal with stagnation, EnerWorks believes that closed-loop systems are the best suited to all climates, from arctic to tropical. The EnerWorks Overheat Protected system has the following design features to help it during stagnation - note that no user intervention is required when stagnation occurs:

- a. Each EnerWorks Overheat Protected Collector has a patented temperature limiting device that vents out excess heat. This is done in a “passive”, mechanical way so that the device is not dependent on a power source, i.e. it works automatically even during a power outage.*
- b. The expansion tank, its air chamber and system pressure are carefully tuned so that a small amount of fluid boiling is allowed in the small diameter collector tubes. Fluid in the collector evaporates and the vapors push the rest of the fluid volume out of the collector. Because vapor has a very large specific volume and very small mass, in effect only a very tiny amount of fluid is exposed to high temperatures. This dramatically slows down fluid degradation. In essence, this is a “vapor drain-back” system, without any of the issues of traditional drain-backs.*
- c. Where local regulation allows it, EnerWorks recommends the use of a specially formulated propylene-glycol that can withstand high temperatures with minimal degradation. This fluid also provides advanced corrosion protection.*
- d. Fluid pH check and/or change is recommended at least once every three years.*
- e. The last protection level is provided by a pressure relief valve set at 50 psi. Worst case, the PRV leaks a few drops of fluid.*
- f. Collector materials are carefully selected to prevent out gassing and to be able to withstand collector stagnation temperatures (which are lower due to the temperature limiting device)*

3. Recommendations

*For southern states – Florida, Texas, Louisiana, New Mexico, California – EnerWorks recommends a single-collector appliance for families of up to five. For larger families, or where solar heat is used for other than just domestic hot water in the summer, a two-collector appliance is appropriate. Over-sizing solar appliances should be avoided as it results in lower savings. Extended stagnation is undesirable from both economic and technical reasons. Reasonable episodes of stagnation will not hurt the EnerWorks system or the fluid; no action is required by the owner (covering the collectors just to prevent stagnation is **not** recommended).*

Company	System pressure control	System stagnation control*	Heat exchanger back-flushing/anti-fouling**	Specialized vs. standard components***
Alternate Energy Technologies (AET) Jacksonville, FL	N	N	N	Standard
Schuco, Germany CT, USA	N	N	N	Specialized
Sonnenkraft (Velux) Austria FL, USA	N	N	N	Specialized
SunEarth Inc. Fontana, CA	N	N	N	Standard
Stiebel Eltron Germany MA, USA	N	N	N	Specialized
Thermo Dynamics Halifax, NS	N	N	N	Standard
Viessmann Germany Waterloo, ON	N	N	N	Specialized
EnerWorks Dorchester, ON	Patented pressure control	Patented stagnation control	Patented anti-fouling protection	Standard

*Stagnation occurs when circulation pump stops. Pump may stop due to power failure or if solar storage is full. Stagnation leads to overheating and damage to heat transfer fluid.

**Heat exchanger may become fouled due to water sediment.

***Specialized components refers to metric-sized fittings and custom storage vessels, standard components denotes standard size North American storage tanks and common fittings.

Differential Controller Operated System

The direct-pumped system has one or more solar energy collectors installed on the roof and a storage tank somewhere below, usually in a garage or a utility room. A pump circulates the water from the tank up to the collector and back again. This is called a direct (or open loop) system because the sun's heat is transferred directly to the water circulating through the collector tubing and storage tank; no anti-freeze solution or heat exchanger is involved.

This system has a differential controller that senses temperature differences between water leaving the solar collector and the coldest water in the storage tank. When the water in the collector is about 15-20° F (-9.5° C to -6.67° C) warmer than the water in the tank, the pump is turned on by the controller. When the temperature difference drops to about 3-5° F (-16.1° C to -15° C), the pump is turned off.

In this way, the water always gains heat from the collector when the pump operates.

A flush-type freeze protection valve installed near the collector provides freeze protection. Whenever temperatures approach freezing, the valve opens to let warm water flow through the collector.

The collector should also allow for manual draining by closing the isolation valves (located above the storage tank) and opening the drain valves.

Automatic recirculation is another means of freeze protection. When the water in the collector reaches a temperature near freezing, the controller turns the pump on for a few minutes to warm the collector with water from the tank.

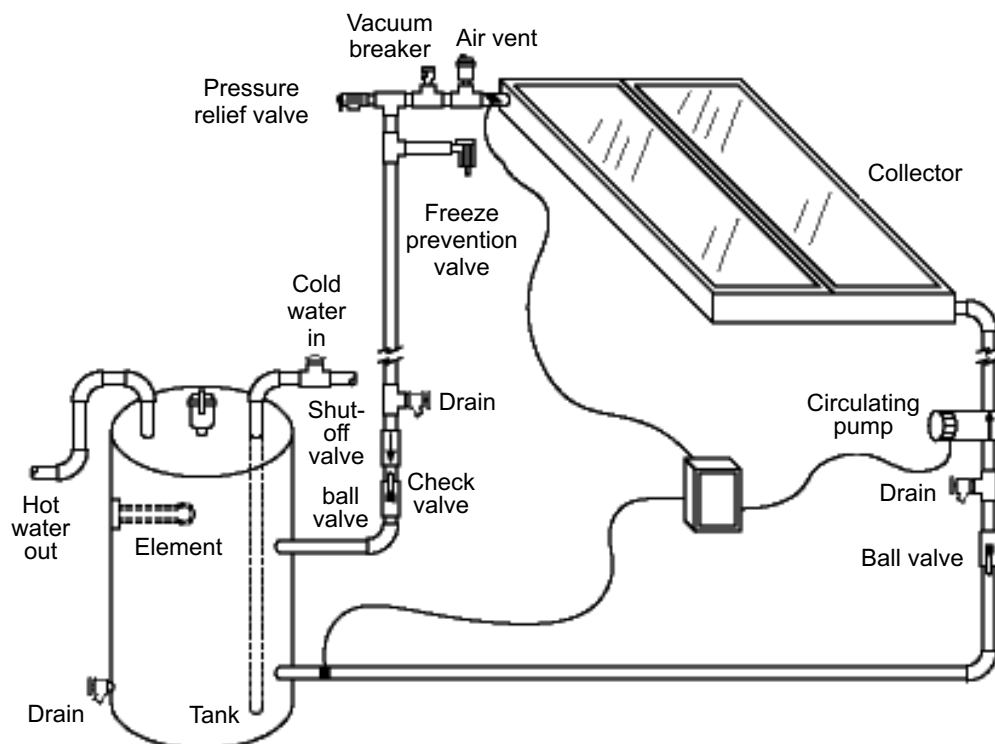


Fig. 1- Differential Controller Operated System

Photovoltaic Operated System

The system shown in Figure 2 differs from other direct-pumped systems in that the energy to power the pump is provided by a photovoltaic (PV) panel. The PV panel converts sunlight into electricity, which in turn drives the direct current (DC) pump. In this way, water flows through the collector only when the sun is shining.

The DC pump and PV panel must be suitably matched to ensure proper performance. The pump starts when there is sufficient solar radiation available to heat the solar collector. It shuts off later in the day when the available solar energy diminishes. As in the previous systems, a thermally operated valve provides freeze protection.

Common appliance timers also may control solar system operation. These timers must incorporate battery backup in the event of power failures.

The timer is set to operate during a period of the day when solar radiation is available to heat the potable water. In order to avoid loss of energy from the tank during overcast days, the collector feed and return lines are both connected at the bottom of the storage tank with a special valve. During normal operation, natural stratification allows the warmer water to rise to the top of the tank.

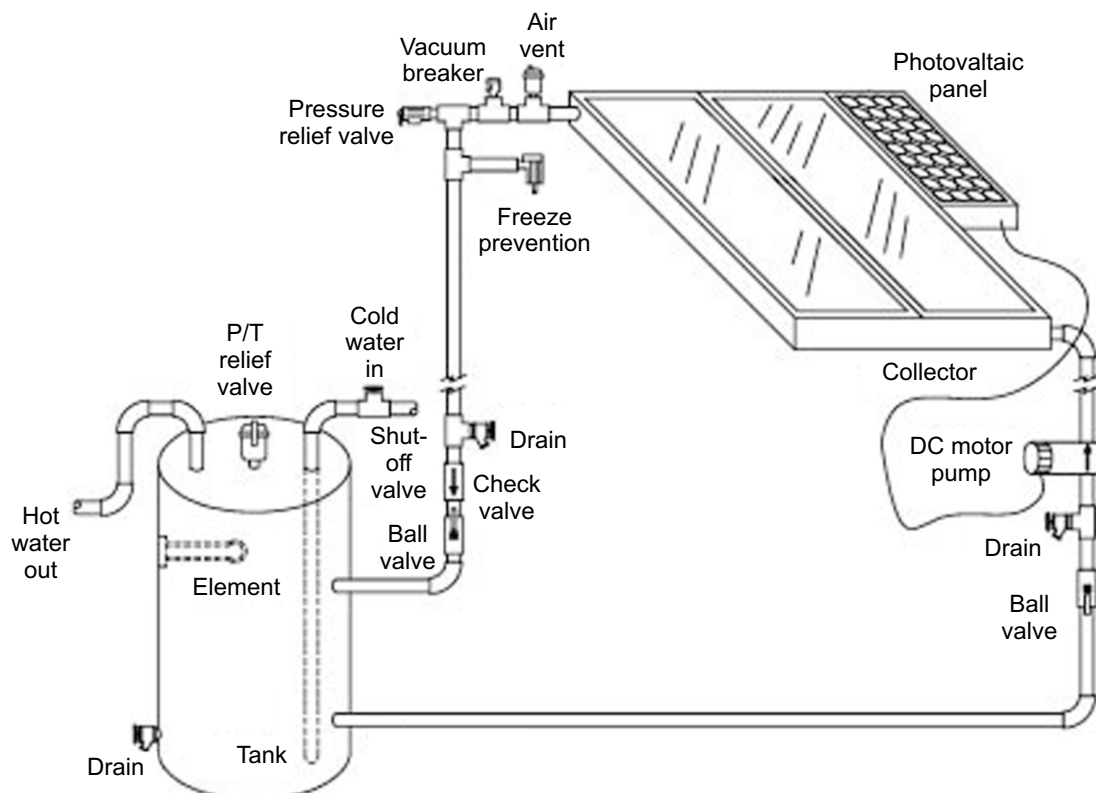


Fig. 2- Direct system with photovoltaic-powered pump

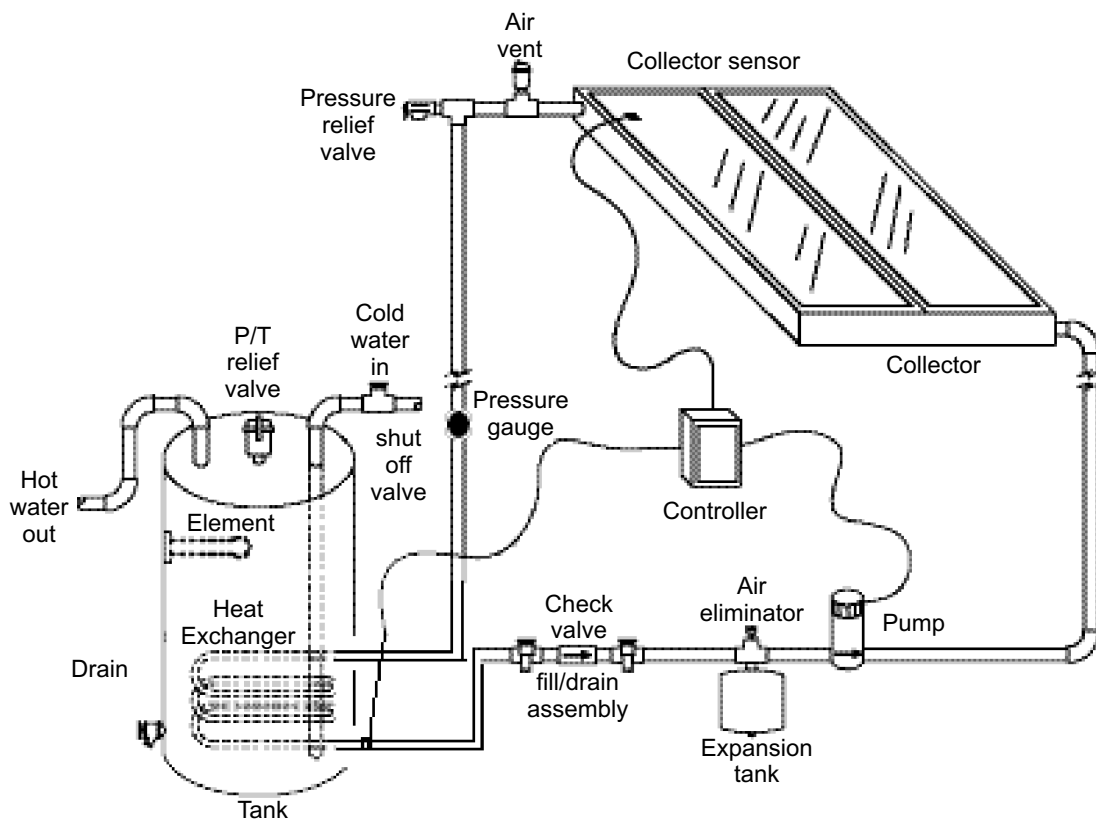
Indirect-Pumped System

This system design is common in northern climates, where freezing weather occurs more frequently. An antifreeze solution circulates through the collector, and a heat exchanger transfers the heat from the antifreeze solution to the tank water. When toxic heat exchange fluids are used, a double-walled exchanger is required. Generally, if the heat exchanger is installed in the storage tank, it should be in the lower half of the tank.

The system illustrated in Figure 3 is an example of this system type. Here, a heat transfer solution is pumped through the collector in a closed loop. The loop includes the collector, connecting piping, the pump, an expansion tank and a heat exchanger. A heat exchanger coil in the lower half of the storage tank transfers heat from the heat transfer solution to the potable water in the solar storage tank. An alternative to this design is to wrap the heat exchanger around the tank. This keeps it from contact with potable water.

The “brain” of the system is a differential controller. In conjunction with collector and tank temperature sensors, the controller determines when the pump should be activated to direct the heat transfer fluid through the collector.

The fluid used in this system is a mixture of distilled water and antifreeze similar to that used in automobiles. This type of fluid freezes only at extremely low temperatures so the system is protected from damage caused by severe cold.



Drain-Back System

A fail-safe method of ensuring that collectors and collector-loop piping never freeze is to remove all water from the collectors and piping when the system is not collecting heat. This is a major feature of the drain-back system illustrated in Figure 4. Freeze protection is provided when the system is in the drain mode. Water in the collectors and exposed piping drains into the insulated drain-back reservoir tank each time the pump shuts off. A slight tilt of the collectors is required in order to allow complete drainage. A sight glass attached to the drain-back reservoir tank shows when the reservoir tank is full and the collector has been drained.

In this particular system, distilled water is recommended to be used as the collector loop fluid-transfer solution. Using distilled water increases the heat transfer characteristics and prevents possible mineral buildup of the transfer solution.

When the sun shines again, the pump is activated by a differential controller. Water is pumped from the reservoir to the collectors, allowing heat to be collected. The water stored in the reservoir tank circulates in a closed loop through the collectors and a heat exchanger at the bottom of the solar tank.

The heat exchanger transfers heat from the collector-loop fluid to the potable water in the solar tank.

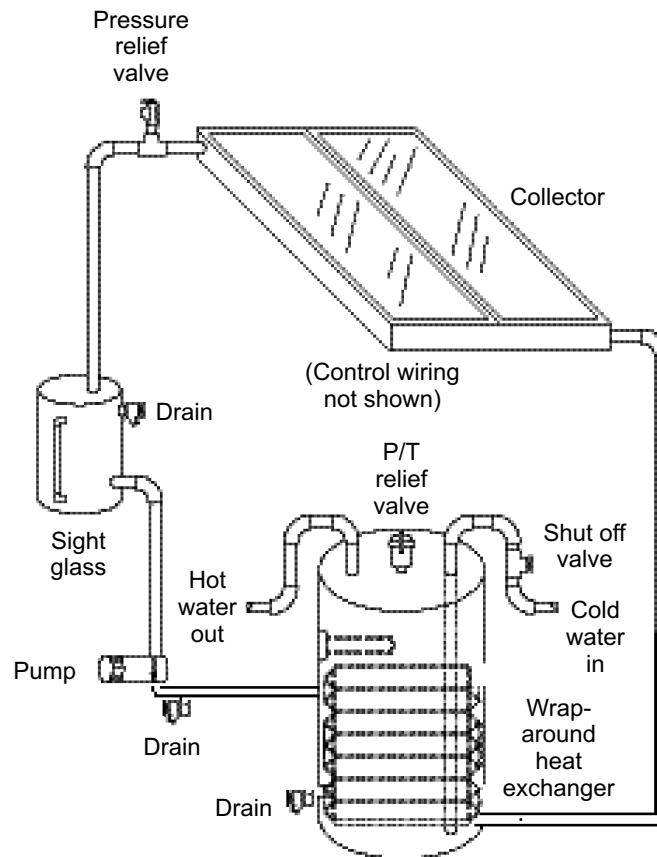


Fig. 4 - Indirect-pumped system using distilled water

Integral Collector Storage (ICS) System

In the integral collector storage solar system shown in Figure 5, the hot water storage system is the collector. Cold water flows progressively through the collector where it is heated by the sun. Hot water is drawn from the top, which is the hottest, and replacement water flows into the bottom. This system is simple because pumps and controllers are not required. On demand, cold water from the house flows into the collector and hot water from the collector flows to a standard hot water auxiliary tank within the house.

A flush-type freeze protection valve is installed in the top plumbing near the collector. As temperatures near freezing, this valve opens to allow relatively warm water to flow through the collector to prevent freezing. In south Florida and certain areas of central Florida, the thermal mass of the large water volume within the ICS collector provides a means of freeze protection.

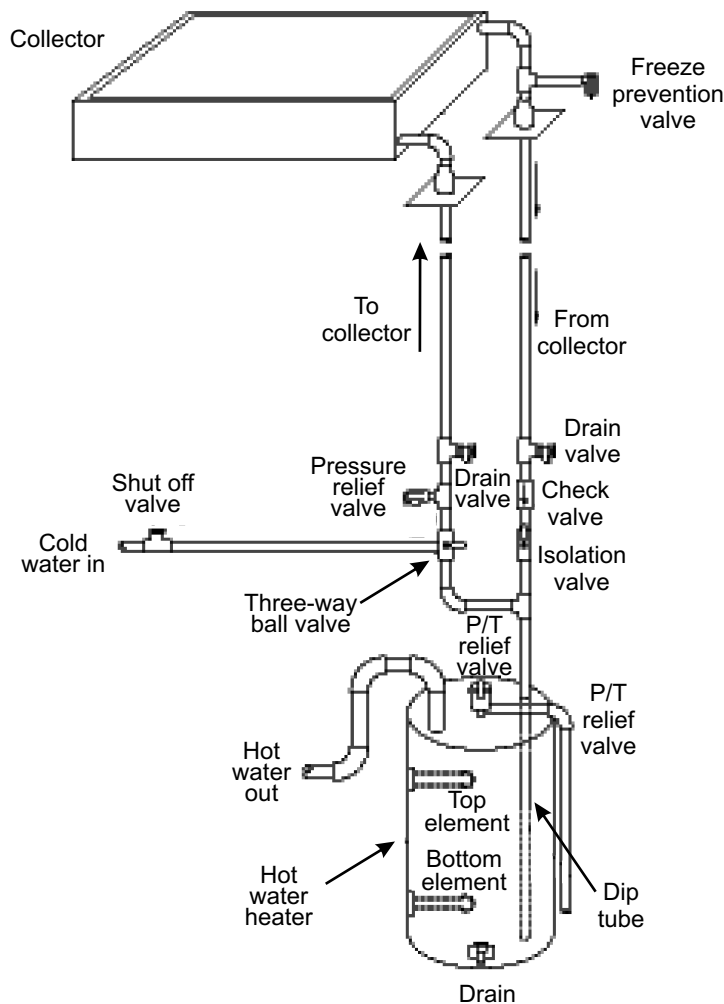


Fig. 5 - Integral collector storage system

Thermosiphon System

A typical thermosiphon system is indicated in Figure 6. As the sun shines on the collector, the water inside the collector flow-tubes is heated. As it heats, this water expands slightly and becomes lighter than the cold water in the solar storage tank mounted above the collector. Gravity then pulls heavier, cold water down from the tank and into the collector inlet. The cold water pushes the heated water through the collector outlet and into the top of the tank, thus heating the water in the tank.

A thermosiphon system requires neither pump nor controller. Cold water from the city water line flows directly to the tank on the roof. Solar heated water flows from the rooftop tank to the auxiliary tank installed at ground level whenever water is used within the residence.

This system features a thermally operated valve that protects the collector from freezing. It also includes isolation valves, which allow the solar system to be manually drained in case of freezing conditions, or to be bypassed completely.

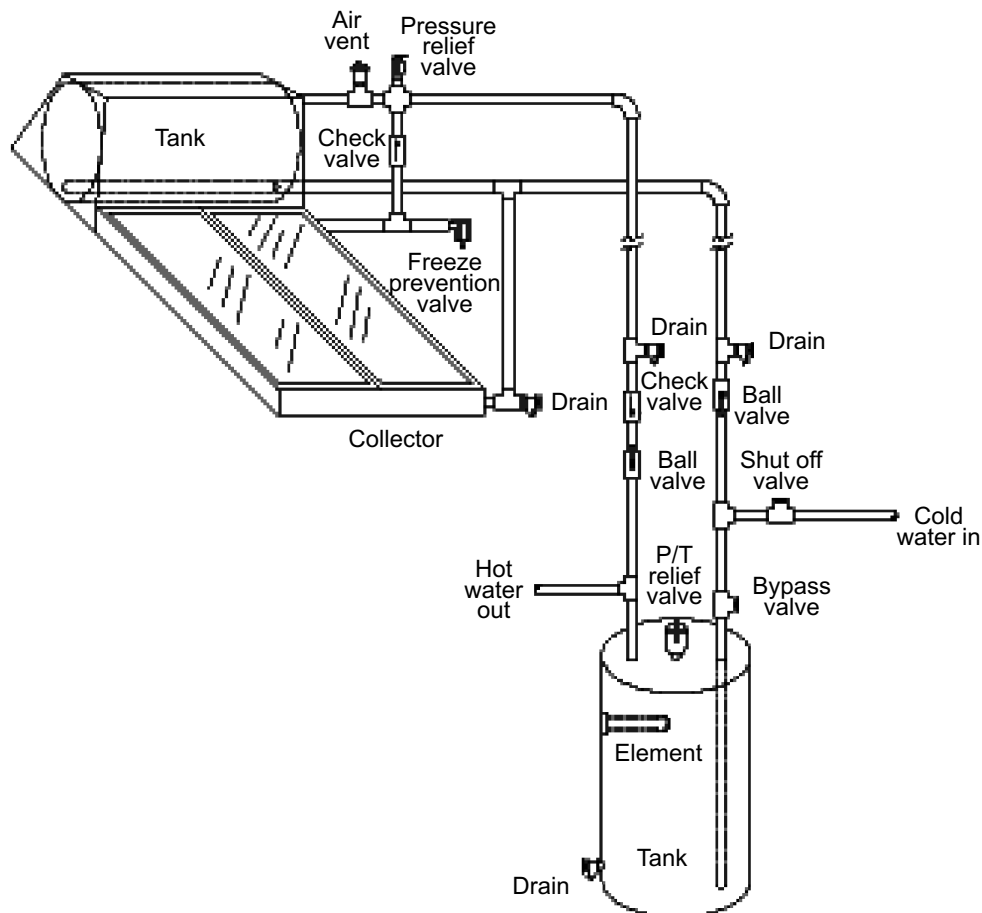


Fig. 6 - Thermosiphon system



SolSim
User Guide

Solar Water Heating Appliances

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Important: Information current as of Solsim version 1.6.0

1.0 Introduction

SolSim (abbreviation of “solar simulator”) is a simulation software originally developed for EnerWorks Inc. by the Solar Calorimetry Laboratory at Queen’s University. Using models of the EnerWorks residential appliance and typical meteorological data, it calculates an estimated annual amount of collected solar radiation, which is then used to achieve the amount of solar energy supplied by the appliance.

With this energy value known, economics information is calculated based on monetary inputs for fuel prices (along with escalation and tank efficiencies) and appliance price. The amount of carbon dioxide (CO₂) offset by the appliance is also calculated based on the generation mix for electricity or on the fuel type (natural gas, propane, oil).

The results can then be saved into HTML format for sharing or printing as an estimate of how much the EnerWorks appliance can save the customer.

1.1 Installing SolSim

If you received SolSim as an executable file (with the extension exe), the file will be called “SolSim 1.6.1 (Canada).exe” or “SolSim 1.6.0 (USA).exe”. Double-click on the file to launch the installer.

If you received SolSim in a zipped file (with the extension zip), open the zip file and extract the executable install program.

SolSim will run on any modern version of Microsoft® Windows®.

2.0 Inputs

The inputs that can be changed by the user are located on the main screen and on four subscreens. The *Simulate* button may be pressed at any time, and must be pressed after any changes to inputs in order to see the changes reflected in the outputs.

2.1 Main Screen

The main dialog appears after the splash screen. It contains the inputs for location of the site (choose the nearest weather station), weekly household hot water consumption, average annual groundwater temperature at the site, set-point temperature of the auxiliary tank, volume of the solar tank, whether the tank is a standard double-tank pre-heat appliance (*High Performance*) or a single-tank appliance (*Space-Saver™*), configuration of the solar collectors, and some economics information.

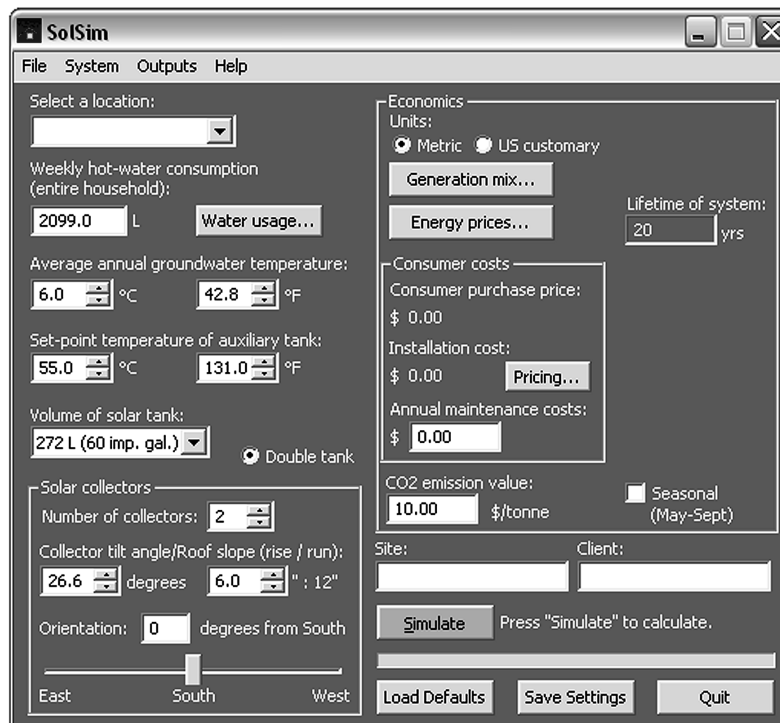


Fig. 1: SolSim's Main Screen.



Fig. 2: Location Selection.

2.1.1 “Location” Drop-Down Menu

The location is a major factor affecting system performance. When selecting a location, weather data for that location is then loaded. The weather data used is in Watsun TMY (typical meteorological year) format¹, which contains latitude (and sometimes longitude) of the location and hourly values of ground reflectance, ambient air temperature (°C), amount of solar radiation (W/m²), wind speed, and relative humidity for every day of the year.

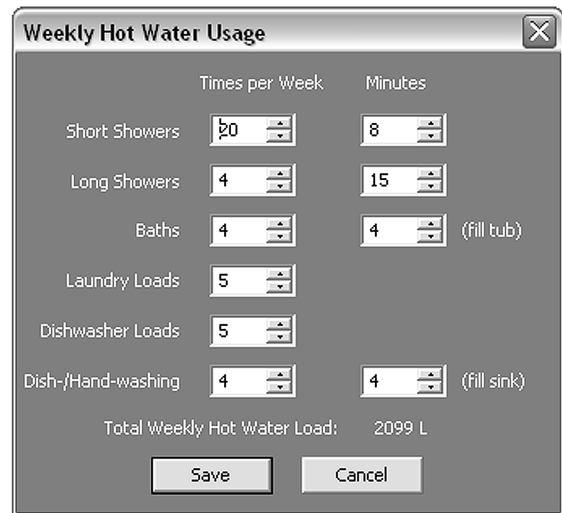
Latitude gives an indication of the optimum tilt angle of the collectors (discussed later in section 2.1.6). The amount of solar radiation is used to calculate the hourly solar energy, which, summed up, gives the annual solar energy.

2.1.2 “Weekly Hot-Water Consumption (Entire Household)” Field

There are two ways of inputting household water usage: enter a direct value in the field or press the “Water usage...” button to bring up the “Weekly Hot Water Usage” UI (see figure 3).

The screen for water usage allows a customized weekly water profile, specifying the number and length of showers (short between 2 and 15 minutes; long between 15 and 25 minutes), the number of baths and time it takes to fill the tub, the number of laundry and dishwasher loads, and the number of dish-washing or hand-washing activities with the time it takes to fill the sink. This is a more intuitive fashion for entering water profiles in case a weekly average is not known.

An alternative way of obtaining the load of hot water is that, in general, hot water consumption is approximately one third of total water consumption.



	Times per Week	Minutes	
Short Showers	20	8	
Long Showers	4	15	
Baths	4	4	(fill tub)
Laundry Loads	5		
Dishwasher Loads	5		
Dish-/Hand-washing	4	4	(fill sink)
Total Weekly Hot Water Load:		2099 L	

Fig. 3: Change the weekly water load with specific activities.

2.1.3 “Average Annual Groundwater Temperature” Field

These values are automatically filled when the location is selected; however, one can enter their own values should the need arise. The values are an average of the maximum and minimum values given in RETScreen².

2.1.4 “Set-Point Temperature of Auxiliary Tank” Field

This is the set-point of the existing hot-water tank in the home (powered by either electricity, natural gas, propane, or oil), or it is the set-point for the electric element in a Space-Saver™ appliance. According to BC Hydro³, 140 °F (60 °C) is recommended for electric tanks and 131 °F (5 °C) is recommended for gas-fired tanks. Lower temperatures permit bacteria growth and higher temperatures waste energy.

2.1.5 “Volume of Solar Tank” Drop-Down Menu

The size of the solar storage tank influences the amount of solar-heated water that can be stored. Tanks are sized based on the household water usage along with the amount of solar energy available. The volume of the tank is also dependent on the number of collectors:

2.1.6 “Solar Collectors” Settings

Number of collectors	Minimum tank volume	
	High Performance	Space-Saver™
1	40 imperial gallons / 60 US gallons	80 US gallons
2	60 imperial gallons / 80 US gallons	120 US gallons
3	80 imperial gallons / 100 US gallons	N/A
4	100 imperial gallons / 120 US gallons	N/A

This Table can be viewed under (Recommendations) in the “Help” menu.

The group of settings within the “Solar collectors” box specifies the number and orientation of the solar panels.

2.1.6.1 “Number of Collectors” Field

This value specifies the number of collectors, from one to four, installed. The collectors are in series for one-, two-, and three-collector appliances. A four-collector appliance is a pair – in parallel – of two collectors in series.

2.1.6.2 “Collector Tilt Angle/Roof Slope” Fields

These two values will update each other dynamically. The collector angle is used to specify a certain tilt (0° = flat on the ground; 90° = perpendicular to the ground) while the roof slope (also called roof pitch, rise over run) uses a ratio in inches. The value for collector angle is the one used in the calculations for the simulation.

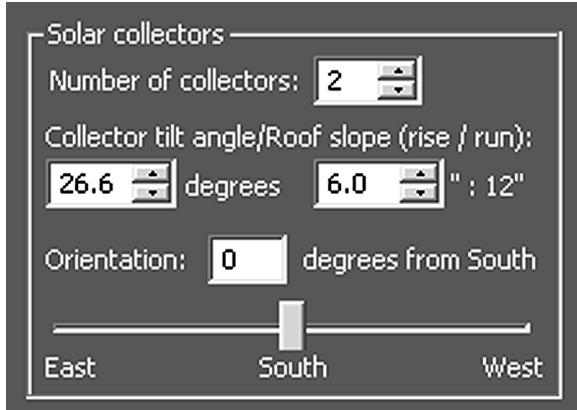


Fig. 4: Settings for solar collectors.

2.1.6.3 “Orientation” Field And Slider

Also known as the azimuth angle, the orientation is the compass angle (corrected for magnetic declination) using due south at 0° (making due west $+90^\circ$ and due east -90°). Usually a due-south orientation is optimal, but certain locations may have different optimal azimuth due to environmental variables. The value can be typed in or the slider can be moved to obtain the desired orientation.

2.1.7 “Economics” Settings

The economics section takes inputs for monetary and CO_2 values. The “Generation mix...” and “Energy prices...” buttons are explained in sections 2.2 and 2.3 respectively.

2.1.7.1 “Units” Radio Buttons

Choosing “Metric” or “US customary” will display all values in the selected units.

2.1.7.2 “Consumer Costs” Settings

“Consumer purchase price” is the cost of the system not including installation. “Installation cost” is strictly the cost of installation. The “Pricing...” button is explained in section 2.4.

“Annual maintenance costs” is how much it costs to have the appliance inspected annually and have the heat-transfer fluid checked/replaced triennially.

2.1.7.3 “ CO_2 Emission Value” Field

This is the dollar value per ton (tonne) of carbon dioxide for carbon credits. In Canada, the rate is

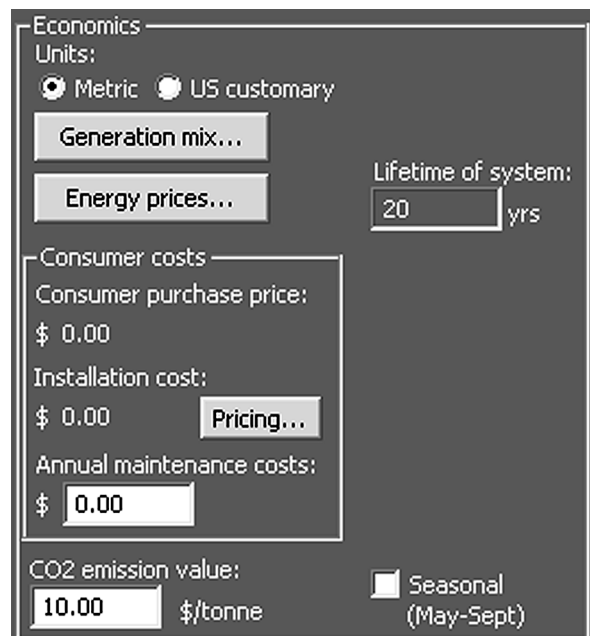


Fig. 5: Economics Group.

currently \$10/ton (tonne)⁴.

2.1.7.4 “Lifetime of System” Field

This input is a constant of 20 years. It is used to simulate the lifetime of the system, although the EnerWorks residential appliance has an expected lifetime of at least 25 years.

2.1.7.5 “Seasonal (May-Sept)” Field

When this checkbox is activated, the simulation will only calculate results from May 1 through to September 30. This is intended for seasonal (i.e. late spring, summer, and early fall) residences such as cottages.

2.1.8 “Site” & “Client” Fields

These two fields give the option of specifying a certain site and client. They are completely optional and only appear in the print-outs.

2.1.9 Control Buttons

This yellow “Simulate” button is pressed after all inputs have been decided. The progress bar below it indicates the progress of the simulation. It must be pressed every time there is a change in inputs in order to affect the outputs.

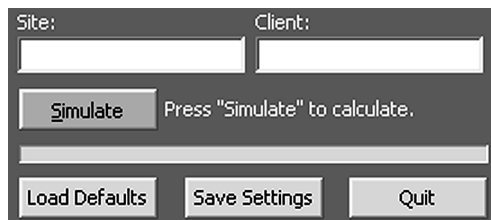


Fig. 6: Command Buttons.

“Load Defaults” loads the program defaults, erasing all current inputs including those on all subscreens. The program gives a warning message before proceeding and allows you to cancel.

“Save Settings” saves the current inputs on the main screen (i.e. does not save any settings on the subscreens as the values there are saved every time the “Save” button is pressed on those screens). There is no confirmation.

“Quit” closes the program after confirmation.

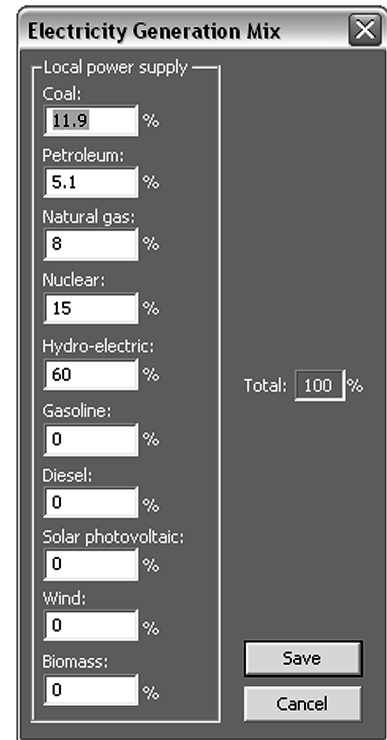
2.2 “Generation Mix” Screen

The generation mix determines the amount of CO₂ emitted from water heaters powered by electricity.

The values don’t have to add up to 100% and should match the power supply of the selected location as closely as possible.

For Canada, numbers for the national average generation mix can be found via our website <http://www.enerworks.com>. For the USA, numbers for the national average generation mix can also be found on the Energy Information Administration’s Web site via our website <http://www.enerworks.com>.

*The generation percentages can be calculated manually for each state by visiting http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=XX, where **XX** is the state abbreviation or by clicking on an updated link at <http://www.enerworks.com>.*



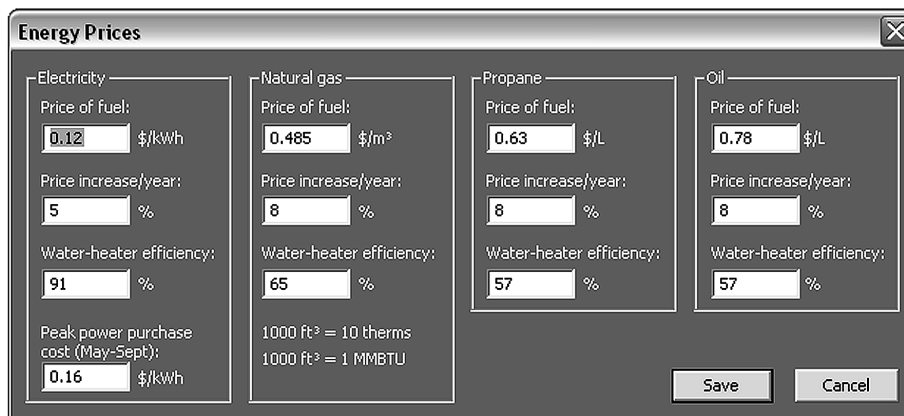
Energy Source	Percentage (%)
Coal	11.9
Petroleum	5.1
Natural gas	8
Nuclear	15
Hydro-electric	60
Gasoline	0
Diesel	0
Solar photovoltaic	0
Wind	0
Biomass	0
Total	100

Fig. 7: The “Generation Mix” Screen.

2.3 “Energy Prices” Screen

In order to figure out energy costs both with and without solar thermal, the price for each fuel type of interest (electricity, natural gas, propane, or oil) is required, along with an annual inflation rate (also called “escalation”) for each fuel type. Also influencing energy costs and the performance of the solar appliance is the efficiency of the auxiliary (existing) tank. These efficiencies are assumed to be constant over the simulation period.

Ensure that the prices being inputted are the final delivered price, including delivery charges, transportation charges, taxes, and so forth. Failing to do so will result in worse economics. Some jurisdictions have a peak-power purchase cost for electricity in the summer months. This value



Electricity	Natural gas	Propane	Oil
Price of fuel: 0.12 \$/kWh	Price of fuel: 0.485 \$/m ³	Price of fuel: 0.63 \$/L	Price of fuel: 0.78 \$/L
Price increase/year: 5 %	Price increase/year: 8 %	Price increase/year: 8 %	Price increase/year: 8 %
Water-heater efficiency: 91 %	Water-heater efficiency: 65 %	Water-heater efficiency: 57 %	Water-heater efficiency: 57 %
Peak power purchase cost (May-Sept): 0.16 \$/kWh	1000 ft ³ = 10 therms 1000 ft ³ = 1 MMBTU		

Fig. 8:
The “Energy Prices” Screen.

can be entered at the bottom of the UI. SolSim assumes this timespan to be between May 1 and September 30.

The energy prices are used to calculate total percent of annual savings, payback, and return on investment in conjunction with the installed cost of the system.

Current fuel prices for the USA can be found on the Energy Information Administration's Web site.

- Electricity: http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_a.html
- Natural gas: http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_a_EPG0_PRS_DMcf_m.htm
- Propane and oil: http://tonto.eia.doe.gov/dnav/pet/pet_pri_wfr_dcus_nus_w.htm

Current fuel prices for Canada need to be sourced from the utilities.

2.4 "Pricing" Screen

The "Pricing" dialog is necessary for calculating certain economic outputs, particularly the total percent of annual savings, payback, and return on investment.

Current pricing is available from EnerWorks. Information on rebates and incentives for the United States is available on the DSIRE Web site at <http://www.dsireusa.org>. Most information for Canada's rebates and incentives can be obtained from CanSIA's Web site at <http://www.cansia.ca> by clicking on the "Government Incentives" button.



	Cost	Margin	Consumer price
Appliance	\$ 0.00	0.00 %	\$ 0.00
Mounting hardware	\$ 0.00	0.00 %	\$ 0.00
Installation kits	\$ 0.00	0.00 %	\$ 0.00
Solar storage tank	\$ 0.00	0.00 %	\$ 0.00
Installation	\$ 0.00	0.00 %	\$ 0.00
Additional supplies	\$ 0.00	0.00 %	\$ 0.00
Shipping			\$ 0.00
SUB-TOTAL			\$ 0
Incentives			-\$ 0.00
TOTAL			\$ 0

Fig. 8: The "Pricing" Screen.

3.0 Outputs

After all of the appropriate inputs have been set, the “Simulate” button must be pressed before any outputs can be viewed.

3.1 “Economics Summary” Screen

This screen shows the economic information that is calculated from the simulation.

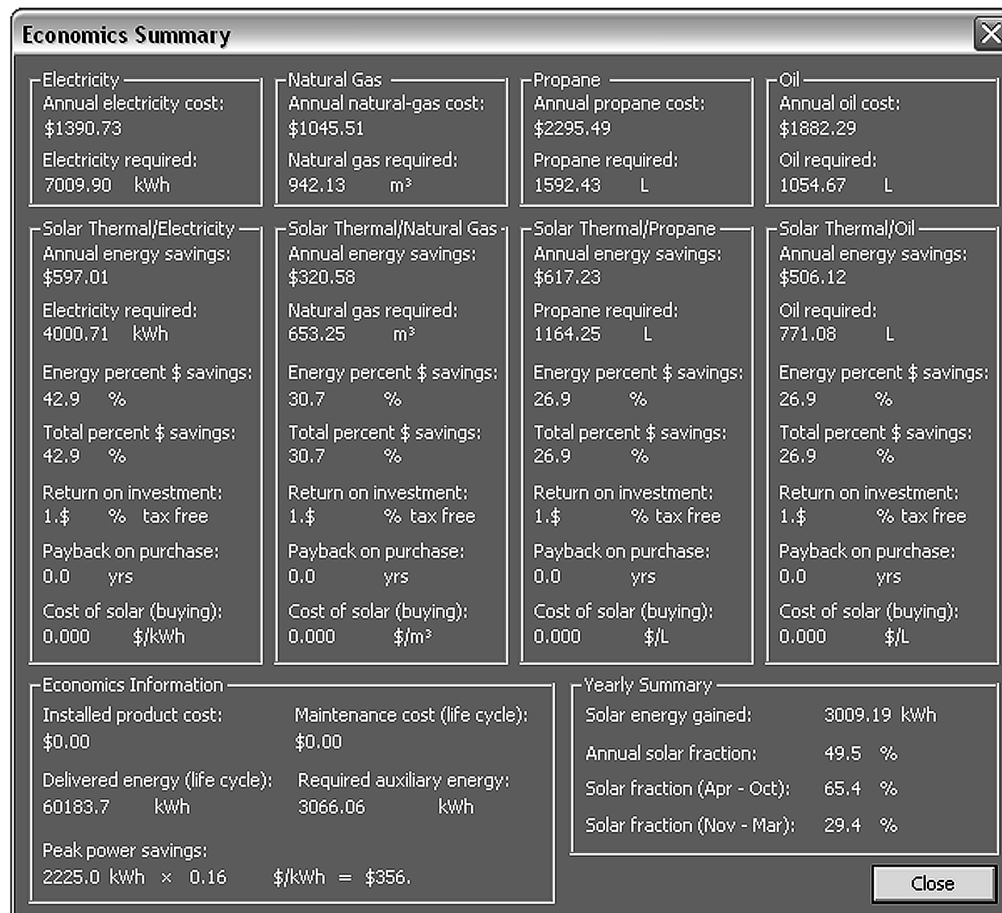


Fig 10: The Economics screen.

3.1.1 Fuel Information

For each fuel type, the 20-year annual average is shown for energy cost, amount of energy required without solar thermal, annual energy savings with solar thermal, and amount of energy required with solar thermal. Total percent savings is based on the installed cost of the product plus the 20-year energy costs with solar thermal. Return on investment is the inverse of payback on purchase, the latter of which is calculated based on how long it takes for the energy savings to pay for the installed appliance.

To calculate the annual fuel cost, the amount of energy required to heat the water load is multiplied by the tank increase (5%) and then for each fuel type is divided by the efficiency of the auxiliary water

tank and converted into the appropriate units. This is displayed as “<fuel type> required”.

With the amount of energy required known, the following calculation is performed to obtain the 20-year annual average cost of fuel:

$$\frac{19}{\sum_{j=0}^{19} \text{annual_energy_required} * \text{energy_price} * (1 + \text{escalation})^j} \div 20 \quad (\text{eq.1})$$

The annual amount of energy supplied by the EnerWorks appliance is used to find out how much of each fuel type is offset. The values for “Annual energy savings” under the “Solar Thermal/<fuel type>” headings are calculated using the formula below:

$$\frac{19}{\sum_{j=0}^{19} \text{annual_energy_saved} * \text{energy_price} * (1 + \text{escalation})^j} \div 20 \quad (\text{eq.2})$$

With solar thermal, the “<fuel type> required” value is calculated using the annual amount of energy required (including factoring in the tank efficiency) subtracting the amount of solar energy supplied.

“Energy percent \$ savings” shows how much is being saved annually over the 20-year average on energy bills. The numerator is the amount of dollars saved and the denominator is the amount required without solar:

$$(\text{eq.2}) \div (\text{eq.1}) \times 100 \quad (\text{eq.3})$$

“Total percent \$ savings” is the percentage savings based on the 20-year average energy savings as the numerator and the denominator is 20-year average energy costs without solar thermal plus the initial cost of the system. It is calculated using the following calculation:

$$(\text{eq.2}) \times 20 \div (\text{total_installed_cost} + \text{total_maintenance_cost} + (\text{eq.1}) \times 20) \times 100 \quad (\text{eq.4})$$

“Return on investment” is computed using the calculation below:

$$(\text{eq.2}) \div (\text{total_installed_cost} + \text{total_maintenance_cost}) \times 100 \quad (\text{eq.5})$$

“Payback on purchase” is the inverse of the return on investment without being expressed as a percentage:

$$(total_installed_cost + total_maintenance_cost) \div (eq.2) \quad (eq.6)$$

3.1.2 “Economics Information” Group

“Installed product cost” is taken from the Pricing Screen.

“Maintenance cost (life cycle)” is the 20-year total cost of maintenance.

“Delivered energy (life cycle)” is simply the annual average amount of solar energy gained multiplied by 20 years:

$$annual_average_solar_energy \times 20 \quad (eq.7)$$

“Required auxiliary energy” is the amount of additional energy required to heat water (this is straight energy, i.e. not including efficiencies or tank losses). It is the total amount of energy required to heat water subtracting the amount of solar energy gained:

$$annual_energy_required - annual_average_solar_energy \quad (eq.8)$$

“Peak power savings” is a result of the amount of solar energy supplied in the summer multiplied by the dollar value given in the Energy Prices screen (see section 2.3).

3.2 “Emissions Credits” Screen

Emissions information is computed using the emission values for each fuel type (electricity is based on the generation mix [see section 2.2]). The credit values are derived from the value on the main screen (see section 2.1.7.3).

Emission Credits			
Electricity CO2 emissions: 1429.08 kg/yr	Natural Gas CO2 emissions: 1886.35 kg/yr	Propane CO2 emissions: 2418.23 kg/yr	Oil CO2 emissions: 2966.55 kg/yr
Solar Thermal/Electricity CO2 emissions: 752.27 kg/yr CO2 not emitted: 676.81 kg/yr CO2 prevented: 47.4 % CO2 emission value: 6.77 \$/yr	Solar Thermal/Natural Gas CO2 emissions: 1279.03 kg/yr CO2 not emitted: 607.32 kg/yr CO2 prevented: 32.2 % CO2 emission value: 6.07 \$/yr	Solar Thermal/Propane CO2 emissions: 1735.49 kg/yr CO2 not emitted: 682.74 kg/yr CO2 prevented: 28.2 % CO2 emission value: 6.83 \$/yr	Solar Thermal/Oil CO2 emissions: 2129.00 kg/yr CO2 not emitted: 837.55 kg/yr CO2 prevented: 28.2 % CO2 emission value: 8.38 \$/yr

Fig. 11: The “Emission Credits” Screen.

3.3 “Performance Graphs” Screen

The performance graphs give a visual indication of various aspects of the performance of the appliance.

3.3.1 “Annual Energy” Graph

Energy (in kWh) is measured on this graph – note that the scale does not start at 0 but at the minimum energy value. The red line represents the monthly amounts of energy required to heat water using just an auxiliary tank (no efficiencies taken into effect). The blue line represents the monthly amounts of solar energy gained (gained = auxiliary - solar), which can never exceed the amount required since it is measuring energy consumed, not energy produced or delivered.

Future versions of the graph may include energy produced to indicate possible stagnation.

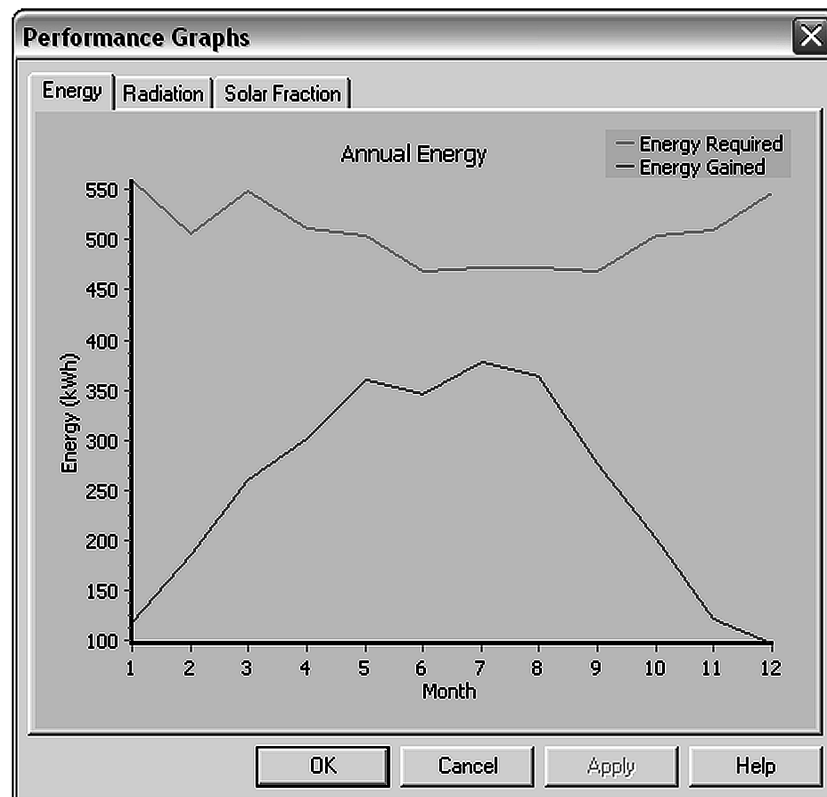


Fig. 12: The “Annual Energy” Graph.

3.3.2 “Annual Radiation” Graph

Each bar represents the total amount of solar radiation for the month of the year.

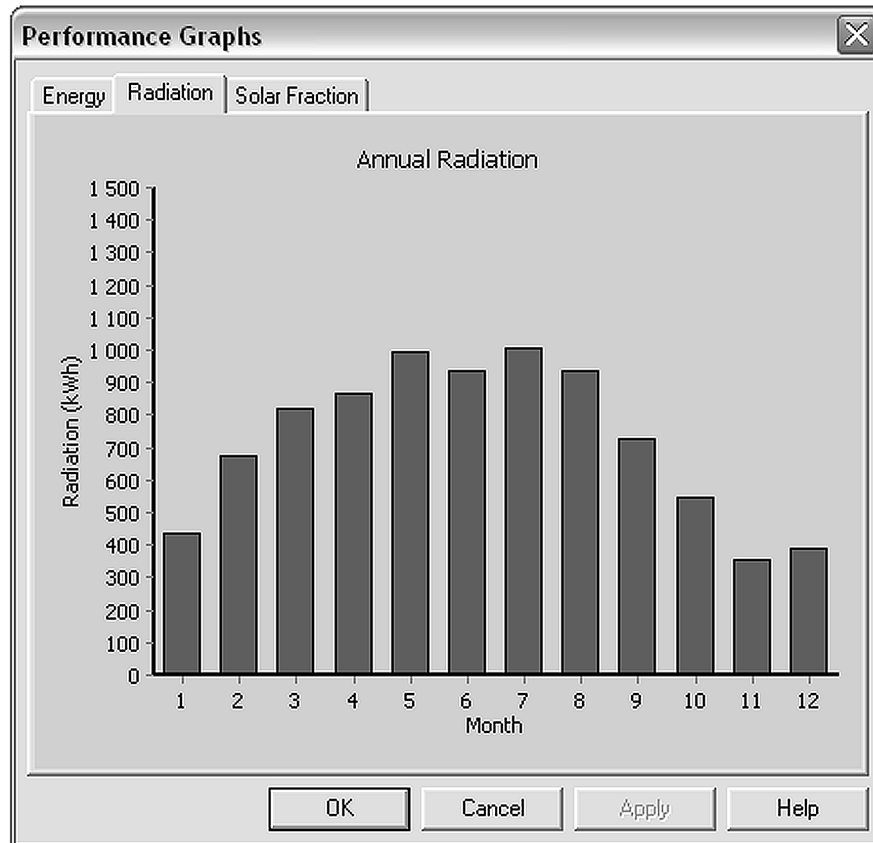


Fig. 13: The “Annual Radiation” Graph.

3.3.3 “Annual Solar Fraction” Graph

Solar fractions for each month are displayed in this graph. Solar fraction is defined as the amount of energy for heating water supplied by the appliance divided by the amount of total energy required to heat water.

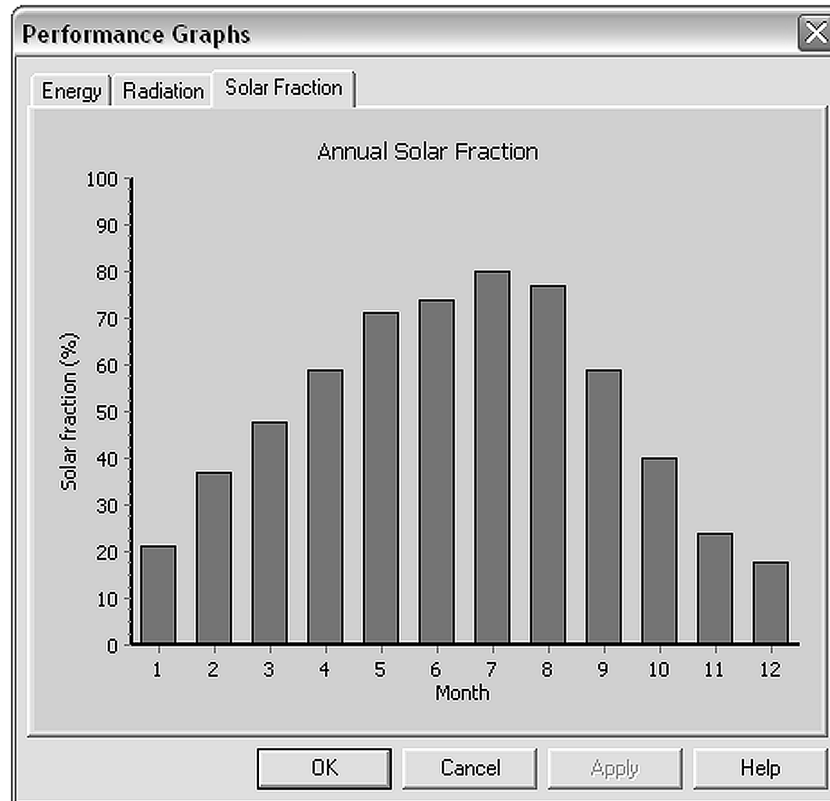


Fig. 14: The “Solar Fraction” Graph.

3.4 Saving And Printing Outputs

In order to save the results of a simulation, go to the “File” menu and select “Save Outputs”. There is a choice between saving in HTML format (recommended) and plain-text format. HTML files can be opened in a Web browser for viewing. HTML files can be opened in some word processors such as Microsoft® Word for editing.

In order to print a simulation, open the saved file and print it. If the graphs are to be included, the HTML file can have the graphs included by opening the file in an editor and inserting screen captures of the graphs.

4.0 Footnotes

1. *Watsun TMY format:*

Table 4.1 - Watsun TMY weather file format

Header: 0000×0×CityNameProvince×LATIT

where:

CityNameProvince: Name of city / province (16 characters)

LATIT: latitude in degrees (5 characters)

×: space

The header is followed by 365 groups of four records. Records are as follows:

1. Day of year [], ground reflectance [], dry bulb temperature [C]
2. Global radiation on a horizontal surface [W/m²]
3. Wind speed [km/h]
4. Relative humidity [%]

FORTRAN formats are

?? for record 1: (I3, 1X, F3.1, 17X, 24I3)

?? for records 2-4: (24I43)

2. *RETScreen International - <http://www.etscreen.net>*

3. *BC Hydro - Power Smart at Home - Water Heating* <http://www.bchydro.com/powersmart/elibrary/elibrary629.html#2>

4. *The National, June 2007: \$20 for every two tonnes*



Selection, Sizing and Site Evaluation



232023

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Toll-free: 1-877-268-6502
Fax: (519) 268-6292
www.enerworks.com

Foreword

Use this Selection, Sizing and Site Evaluation manual to select the best EnerWorks Solar Water Heating Appliance for your needs and to choose the most appropriate installation location. This manual complements installation training available through EnerWorks or approved distributors. EnerWorks training is mandatory to become an EnerWorks authorized dealer.

EnerWorks encourages installers of EnerWorks products to always keep workmanship, best practices and safety in mind. An organized installation will benefit both installer and end-user.

The EnerWorks Solar Collector is one of the highest-rated in North America. This assessment was carried out by third-party testing under the supervision and scrutiny of the Solar Rating and Certification Corporation (SRCC). The EnerWorks Solar Collector has SRCC OG-100 certification and the EnerWorks Residential Solar Water Heating Appliances are certified to OG-300 standards. This certification does not imply endorsement or warranty of these products by SRCC.

The EnerWorks High Performance Appliance is certified by the International Association of Plumbing and Mechanical Officials (IAPMO) as meeting the standards of the Uniform Solar Energy Code (USEC®). This certification does not imply endorsement or warranty by IAPMO.

The High Performance Appliance described in this manual, when properly installed and maintained, meets or exceeds the standards established by the Florida Solar Energy Center (FSEC), in accordance with Section 377.705, Florida Statutes. This certification does not imply endorsement or warranty of this product by the Florida Solar Energy Center or the State of Florida.

The EnerWorks High Performance Appliance is the first system in North America to achieve the Canadian Standards Association (CSA) certification (CSA F379.1). This certification does not imply endorsement or warranty by CSA.



CALIFORNIA PROPOSITION 65 WARNING: This product contains chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.



Appliance must only be installed by an EnerWorks-authorized dealer or warranty is void.



Recognize this symbol as an indication of important safety information!



EnerWorks Residential Solar Water Heating Appliances must be installed as directed by this manual by an EnerWorks-authorized dealer or warranty is void.

CARE, HANDLING AND STORAGE

EnerWorks Solar Collectors are manufactured with tempered glass. Though extremely resistant to impact, tempered glass can break if an edge is subjected to stress. During storage and installation, protect glass edges. Glass breakage is not covered by warranty.

Store collectors in a dry place, lying flat with glass up, or leaning on long edge with glass facing out and connections at top. Protect collector from scratches and damage by placing it on a soft surface such as a blanket or cardboard. When hoisting collectors to roof, be very careful not to bang glass edge. Collectors must not be levered over ladder or eave or they may be damaged. Be very careful of collector connections as they are soft copper and may be easily damaged. A leak-proof heat-transfer fluid loop can only be achieved if collector connections are not damaged.

Do not store collectors outside with glass face down. Due to EnerWorks's patented stagnation-control device, back of collector is not sealed to atmosphere. Rain may enter collector if it is stored face down. Any damage due to ingress of rain is not covered by warranty.

It is best to store both the EnerWorks Solar Collectors and the EnerWorks Energy Pack in a cool, dry place.

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Safety



Neither Energy Kinetics nor EnerWorks assume responsibility for damage, loss or injury related to installation of this appliance.



Observe any and all regulations relating to installation of solar appliances and to plumbing to potable water supply. Plumbing and/or building permits may be necessary. EnerWorks Solar Water Heating Appliances utilize a single-wall heat exchanger. Single-wall heat exchangers may not be acceptable in all jurisdictions.



Assemblies and materials used during installation shall meet requirements of local, regional, state, provincial, and federal regulations and fire codes. Any penetrations made in drywall or any other firewall must be fixed to maintain integrity of fire protection.



All persons working on roofs should have successfully completed a fall-safety course and should be properly equipped with appropriate safety equipment.

2 – EnerWorks Solar Water Heating Appliance

2.1 Description

The EnerWorks Solar Water Heating Appliance has four main parts (Figs. 2.2 & 2.3) – the solar collectors, the line-set, the Energy Pack and the solar storage tank.

The Energy Pack uses a pump to circulate a heat-transfer fluid through the “collector loop”. This collector loop includes the solar collectors, the fluid lines or “line-set” and a heat exchanger. The collector loop is a “closed loop”, meaning there is no contact of the heat transfer fluid with your potable water or with the atmosphere. The collector loop contains only a small volume of heat-transfer fluid which is food-grade and freeze-protected. Though freeze protection may not be necessary in all areas, the heat-transfer fluid also has an elevated boiling point and so is suitable throughout North America.

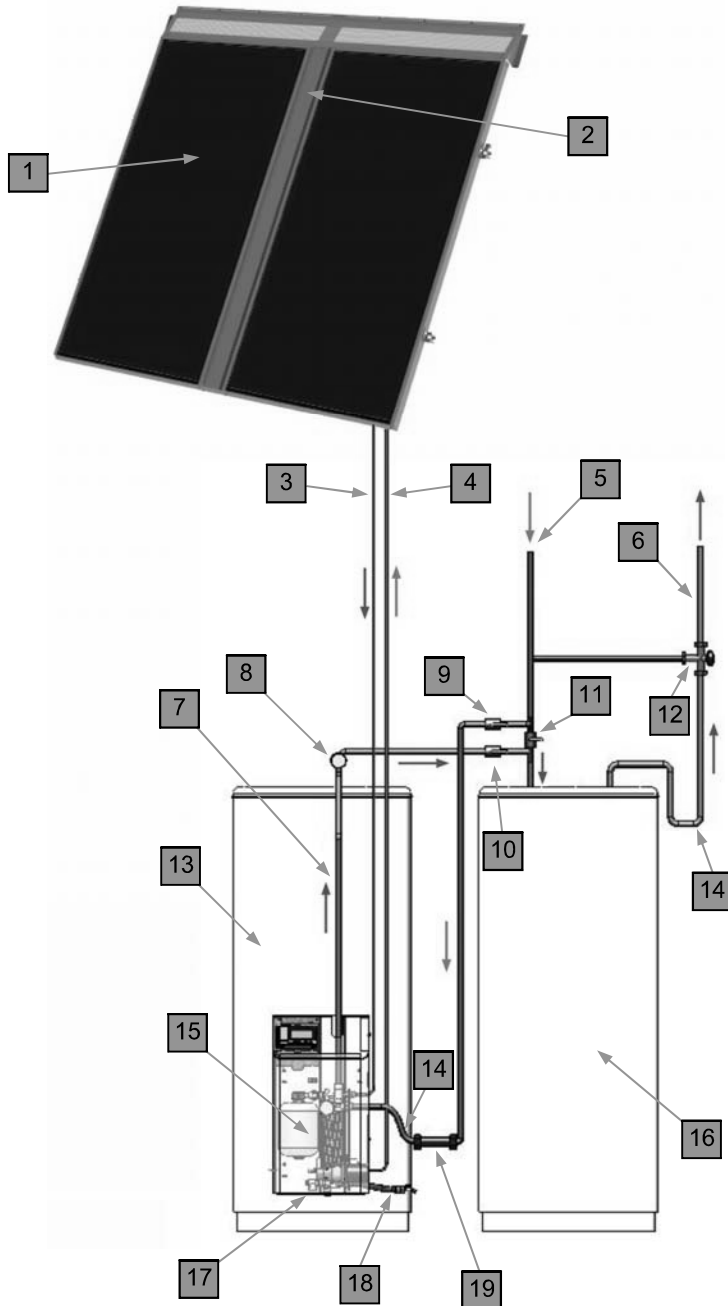
When exposed to sunlight, the solar collectors get hot. As the heat-transfer fluid passes through the collectors, it absorbs heat and then travels down the line-set to the Energy Pack. The hot fluid passes through the heat exchanger and heat is transferred to the potable water. After giving up its heat to the potable water, the cool heat-transfer fluid is pumped back to the solar collectors to be heated again. Hot potable water is stored in the solar storage tank.

In the High Performance Solar Water Heating Appliance (Fig. 2.2), the solar storage tank is a standard, North American, electric hot-water tank. No power is connected to this tank – it only stores solar-heated water. The solar storage tank is plumbed in series with the original water heater (electric, fossil fuel or on-demand). Whenever hot water is used in the home, solar-heated water leaves the solar storage tank and enters the original water-heater. The original water-heater now requires much less energy for water heating.

Thus, the Appliance displaces energy, but it does not replace the original water-heater. The original heater guarantees hot water even under poor solar conditions (at night or when very cloudy). It also ensures that hot water is stored or supplied at an appropriate temperature to kill harmful bacteria. The acceptable temperature set-point is specified in local plumbing codes. Do not turn off or bypass the back-up water heater. Even in summer months, additional heat from the back-up heater may be required.

The Space-Saver™ Solar Water Heating Appliance (Fig. 2.3) incorporates solar water-heating and auxiliary water-heating in a single tank. The Space-Saver™ Appliance is the solar solution for homes (in the United States) that cannot accommodate two tanks. For more information on Appliance components and function, please see the Owner Manual.

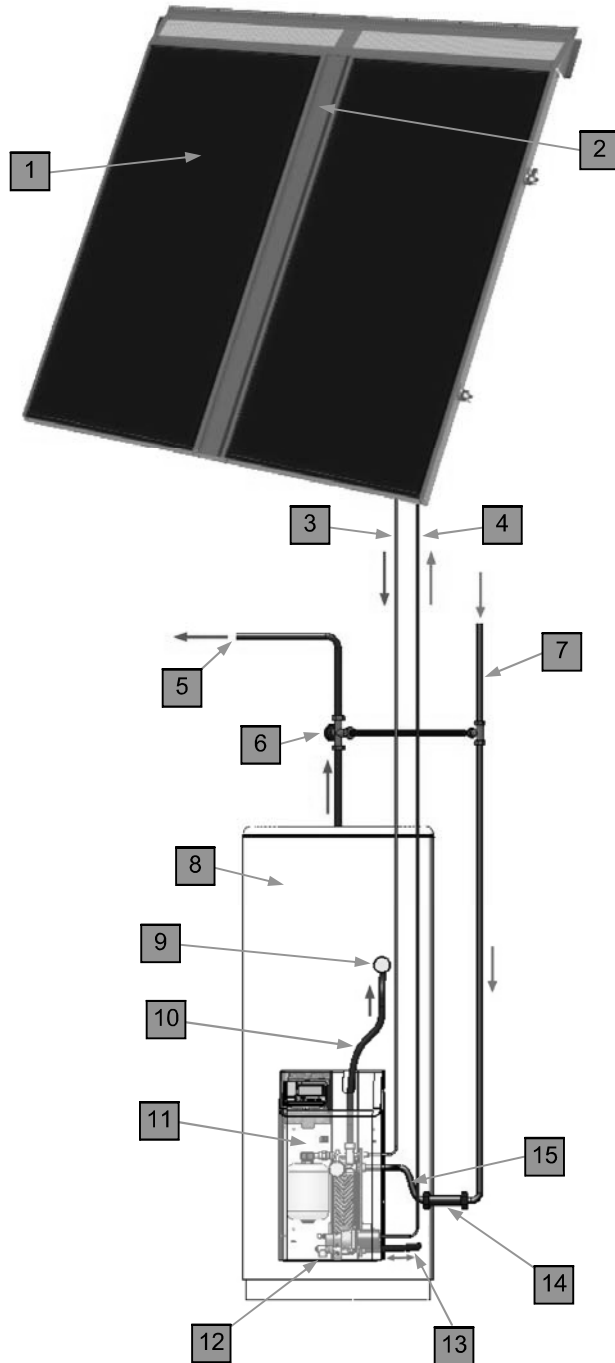
2.2 High Performance Appliance Schematic



- 1 Solar collectors (1 to 4)
- 2 Line-set roof-penetration (behind flashing)
- 3 Heat-transfer fluid line from collectors to Energy Pack (red – carries hot fluid)
- 4 Heat-transfer fluid line from Energy Pack to collectors (blue – carries cool fluid)
- 5 Cold mains water supply (blue)
- 6 Hot water supply to home (red)
- 7 Thermosiphon loop, solar-heated water to storage tank (red)
- 8 Thermometer
- 9 Bypass valves (to isolate Appliance for service)
- 10 Bypass valves (to isolate Appliance for service)
- 11 Bypass valves (to isolate Appliance for service)
- 12 Anti-scald valve (not included, may be required by code)
- 13 Solar storage tank
- 14 Heat trap (U-bend limits heat loss)
- 15 Energy Pack
- 16 Pre-existing or auxiliary hot water tank
- 17 Pressure relief valve (inside cover)
- 18 Thermosiphon loop feed (from storage)
- 19 Cold mains water flow meter

Fig. 2.2 EnerWorks High Performance Solar Water Heating Appliance (with optional leaf-guard)

2.3 Space-Saver™ Appliance Schematic (USA only)



- 1 Solar collectors (1 or 2)
- 2 Line-set roof-penetration (behind flashing)
- 3 Heat-transfer fluid line from collectors to Energy Pack (red – carries hot fluid)
- 4 Heat-transfer fluid line from Energy Pack to collectors (blue – carries cool fluid)
- 5 Hot water supply to home (red)
- 6 Anti-scald valve (required)
- 7 Cold mains water supply (blue)
- 8 Solar storage tank with electric back-up
- 9 Thermometer
- 10 Thermosiphon loop, solar-heated water to storage tank (red)
- 11 Energy Pack
- 12 Pressure relief valve (inside cover)
- 13 Thermosiphon loop feed (from storage)
- 14 Cold mains water flow meter
- 15 Heat trap (U-bend limits heat loss)

Fig. 2.3 EnerWorks Space-Saver™ Solar Water Heating Appliance (with optional leaf-guard)

3 – Choosing The Correct Water-Heating Solution

Depending on the application and the available space, EnerWorks offers a choice of residential water-heating solutions: the High Performance Appliance and the Space-Saver™ Appliance (USA only).

3.1 High Performance Appliance (Pre-Heat)

The EnerWorks High Performance Solar Water Heating Appliance is a pre-heat system (often referred to as a two-tank system). It is installed to pre-heat the water that enters the existing water-heater (electric or fossil fuel hot-water tank, or on-demand water-heater). When hot water is needed in the home, solar-heated water from a solar storage tank enters the existing water-heater. The existing water-heater thus requires less energy. The pre-heat Appliance provides exceptional performance due to additional hot water storage capacity.

If paired with an on-demand water-heater, on-demand heater must be temperature modulated (not only flow-modulated) and able to accept hot water at inlet (check manufacturer’s specifications). A tempering valve may be necessary upstream of the on-demand heater to prevent quick cycling – check with manufacturer if on demand water-heater can be used with solar pre-heat system.



Solar storage tank size does not depend on size of existing water-heater but on number of solar collectors. Number of collectors depends on hot water use and on number of individuals in home. Solar storage tank must be certified by a nationally recognized standard (e.g. UL or CSA).

Use Table 3.1 to determine appropriate number of collectors and minimum size of solar storage tank for High Performance Appliance installed in cool climates (northern USA and Canada).

Use Table 3.2 to determine appropriate number of collectors and minimum size of solar storage tank for High Performance Appliance installed in warm climates (southern USA).

Table 3.1: Sizing High Performance (pre-heat) Appliance for COOL CLIMATE Northern United States (above ~37°) and Canada*

Individuals in home	Appliance Size	Minimum Solar Storage Tank Size for COOL CLIMATE (Standard North American Electric Tank)		
2 - 3	1-collector	50 gal US	40 gal Imp	170 - 275 L
3 - 5	2-collector	80 gal US	60 gal Imp	275 - 365 L
5 - 7	3-collector	120 gal US	80 gal Imp	365 – 455 L
7 - 10	4-collector	120 gal US	100 gal Imp	455 – 545 L
For commercial applications, contact your distributor				

*Guideline only – decision may vary depending on water use and application, climate, altitude and local conditions. If in doubt, up-size storage or contact your distributor.

Table 3.2: Sizing High Performance (pre-heat) Appliance for WARM CLIMATE Southern United States (below ~37°N)*

Individuals in home	Appliance size	Solar Storage Tank size for WARM CLIMATE Standard North American electric tank	
2 - 4	1-collector	65 or 80 gal US	245 - 300 L
5 - 7	2-collector	120 gal US	455 L
For commercial applications, contact your distributor			

*Guideline only – decision may vary depending on water use and application, climate, altitude and local conditions. If in doubt, up-size storage or contact your distributor.

3.2 Space-Saver™ Appliance (Single-Tank, USA only)

For homes or apartments that do not have space for two tanks, a space-saving, single-tank appliance is available. The EnerWorks Space-Saver™ Solar Water Heating Appliance has a storage tank that combines both solar and electric heating. It has an upper heating element and a side-entry port for solar thermosiphon loop connection.



Space-Saver™ Appliances may be installed in the United States only with tanks described in Table 3.3. Space-Saver™ Appliances are not available in Canada as tanks do not have CSA certification.

Table 3.3: Acceptable tanks for Space-Saver™ Appliance include ONLY the following

Capacity	Manufacturer Model	Model No. Type	Element Wattage	Height	Diameter	Weight	R-Value
80 gal US	Rheem* Solaraide™	81VR-80-1 side-connect	4500 W	58.75 in	24.5 in	192 lb	R-17.3
120 gal US	Rheem* Solaraide™	81VR-120-1 side-connect	4500 W	62 in	28.25 in	336 lb	R-16.7
80 gal US	Ruud* Solar Servant™	RSPER80-1 side-connect	4500 W	58.75 in	24.5 in	192 lb	R-17.3
120 gal US	Ruud* Solar Servant™	RSPER120-1 side-connect	4500 W	62 in	28.25 in	336 lb	R-16.7

*Rheem/Ruud Water Heaters, www.rheem.com, www.ruud.com

Solar storage tank size does not depend on size of previous water-heater but on number of solar collectors. Number of collectors depends on hot water use and on number of individuals in home. Solar storage tank must be certified by a nationally recognized testing laboratory (e.g., UL).

Use *Table 3.4* to determine appropriate number of collectors and minimum size of solar storage tank for Space-Saver™ Appliance installed in cool climates (northern USA).

Table 3.4: *Sizing the Space-Saver™ (single-tank) Appliance for COOL CLIMATE Northern United States (above ~37°N)**

Individuals in home	Appliance Size	Rheem Solaraide™ or Ruud Solar Servant™ Solar Electric Hot Water Tank for COOL CLIMATE
2 - 3	1-collector	120 gal US Rheem Solaraide™ or Ruud Solar Servant™
4 - 5	<i>High-Performance (pre-heat) Appliance is recommended</i>	
For commercial applications, contact your distributor		

*Guideline only – decision may vary depending on water use and application, climate, altitude and local conditions. If in doubt, contact your distributor.



At times of low solar radiation, Space-Saver™ Appliance may not be able to meet hot water recovery rates desired by large families in northern USA as Solaraide™ tank has only one heating element. Space-Saver™ Appliance may still be installed if families do not require large volumes of hot water in short time spans, or if a larger wattage (6000W) heating element is installed to replace the standard wattage (4500W) element.

Use *Table 3.5* to determine appropriate number of collectors and minimum storage Space-Saver™ Appliance installed in warm climates (southern USA)

Table 3.5: *Sizing the Space-Saver™ (single-tank) Appliance for WARM CLIMATE Southern United States (below ~37°N*)*

Individuals in home	Appliance Size	Rheem Solaraide™ or Ruud Solar Servant™ Solar Electric Hot Water Tank for WARM CLIMATE
2 - 3	1-collector	80 gal US or 120 gal US Rheem Solaraide™ or Ruud Solar Servant™
4 - 5	2-collector	120 gal US Rheem Solaraide™ or Ruud Solar Servant™
6 - 7	<i>High-Performance (pre-heat) Appliance is recommended</i>	
For commercial applications, contact your distributor		

*Guideline only – decision may vary depending on water use and application, climate, altitude and local conditions. If in doubt, up-size storage or contact your distributor.

3.3 Appliance And Solar Storage Tank Considerations

3.3.1 Tank Size

If a home requires hot water regularly throughout the day, the minimum solar storage tank size is a good solution, providing good value and taking up a minimum of space.

If a home's hot water use is concentrated at the beginning and at the end of the day, a solar storage tank larger than the minimum required size will provide greater storage capacity of hot water and better performance.

A smaller family may benefit from a larger tank. With less hot water use, more storage may limit the occurrence of stagnation and maximize daily energy gain.

3.3.2 AC Power Required

EnerWorks Energy Pack requires 120 VAC and should be installed in proximity to a 120 VAC electrical outlet. Total draw from Energy Pack is approximately 23 W.

Surge protection is recommended as any damage to Energy Pack components due to power surge is not covered by warranty.

Space-Saver™ (single-tank) Appliance requires 240 VAC-connection for heating element.

A licensed electrician may be required to make electrical connections. Follow all codes and regulations.



3.3.4 Space Requirements

Allow sufficient space around solar storage tank for installation and maintenance procedures.

Three- and four-collector appliances require space for a 2 gal US (7.8 L) expansion tank to be mounted on side of solar storage tank or on wall.

Follow tank manufacturer's instructions and all electrical, building, fire and plumbing codes regarding placement and installation of hot-water tanks.



3.3.5 Drain Pan

Tank should be placed in an area that will prevent damage to floors, ceilings, and furniture in the event of a leak. If this is not possible, a drain pan must be installed under water heater. Pan must have a pipe to a drain or other outlet for water.



Follow all code requirements regarding drain pans, proximity to drain and draining procedures.

3.3.6 Minimizing Heat Loss, Maximizing Performance

Tank insulation wraps or blankets are very effective at minimizing heat loss and improving performance. The High Performance Appliance can utilize any standard North American electric hot water tank as solar storage. Choosing a well-insulated tank will limit stand-by losses, improve performance and increase return on investment.

Rigid foam board insulation placed under water-heater tanks can further reduce heat loss. About two inches of extruded polystyrene (XPS) board is recommended as it resists compression and does not absorb water.

4 - Site Evaluation

To achieve good performance and a good return on investment, the Appliance must be sized correctly and it must be oriented properly. Site evaluation is necessary to determine whether a site is appropriate and to evaluate the complexity of the installation. It is also necessary to determine the hot water loads, number of individuals in a home, number of collectors and size of solar storage tank.

A site survey (see Appendix – Residential Site Survey) has been developed to assist installers in evaluating potential installation locations. This can be removed from the Appendices and copied as needed. Other tools such as the EnerWorks software, SolSim™, and Solar Pathfinder may assist in determining the best location and orientation for the solar collectors. SolSim and its user guide are available to EnerWorks-authorized dealers.

For roof-mounting, installer should ensure that roof cladding or sheathing is in good repair. Also ensure that rafters and trusses are adequate to support weight of solar collector(s) and mounting assembly.



Building and plumbing permits and/or inspections may be necessary to proceed with installation. Follow all code requirements and regulations.



4.1 Collector Location, Orientation And Shading

Collector(s) should face as close to south as possible for optimal performance. Within 45° of south is acceptable as there is less than 10% loss (Fig. 4.1.1).

The roof angle from horizontal for optimal year-round performance is equivalent to latitude of location plus or minus 15°. A steeper angle provides better winter performance as the sun is lower in the sky. Collectors will also shed snow more effectively. A shallow angle maximizes energy capture in summer when sun is high. Be cautious of placement on low angle roofs due to snow shedding and potential for ice-damming. A minimum collector angle of 14° (3:12 pitch) is necessary for stagnation-control device to function.

Shading of collectors greatly reduces performance. When selecting installation location, consider potential shading by trees and other buildings, especially between peak solar hours of 10:00 and 15:00. A Solar Pathfinder or similar device may be used to determine potential shading throughout the year.

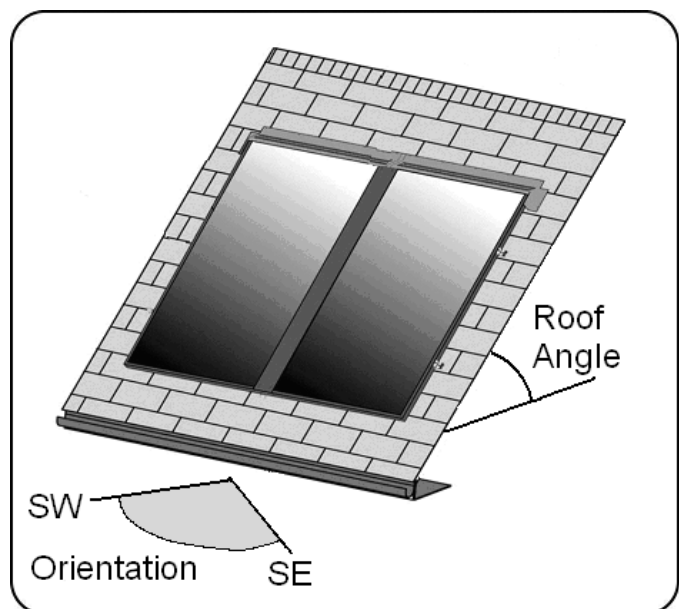


Fig. 4.1.1 – Collector Orientation.

4.2 Available Roof Space

Appliance may consist of one to four collectors depending on required volume of hot water. Check appliance specification sheet for sizing guidelines. Each collector is 4' x 8' (1.219 m x 2.438 m) and must be mounted in “portrait” orientation. Installation area must be clear of roof vents, fans, satellite dishes, etc. Refer to section **7.2 Locating rafters and positioning C-channel** for more details.

4.3 Collector Racks

A rack may be used on the ground or to increase collector-angle on low-angled roofs. Consideration must be given to wind and snow loads, and to aesthetic.



EnerWorks Solar Collectors are not as sensitive to orientation as photovoltaic panels (PV). Due to size and weight of solar thermal collectors, tracking systems are not advisable.



Racking may require approval or certification by a building engineer and/or local authorities. It is the responsibility of the installer to ensure appropriate design and safety criteria are met.

4.4 Line-Set

Line-set carries heat-transfer fluid from collectors to Energy Pack and back again. Line-set must be flexible, refrigeration-grade 3/8” (9.525 mm) (soft-copper tube. A proper and dedicated bending tool must be used for tight bends. Line should be as smooth as possible with no unnecessary fittings or bends. Site evaluation should include examining location and difficulty of roof and wall penetrations. Appropriate techniques and materials for sealing penetrations are necessary.

New homes may choose to run line-set prior to closing in walls, or alternatively, running a 3” (76.2 mm) chase from attic to mechanical room for later use. A line-set inside building may be shorter and will lose less heat. Outside line-sets must be covered as insulation is not UV-stable. Line-set may be covered by a false downspout that matches siding or existing eavestrough, or through electrical conduit. Installer should consult homeowner regarding aesthetics and complexity of installation.

4.5 Location Of Energy Pack And Solar Storage Tank

Energy Pack and solar storage tank will be located in mechanical or utility room, close to existing water-heater. Stairway and doorway clearance must be examined. Additional floor space is required for solar storage tank and Energy Pack. Consideration must be given to location and complexity of wall and ceiling penetrations, and to plumbing of appliance to existing water-heater and to water distribution network.

Energy Pack requires AC power. Solar storage tank and Energy Pack must be installed in proximity to AC outlet. Surge protection is recommended.



4.6 Collector Configurations

EnerWorks Solar Water Heating Appliances are configured with one, two, three or four solar collectors.

4.6.1 One-Collector Configuration

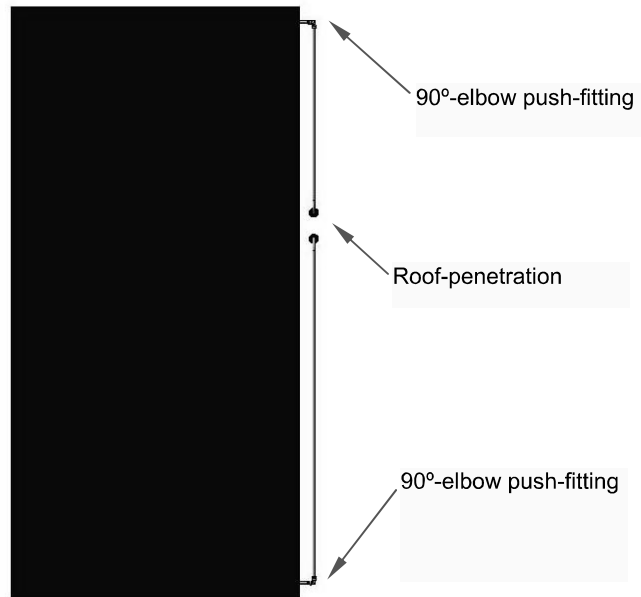


Fig. 4.6.1 – One-collector configuration.

4.6.2 Three-Collector Configuration

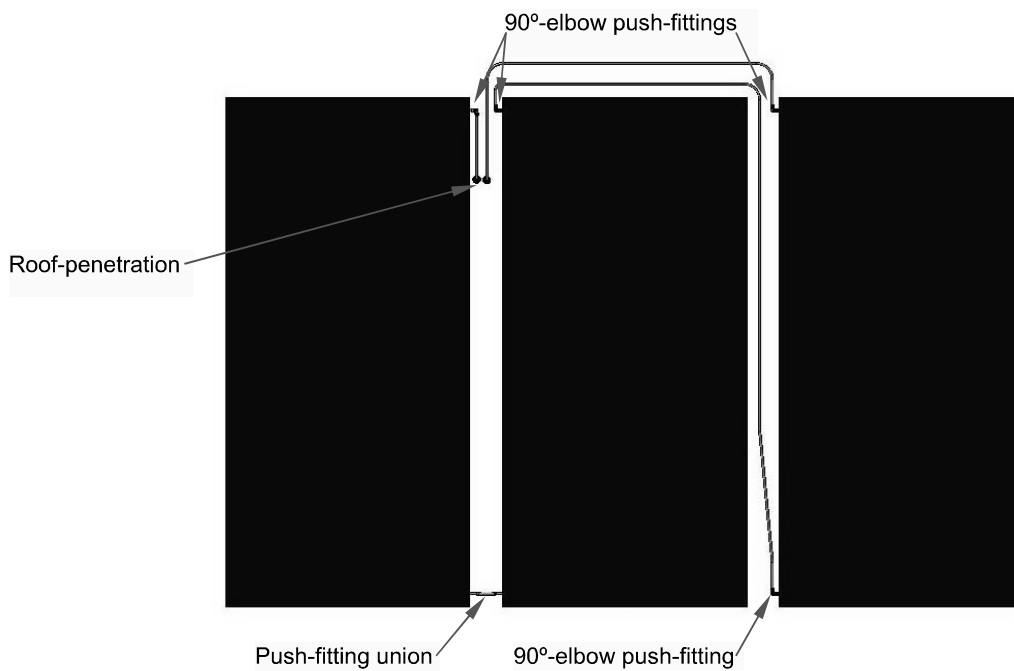


Fig. 4.6.2 – Three-collector configuration.

4.6.3 Four-Collector Configuration

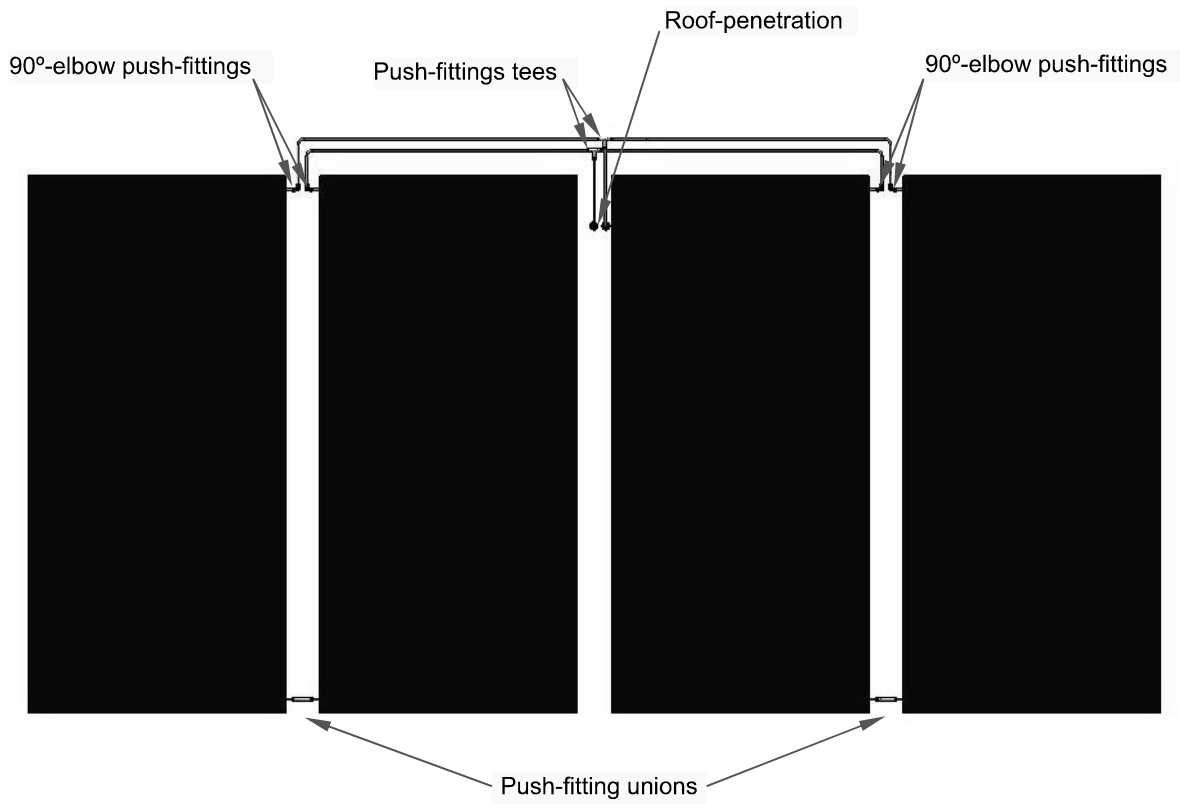


Fig.4.6.3 – Four-collector configuration.



RESIDENTIAL SITE SURVEY

SITE	Name _____	Phone 1 _____	
	Company _____	Phone 2 _____	
	Address _____	Fax _____	
	City _____	e-mail _____	
	State/Prov _____		
	Post Code _____	www. _____	
SITE	Name _____	Phone 1 _____	
	Address _____	Phone 2 _____	
	City _____	Fax _____	
	State/Prov _____	e-mail _____	
	Post Code _____		
SITE	Same as above <input type="checkbox"/>	Coordinates _____ ° _____ ' _____ N	
	Name _____	_____ ° _____ ' _____ W	
	Address _____	Phone 1 _____	
	City _____	Phone 2 _____	
	State/Prov _____	Fax _____	
	Post Code _____	e-mail _____	
WATER	Municipal mains <input type="checkbox"/>	Hardness _____ GPG ppm mg/L	
	Community well <input type="checkbox"/>	(if >29 GPG or >500ppm, water softener must be in place)	
	Private well <input type="checkbox"/>	Turbidity _____ GPG ppm mg/L	
	Lake/River <input type="checkbox"/>	Metals _____	
	Rain <input type="checkbox"/>	Water analysis _____	
	Chlorine shock <input type="checkbox"/>	(Energy Pack must be bypassed if water is shocked with chlorine or carbon filter must be in place)	
WATER & ENERGY USE	Adults _____	Total water use _____ US gal Imp gal L	daily <input type="checkbox"/>
	Teenagers _____	(if not known, approx. 16 US gal, 13 Imp gal, or 60 L per person per day)	weekly <input type="checkbox"/>
	Children _____	Hot water use _____ US gal Imp gal L	monthly <input type="checkbox"/>
	Total _____	(if not known, approximately 1/3 of total hot water use)	annually <input type="checkbox"/>
	Existing water-heater _____	Electric <input type="checkbox"/>	
	Brand / Model _____	Natural gas <input type="checkbox"/>	Storage tank <input type="checkbox"/>
	Size _____ US gal Imp gal L	Oil <input type="checkbox"/>	On-demand <input type="checkbox"/>
	Age _____ yrs	Propane _____	
	Energy use _____ kWh BTU therm ft ³ m ³	Cost of Energy \$ _____	
	monthly <input type="checkbox"/> annually <input type="checkbox"/>	monthly <input type="checkbox"/> annually <input type="checkbox"/>	
	Anticipated # of collectors _____	Solar storage tank size _____	US gal Imp gal L
BUILDING	Age _____ yrs # of stories _____	Roof cladding _____	Asphalt shingle <input type="checkbox"/>
	Line-set route _____	roof-penetration, exterior wall <input type="checkbox"/>	Metal with raised seams <input type="checkbox"/>
	roof-penetration, interior <input type="checkbox"/>	around eave, exterior <input type="checkbox"/>	Tile <input type="checkbox"/>
	in ground <input type="checkbox"/>	Other _____	
	Access to basement _____	Roof/collector direction _____	azimuth _____ °
	Sill height above ground _____	magnetic _____ °	
	Basement construction <input type="checkbox"/>	declination _____ °	
	Space for solar storage tank <input type="checkbox"/>	true _____ °	
	120 VAC available <input type="checkbox"/>	Roof/collector pitch _____	: 12 or _____ °
	Plumbing material _____	Roof condition _____	
	copper <input type="checkbox"/>	Roof access _____	
	PEX <input type="checkbox"/>		
	other _____		
Safety, Notes & Comments			



Solar Collector Installation Manual

1, 2, 3 & 4 Collector High-Performance Appliances

(EWRA1, EWRA2, EWRA3, EWRA4)

1 & 2 Collector Space-Saver™ Appliances (USA only)

(EWRA1-ST, EWRA2-ST)



Solar Water Heating Appliances

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Foreword

EnerWorks encourages installers of EnerWorks products to always keep workmanship, best practices and safety in mind. An organized installation will benefit both installer and end-user.

The EnerWorks Solar Collector is one of the highest-rated in North America. This assessment was carried out by third-party testing under the supervision and scrutiny of the Solar Rating and Certification Corporation (SRCC). The EnerWorks Solar Collector has SRCC OG-100 certification and the EnerWorks Residential Solar Water Heating Appliances are certified to OG-300 standards. This certification does not imply endorsement or warranty of these products by SRCC.

The EnerWorks High Performance Appliance is certified by the International Association of Plumbing and Mechanical Officials (IAPMO) as meeting the standards of the Uniform Solar Energy Code (USEC®). This certification does not imply endorsement or warranty by IAPMO.

The High Performance Appliance described in this manual, when properly installed and maintained, meets or exceeds the standards established by the Florida Solar Energy Center (FSEC), in accordance with Section 377.705, Florida Statutes. This certification does not imply endorsement or warranty of this product by the Florida Solar Energy Center or the State of Florida.

The EnerWorks High Performance Appliance is the first system in North America to achieve the Canadian Standards Association (CSA) certification (CSA F379.1). This certification does not imply endorsement or warranty by CSA.



Appliance must only be installed by an EnerWorks-authorized dealer or warranty is void.



Recognize this symbol as an indication of important safety information!



EnerWorks Residential Solar Water Heating Appliances must be installed as directed by this manual by an Energy Kinetics and EnerWorks-authorized dealer or warranty is void.

CALIFORNIA PROPOSITION 65 WARNING: This product contains chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

CARE, HANDLING & STORAGE

EnerWorks Solar Collectors are manufactured with tempered glass. Though extremely resistant to impact, tempered glass can break if an edge is subjected to stress. During storage and installation, protect glass edges. Glass breakage is not covered by warranty.

Store collectors in a dry place, lying flat with glass up, or leaning on long edge with glass facing out and connections at top. Protect collector from scratches and damage by placing it on a soft surface such as a blanket or cardboard. When hoisting collectors to roof, be very careful not to bang glass edge. Collectors must not be levered over ladder or eave or they may be damaged. Be very careful of collector connections as they are soft copper and may be easily damaged. A leak-proof heat-transfer fluid loop can only be achieved if collector connections are not damaged.

Do not store collectors outside with glass face down. Due to EnerWorks' patented stagnation-control device, back of collector is not sealed to atmosphere. Rain may enter collector if it is stored face down. Any damage due to ingress of rain is not covered by warranty.

It is best to store both the EnerWorks Solar Collectors and the EnerWorks Energy Pack in a cool, dry place.

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Safety



Neither Energy Kinetics nor EnerWorks assume responsibility for damage, loss or injury related to installation of this appliance.



Observe any and all regulations relating to installation of solar appliances and to plumbing to potable water supply. Plumbing and/or building permits may be necessary. EnerWorks Solar Water Heating Appliances utilize a single-wall heat exchanger. Single-wall heat exchangers may not be acceptable in all jurisdictions.



Assemblies and materials used during installation shall meet requirements of local, regional, state, provincial, and federal regulations and fire codes. Any penetrations made in drywall or any other firewall must be fixed to maintain integrity of fire protection.



All persons working on roofs should have successfully completed a fall-safety course and should be properly equipped with appropriate safety equipment.

2 – EnerWorks Solar Water Heating Appliance

2.1 Description

The EnerWorks Solar Water Heating Appliance has four main parts (Figs. 2.2 & 2.3) – the solar collectors, the line-set, the Energy Pack and the solar storage tank.

The Energy Pack uses a pump to circulate a heat-transfer fluid through the “collector loop”. This collector loop includes the solar collectors, the fluid lines or “line-set” and a heat exchanger. The collector loop is a “closed loop”, meaning there is no contact of the heat transfer fluid with your potable water or with the atmosphere. The collector loop contains only a small volume of heat-transfer fluid which is food-grade and freeze-protected. Though freeze protection may not be necessary in all areas, the heat-transfer fluid also has an elevated boiling point and so is suitable throughout North America.

When exposed to sunlight, the solar collectors get hot. As the heat-transfer fluid passes through the collectors, it absorbs heat and then travels down the line-set to the Energy Pack. The hot fluid passes through the heat exchanger and heat is transferred to the potable water. After giving up its heat to the potable water, the cool heat-transfer fluid is pumped back to the solar collectors to be heated again. Hot potable water is stored in the solar storage tank.

In the High Performance Solar Water Heating Appliance (Fig. 2.2), the solar storage tank is a standard, North American, electric hot-water tank. No power is connected to this tank – it only stores solar-heated water. The solar storage tank is plumbed in series with the original water-heater (electric, fossil fuel, or on-demand). Whenever hot water is used in the home, solar heated water leaves the solar storage tank and enters the original water-heater. The original water-heater now requires much less energy for water heating.

Thus, the Appliance displaces energy, but it does not replace the original water-heater. The original heater guarantees hot water even under poor solar conditions (at night or when very cloudy). It also ensures that hot water is stored or supplied at an appropriate temperature to kill harmful bacteria. The acceptable temperature set-point is specified in local plumbing codes. Do not turn off or bypass the back-up water-heater. Even in summer months, additional heat from the back-up heater may be required.

The Space-Saver™ Solar Water Heating Appliance (Fig. 2.3) incorporates solar water-heating and auxiliary water-heating in a single tank. The Space-Saver™ Appliance is the solar solution for homes (in the United States) that cannot accommodate two tanks. For more information on Appliance components and function, please see the Owner Manual.

2.3 High Performance Appliance Schematic

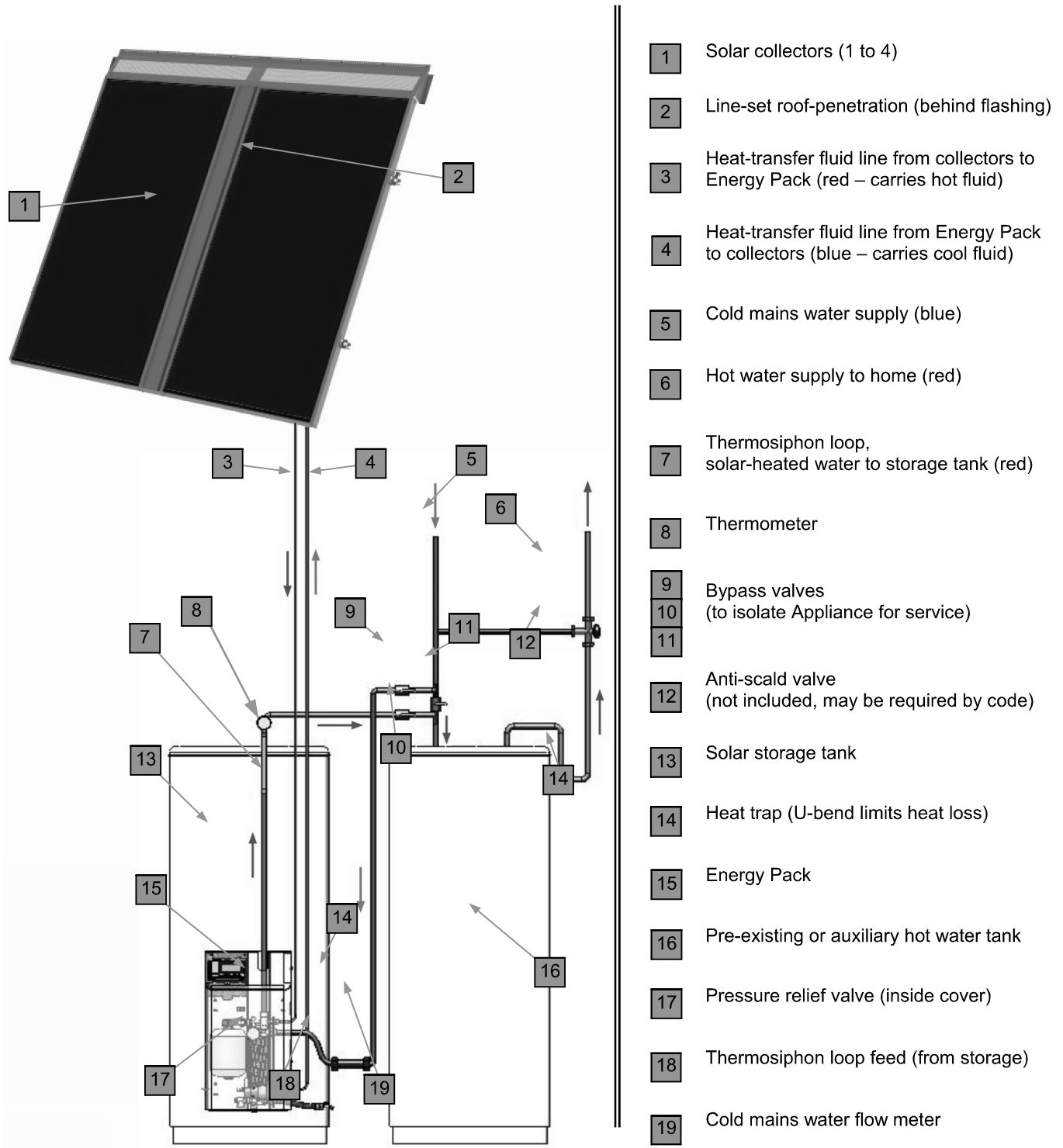
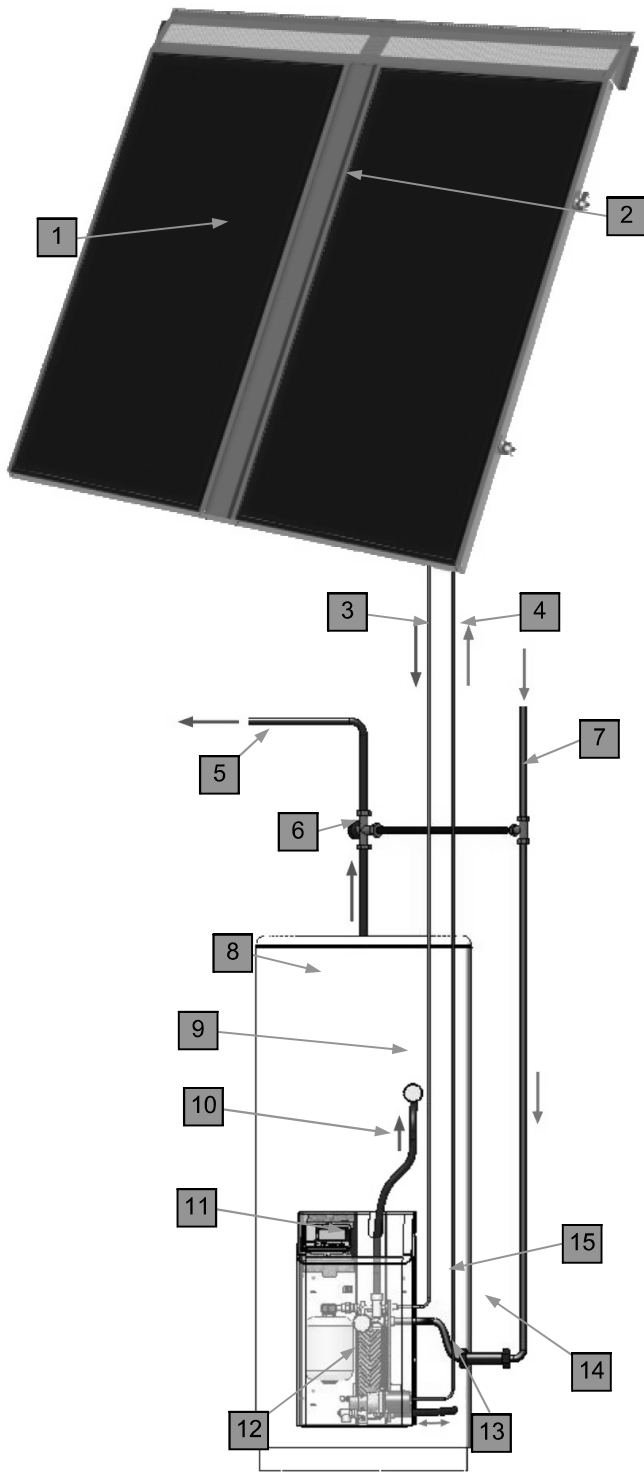


Fig. 2.3 EnerWorks High Performance Solar Water Heating Appliance (with optional leaf-guard)

2.3 Space-Saver™ Appliance Schematic (USA only)



- 1 Solar collectors (1 or 2)
- 2 Line-set roof-penetration (behind flashing)
- 3 Heat-transfer fluid line from collectors to Energy Pack (red – carries hot fluid)
- 4 Heat-transfer fluid line from Energy Pack to collectors (blue – carries cool fluid)
- 5 Hot water supply to home (red)
- 6 Anti-scald valve (required)
- 7 Cold mains water supply (blue)
- 8 Solar storage tank with electric back-up
- 9 Thermometer
- 10 Thermosiphon loop, solar-heated water to storage tank (red)
- 11 Energy Pack
- 12 Pressure relief valve (inside cover)
- 13 Thermosiphon loop feed (from storage)
- 14 Cold mains water flow meter
- 15 Heat trap (U-bend limits heat loss)

Fig. 2.3 EnerWorks Space-Saver™ Solar Water Heating Appliance (with optional leaf-guard)

3 - Site Evaluation

To achieve good performance and a good return on investment, the Appliance must be sized correctly and it must be oriented properly. Site evaluation is necessary to determine whether a site is appropriate and to evaluate the complexity of the installation. It is also necessary to determine the hot water loads, number of individuals in a home, number of collectors and size of solar storage tank.

A site survey (see Appendix – Residential Site Survey) has been developed to assist installers in evaluating potential installation locations. This can be removed from the Appendices and copied as needed. Other tools such as the EnerWorks software, SolSim™, and Solar Pathfinder may assist in determining the best location and orientation for the solar collectors. SolSim™ and its user guide are available to EnerWorks-authorized dealers.

⚠ For roof-mounting, installer should ensure that roof cladding or sheathing is in good repair. Also ensure that rafters and trusses are adequate to support weight of solar collector(s) and mounting assembly.

⚠ Building and plumbing permits and/or inspections may be necessary to proceed with installation. Follow all code requirements and regulations.

3.1 Collector Location, Orientation And Shading

Collector(s) should face as close to south as possible for optimal performance. Within 45° of south is acceptable as there is less than 10% loss (Fig. 3.1.1).

The roof angle from horizontal for optimal year-round performance is equivalent to latitude of location plus or minus 15°. A steeper angle provides better winter performance as the sun is lower in the sky. Collectors will also shed snow more effectively. A shallow angle maximizes energy capture in summer when sun is high. Be cautious of placement on low angle roofs due to snow shedding and potential for ice-damming. A minimum collector angle of 14° (3:12 pitch) is necessary for stagnation-control device to function.

Shading of collectors greatly reduces performance. When selecting installation location, consider potential shading by trees and other buildings, especially between peak solar hours of 10:00 and 15:00. A Solar Pathfinder or similar device may be used to determine potential shading throughout the year.

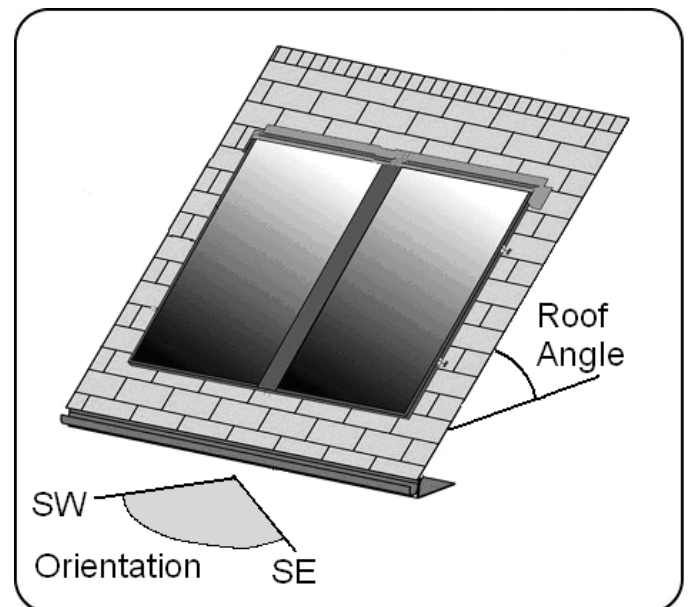


Fig. 3.1.1 – Collector Orientation.

3.2 Available Roof Space

Appliance may consist of one to four collectors depending on required volume of hot water. Check appliance specification sheet for sizing guidelines. Each collector is 4' x 8' (1.219 m x 2.438 m) and must be mounted in “portrait” orientation. Installation area must be clear of roof vents, fans, satellite dishes, etc. Refer to section **7.2 Locating rafters and positioning C-channel** for more details.

3.3 Collector Racks

A rack may be used on the ground or to increase collector-angle on low-angled roofs. Consideration must be given to wind and snow loads, and to aesthetics.



EnerWorks Solar Collectors are not as sensitive to orientation as photovoltaic panels (PV). Due to size and weight of solar thermal collectors, tracking systems are not advisable.



Racking may require approval or certification by a building engineer and/or local authorities. It is the responsibility of the installer to ensure appropriate design and safety criteria are met.

3.4 Line-Set

Line-set carries heat-transfer fluid from collectors to Energy Pack and back again. Line-set must be flexible, refrigeration-grade 3/8” (9.525 mm) (soft-copper tube). A proper and dedicated bending tool must be used for tight bends. Line should be as smooth as possible with no unnecessary fittings or bends. Site evaluation should include examining location and difficulty of roof and wall penetrations. Appropriate techniques and materials for sealing penetrations are necessary.

New homes may choose to run line-set prior to closing in walls, or alternatively, running a 3” (76.2 mm) chase from attic to mechanical room for later use. A line-set inside building may be shorter and will lose less heat. Outside line-sets must be covered as insulation is not UV-stable. Line-set may be covered by a false downspout that matches siding or existing eaves trough, or through electrical conduit. Installer should consult homeowner regarding aesthetics and complexity of installation.

3.5 Location Of Energy Pack And Solar Storage Tank

Energy Pack and solar storage tank will be located in mechanical or utility room, close to existing water-heater. Stairway and doorway clearance must be examined. Additional floor space is required for solar storage tank and Energy Pack. Consideration must be given to location and complexity of wall and ceiling penetrations, and to plumbing of appliance to existing water-heater and to water distribution network.



Energy Pack requires AC power. Solar storage tank and Energy Pack must be installed in proximity to AC outlet. Surge protection is recommended.

4 – Line-Set Installation

4.1 Line-set Description

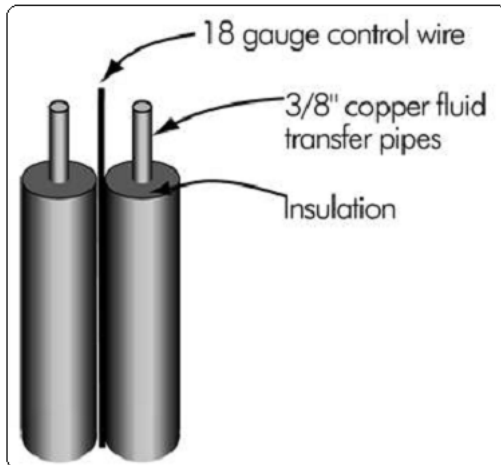


Fig. 4.1.1 – Line-set

Line-set connects Energy Pack to solar collectors. Line-set consists of two 3/8" (9.525 mm) refrigeration-grade, flexible soft-copper tubes. Tubes are individually insulated with refrigeration insulation (3/8" ID - 3/8"-wall). Bundled with the line-set is an 18-gauge, two-conductor control wire that connects the Energy Pack Controller to the solar collector temperature sensor (Fig. 4.1.1).

6.2 Line-Set Routing

Selection of line-set route should be discussed with homeowner with consideration to aesthetics and to complexity and cost of installation (Fig. 4.2.1). Line-set through home will have lowest heat-loss and possibly shortest length (Fig. 4.2.1 option 1). Interior line-set should not run next to bedrooms or day-time living space as some vibration noise from pump may be transferred through line-set. Interior line-set may be more appropriate for bungalow or single-storey applications.

Line-set may penetrate roof into attic (Fig. 4.2.2) and drop from soffit down exterior wall to above foundation or through foundation to mechanical room (Fig. 4.2.1 option 2). This may facilitate installation and minimize vibration noise transferred through lines. Exterior line-set and insulation must be protected by molding, electrical conduit or false downspout that matches existing siding or eavestrough (Fig. 4.2.3). Exterior line-set may be best for two or three-storey applications.

Line-set may run around eave and down exterior wall if access to attic is limited (Fig. 4.2.1 option 3). Insulation is not UV-stable and must be covered. Line-set of rack-mounted collectors on ground may be run underground through conduit such as big-‘O’ to protect insulation (Fig. 4.2.1 option 4).

For new homes, consider installing 3 – 4" (76.2 mm - 101.6 mm) diameter PVC or ABS chase from attic to hot-water tank location. This will facilitate future removal or replacement of line-set if necessary.

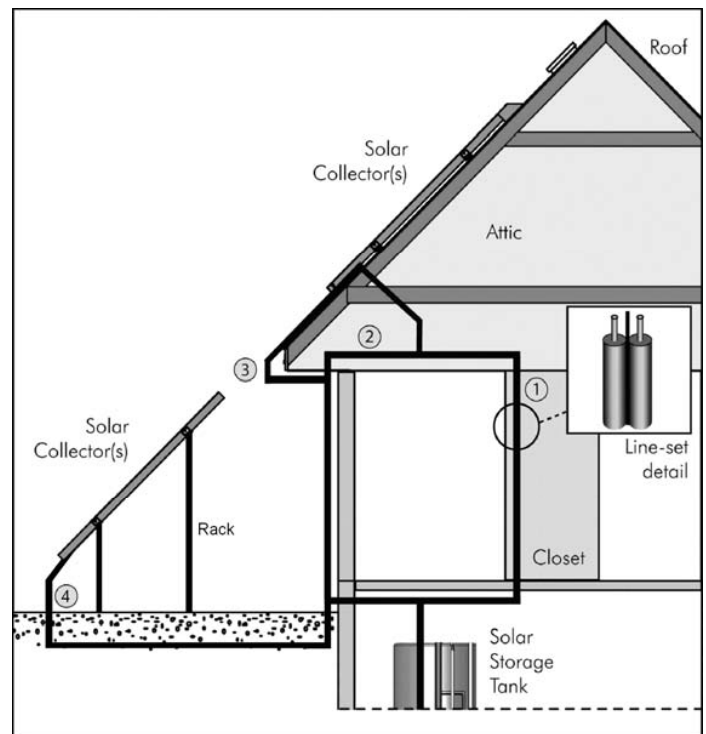


Fig. 4.2.1 – Line-set routes

4.3 Line-Set Installation

Use care to unroll coiled copper tube. Pulling coil axially, like a Slinky, will kink and damage tube. Lines may be insulated completely before installation or as the lines are pulled through.

Leave protective end-caps in place to prevent contamination of heat-transfer fluid. Inside surface of insulation is coated with powder to facilitate installation. This powder must not be introduced into the line-set or it will contaminate and damage the fluid. System degradation due to the contamination of fluid is not covered by warranty.

Seams should be taped with tape that will not dry out and disintegrate (i.e., duct tape). Lines may be pulled individually, or bundled. Use straps to secure lines to rafters. Ensure straps are not in contact with copper lines due to risk of galvanic corrosion (copper or plastic straps are recommended). Do not compress insulation when bundling or securing lines (Fig. 4.3.1).

Line-set tube coils are available in 50' (15.24 m) and 100' (30.48 m) lengths. Line-sets longer than 100' (30.48 m) are not recommended due to the pressure drop through the system. It is best not to have any joints or fittings. If line-set tube must be extended, do not use lead or tin solder. The heat-transfer fluid will degrade lead and tin solder, eventually causing leaks. Silver solder is permissible. Flare union-fittings are also permissible.

Wall, ceiling and roof-penetration may be a 2½" (63.5 mm) hole or two 1¼" (31.75 mm) holes. Penetrations must be sealed appropriately to maintain weather-proofing, sound-proofing and fire integrity. Roof penetration between collectors is recommended as collector flashing hides line-set penetration and eliminates need to protect insulation from damaging UV.











Fig. 4.2.2 – Line-set and control-wire in attic.



Fig. 4.2.3 – Exterior line-set in electrical conduit.



Fig. 4.3.1 – Line-set straps.

-  *When working in attics or confined spaces, determine type and quality of insulation material. Use appropriate respirators or masks as necessary to prevent inhalation of insulation material.*
-  *Line-set must be refrigeration-grade, flexible soft-copper tube. Refrigeration-grade tube is flushed and cleaned during manufacturing, ensuring that heat-transfer fluid will not be contaminated. Using tube that is not refrigeration-grade will void the warranty.*
-  *Sufficient length of line-set must be available in mechanical room and in attic to make connections. For two- and four-collector appliances, leave at least 3 ft (915 mm) of extra line-set in attic for making connections to solar collectors. For one- and three-collector appliances, leave at least 7 ft (2130 mm).*
-  *A dedicated tube-bending tool must be used for tight bends. 3- and 4-collector installations have tight tube bends on roof and a proper tube-bending tool is required. A proper tube-bending tool may be necessary for 1- and 2-collector installations. A tube-bending tool is recommended for line-set connections to Energy Pack to provide clean, vertical lines.*
-  *Supply and return lines do not have to be differentiated. Control wire conductors do not have to be differentiated.*
-  *Line-set must be insulated with refrigeration insulation suitable for high temperatures such as Armaflex, Aerocel or Gulf-O-Flex. Lower quality insulation (e.g. split foam tube) will degrade or melt at high temperatures. Protective caps must be kept on ends of tubes until final connections are made to prevent contamination of tubes and of heat-transfer fluid.*
-  *Line-set roof-penetration should be located between rafters and between solar collectors (immediately next to collector in single collector installation) such that it will be covered by collector flashing.*
-  *Do not have any unnecessary bends or joints in copper tube. If a joint must be made, do not use lead or tin solder. Silver solder or a flare union-fitting may be used. See Appliance heat-transfer fluid line-set connections section of Appliance Installation Manual for guidelines on flare-fittings.*

5 – C-Channel Installation

- ⚠ **A building permit may be necessary for the installation of solar collectors on the roof. It is the responsibility of the homeowner and of the installer to follow all code regulations and requirements.**
- ⚠ **Do not perform roof work when strong winds, rain, thunderstorms or lightning are active or expected.**
- ⚠ **All individuals working on roofs should have completed a fall-safety course and use appropriate safety techniques and equipment. EnerWorks assumes no liability for injury or death during installation or for any damage caused during installation.**

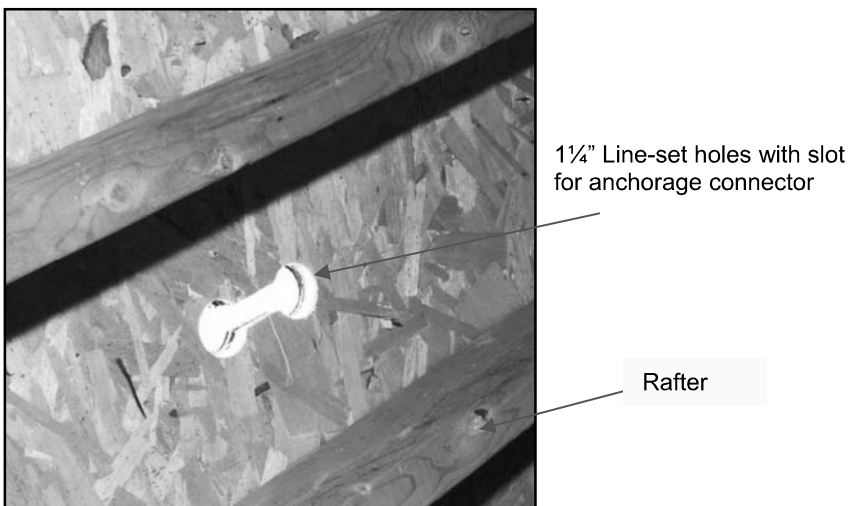
In the interest of safety and an efficient installation process, assemble all necessary tools and components for roof C-channel and collector installation. See Appendix - Tool and Supply Checklist.

- ⚠ **TIP: C-channel twirl-nuts (for securing collectors to C-channel) are equipped with springs that hold them in place. Push twirl-nuts through C-channel and turn 90° clockwise to secure them. Position them at approximate collector mounting points, at center and at ends, before hoisting C-channel to roof; fewer pieces to carry – fewer pieces to drop!**

5.1 Using Roof-Penetration For Fall-Prevention Anchor

It is possible to use line-set roof-penetration as an anchor point for fall prevention. This eliminates need for exterior anchor points with additional cladding penetrations. After C-channel is installed, anchorage-connectors can be moved to C-channel allowing for line-set to be pulled through and roof-penetration to be sealed.

1. From inside attic, determine appropriate line-set roof-penetration location.
2. Drill two 1¼" (31.75 mm) holes, one for each line, approximately 3" (76.2 mm) apart. Ensure that roof-penetration flashing or boot will cover holes before drilling. Cut out section between holes with a saw such that anchorage connector will fit through (Fig. 5.1.1).



3. Insert anchorage connector through hole and securely fix inside attic (Fig. 5.1.2).

Fig. 5.1.1 – Line-set holes.

Each person should have their own anchorage connector. Once C-channel is in place, anchorage connectors can be fixed to C-channel and removed from roof-penetration to allow line-set to be pulled through (Fig. 5.1.2).

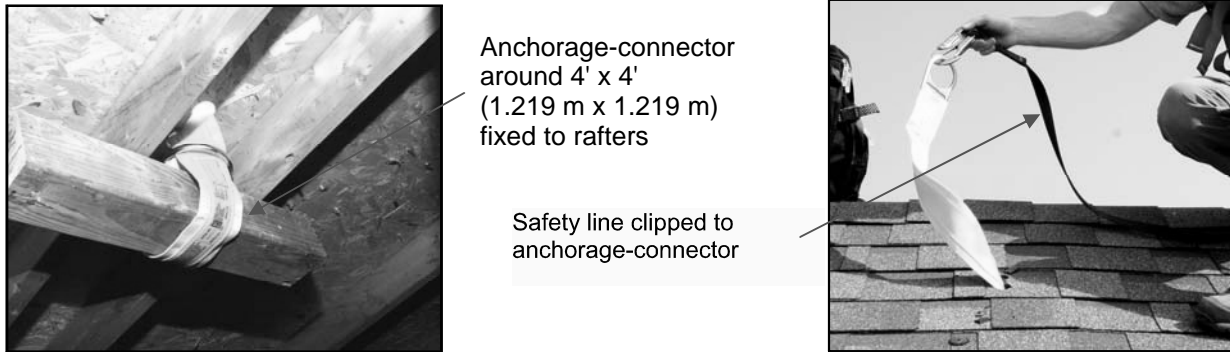


Fig. 5.1.2 – Suggested safety line configuration using line-set hole.



This is only one method for securing anchorage-connector and may not meet local code requirements for fall prevention. It is up to the installer to apply local regulations and requirements regarding fall safety equipment and techniques.

5.2 Locating Rafters And Positioning C-Channel

After roof-penetration has been made and approximate location of solar collectors has been determined:

1. Determine location and spacing of roof rafters (Fig. 5.2.1). This may be easy from inside attic, but rafter positions need to be transferred to exterior roof. This may be done in a number of ways and will depend on access:

- Measure from side edge of roof or carefully remove soffits to determine spacing.
- Temporary metal clips, strips or pipe may be fixed to the rafters inside the attic and a metal detector (eg., Zircon MT6, Bosch D-Tect 100) used to determine rafter location from outside.
- Using roof-penetration as landmark, distance to rafters may be measured inside attic and measurements transferred to exterior.
- A nail may be used, pushed through from inside, to mark location of rafter. Any roof-penetrations must be appropriately sealed.

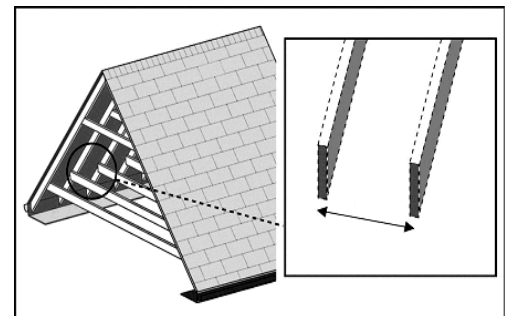


Fig. 5.2.1 – Roof rafter spacing.



Rafters are often not exactly parallel and spacing at eaves may not be equivalent to spacing where C-channel is to be installed.



EnerWorks is not responsible for any damage due to inadequate anchoring of C-channel and of solar collectors.

2. With chalk line, tape, laser and/or permanent marker, mark locations of rafters that will be used for mounting C-channels.

3. Roof-penetration must be between collectors (or immediately next to collector on connection side of single-collector installation). Roof-penetration will serve as landmark to determine position of collectors and of C-channel (Fig. 5.2.2).
4. Collector dimensions are 46¼" wide x 96¼" tall (1175 mm x 2445 mm). A minimum of 10' (3000 mm) of roof slope is needed if leaf-guard is to be installed (leaf-guard is optional with 1 and 2-collector appliances, included with 3- and 4-collector appliances). Only 9' (2740 mm) of roof slope is needed for installations without leaf-guards. A minimum of 24" (610 mm) is required above collector if leaf-guard is to be installed. Only 12" (305 mm) is needed above collector for installations without leaf-guards (Fig. 5.2.2).
5. With this information and referring to Fig. 5.2.2, mark position of collector(s) and of C-channel. Note that when collectors are secured, the distance between them will be approximately 4½" (115 mm).
6. Collector mounting points are 4' or 48" (1220 mm) apart. C-channels must be mounted horizontally (use level), 48" (1220mm) apart, center to center (Fig 5.2.2).

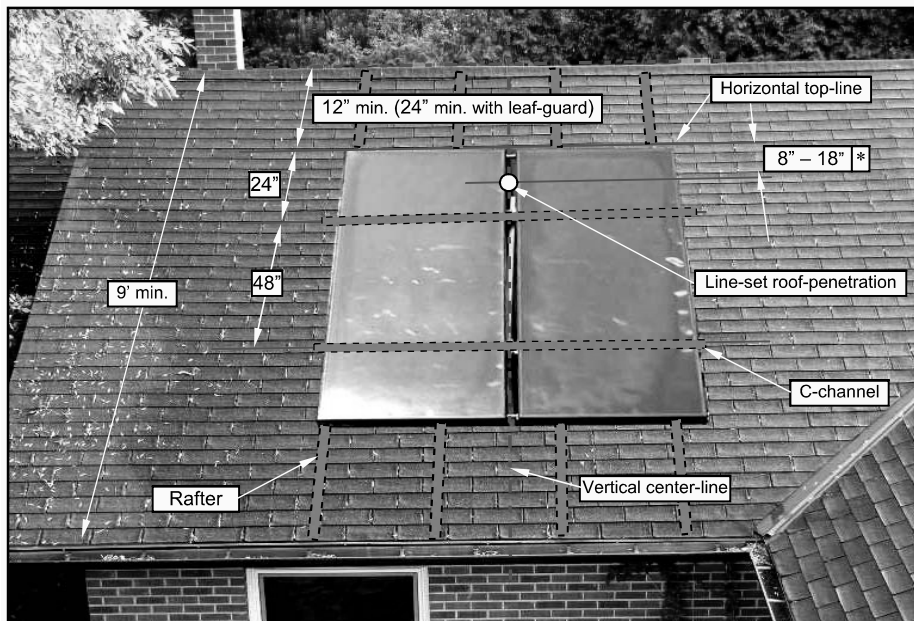


Fig. 5.2.2 – Collector mounting details.

NOTE: Be sure to take position of thermistor wires into consideration when locating line-set roof-penetration.

TIP: If installing a three or four-collector appliance, do not butt upper C-channels (52" (1.321 m) and 102" (2.591 m) for three collectors, 102" (2.591 m) and 102" (2.591 m) for four collectors) up to each other. Similarly, do not butt lower C-channels up to each other. Leave a gap of at least 1" (25.4 mm) between C-channels to ensure center-flashing can be installed.

5.3 Securing C-Channel Asphalt Roof (Shingles)

C-channel is fixed to roof rafters using 5" x Ø3/8" corrosion-resistant (galvanized) lag-bolts. Lag-bolts must be centered in rafters since they carry weight of collector array. If rafter position cannot be adequately determined or if lag-bolts cannot be centered in rafters, an alternative mounting method may be used:

- 4" x 4" (10.16 cm x 10.16 cm) blocks cut to rafter spacing can be fixed between rafters. Lag-bolts can be screwed into 4" x 4" (10.16 cm x 10.16 cm) blocks. This may facilitate installation as distance between peak and blocks may be measured and transferred to exterior.
- Metal or wood (2" x 4" (5.08 cm x 10.16 cm) min.) spanners may be fixed horizontally across rafters. C-channel can then be secured with bolts or threaded rods (Ø3/8") and lock-nuts instead of lag-bolts (Fig. 5.3.1). Spacers should be used between roof board and spanner to limit bowing and flexing of roof sheathing and spanner.

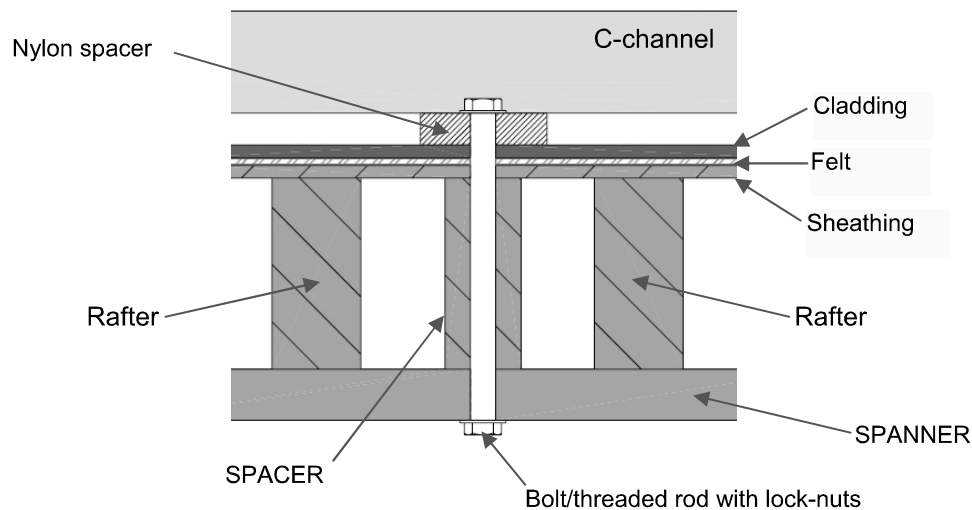


Fig. 5.3.1 – C-channel secured to spanner.

- Holes can be drilled immediately next to rafters and J-bolts or U-bolts (Ø3/8") and locknuts used to secure C-channel to rafters (Fig. 5.3.2).

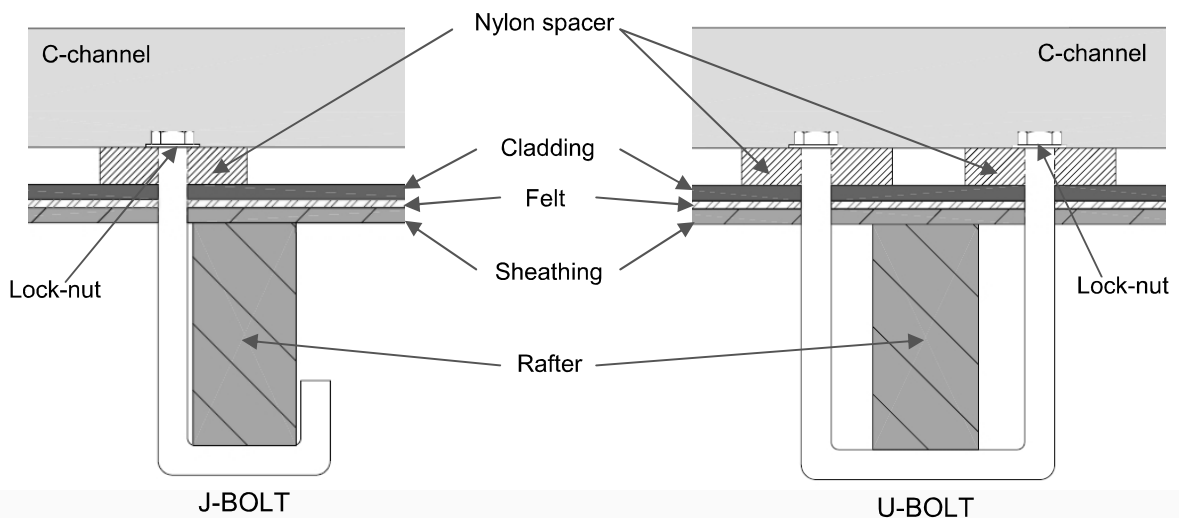


Fig. 5.3.2 – C-channel secured to rafter with J-bolts and U-bolts.

Lag-bolts should be located as close to collector mounting points as possible. C-channels require at least two lag-bolts per collector per length.

1. Once appropriate lag-bolt position has been determined, drill about 5" (12.7 cm) into rafter with a long (min. 6" (15.24 cm)) 1/4"-drill bit (Fig. 5.3.3). Fill hole with polyurethane roofing sealant.
2. Apply roof-sealant to one side of black nylon spacer. Align drilled hole with nylon spacer hole and stick spacer to roof (Fig. 5.3.4).

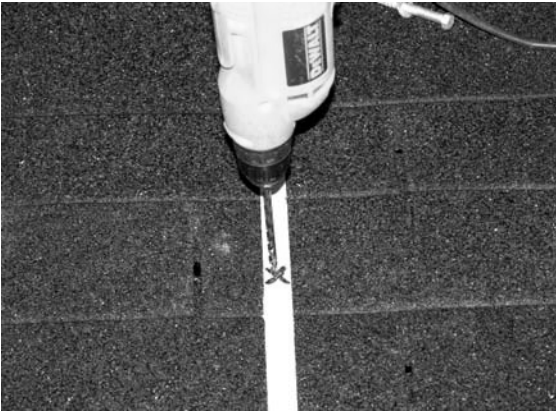


Fig. 5.3.3 – Pre-drill lag-bolt hole.

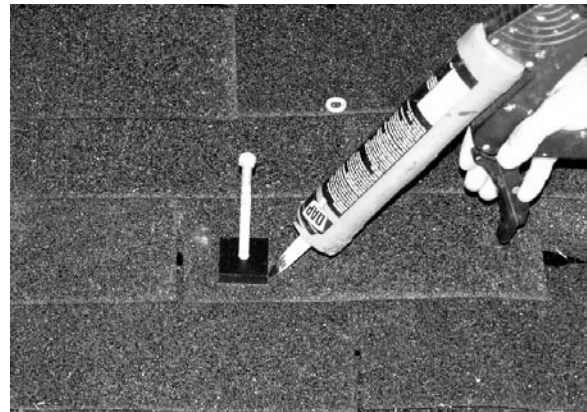


Fig. 5.3.4 – Roof-sealant application.

3. Place C-channel over spacer. Insert lag-bolt through washer. Place lag-bolt with washer in place through C-channel slot and nylon spacer into pre-drilled, sealant-filled rafter hole (Fig. 5.3.5). Tighten lag-bolt with ratchet (and extension) or drill driver (with extension). Do not tighten completely until all necessary C-channel lag-bolts are threaded into rafters.

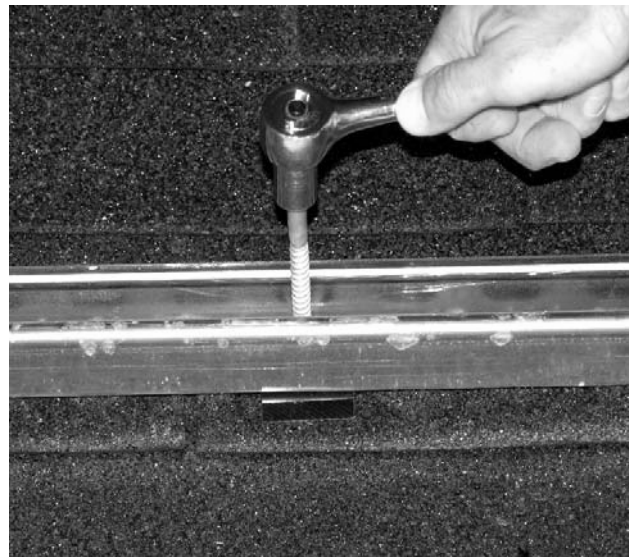
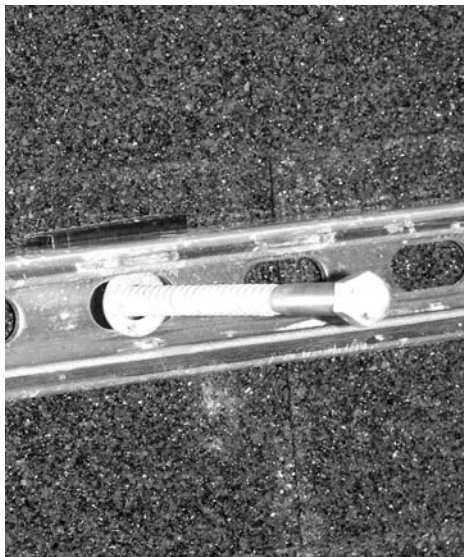


Fig. 5.3.5 – Securing C-channel with lag-bolts.

4. Repeat steps 3 to 5 for other lag-bolts mounting points. Use a level to ensure C-channel is horizontal.

5. With C-channel lag-bolts in place and tightened completely, check that roof-sealant has made a good seal. Apply additional sealant if necessary.
6. Measure down 48" (1220 mm), center to center, to fix lower C-channel position. Follow same procedure to secure and seal lower C-channel. Installation should now look like Fig. 5.3.6. Note safety anchorage-connections were moved from roof-penetration to upper C-channel only after C-channel was completely secure. Moving anchorage-connections allows for line-set to be pulled through roof-penetration.



Fig. 5.3.6 – Secured C-channel with safety anchors.

5.4 Securing C-channel To Metal Roof

Process for installation on metal roof is very similar. EnerWorks Metal Roof Add-on Kit contains additional nylon spacers to raise C-channel farther from roof surface, allowing clearance of raised seams. Longer (6" (15.24 cm)) lag-bolts are also included to ensure a solid anchor.



Metal roofs can be extremely slippery, especially if wet. Do not get on metal roofs if they are covered in dew or if it is raining. Use extra caution when working on metal roofs.

5.5 Roof-Penetration Flashing Boot

Before solar collectors can be installed, line-set (with control wire) must be pushed/pulled through roof-penetration. Flashing boot must be installed to seal penetration. Note in Fig. 5.5.1, insulated lines and control wire are wrapped with tape to protect insulation from ripping as it is pulled through rough-edged penetration.



Fig. 5.5.1 – Line-set and control wire protected with tape.

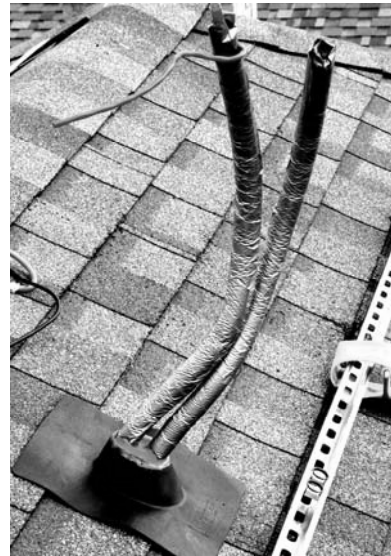


Fig. 5.5.2 – Boot flashing before insertion under shingle.

1. Loosen lower edge of shingles above boot, under which boot-flashing will be inserted.
2. Push boot over ends of line-set and control wire, and down to roof surface (Fig. 5.5.2).
3. Carefully lift shingle above boot and generously apply sealant to both surfaces.
4. Insert upper boot flashing under shingle and press shingle down firmly.
5. Lift remaining edges of boot and generously apply sealant to underside. Press down firmly.
6. Screw roofing screws through boot-flashing into roof (Fig. 5.5.3)
7. Seal boot cavity around line-set with suitable sealant.



Fig. 5.5.3 – Finished line-set boot flashing.

6 – Solar Collector Installation

6.1 Preparation Of Collector(s)

Preparation of collectors for mounting includes: left to right conversion (if necessary), installation of temperature sensor and installation of mounting brackets.



Plastic foil sheet must remain on collectors until pressurization of heat-transfer fluid is complete. If collectors are exposed to sun during appliance charging and before pressurization, flash boiling and damage of heat-transfer fluid will occur and there is a danger of scalding. Do not remove plastic caps from collector tube-ends until ready to make collector line-set connections.



Edges of collector's tempered glass are fragile. Collectors should not rest on edge, be rotated or levered over ladders or eaves, or banged on edge. Glass breakage is not covered by warranty.

6.1.1 Patented Stagnation-Control Device – Left And Right Collectors

EnerWorks Solar Collectors have a patented stagnation-control device. Stagnation occurs if heat-transfer fluid stops circulating. Fluid stops circulating during power outages or when solar storage tank is completely full of hot water and Appliance Controller shuts down pump.

If heat-transfer fluid stops circulating during daylight hours, it cannot transfer heat to potable water and can become super-heated. Boiling and damage to heat-transfer fluid could occur if it weren't for the EnerWorks patented stagnation control device.

Housed in the back of the collector at the top is a thermally-actuated damper. At the bottom is a perforated intake grill.

When temperature in collector gets too hot, thermally-actuated damper opens and hot air can escape from collector. Cooler air is drawn in through intake grill at bottom, allowing natural convection cooling. Excess heat is dumped to atmosphere, limiting temperature of heat-transfer fluid and limiting pressure of collector loop.

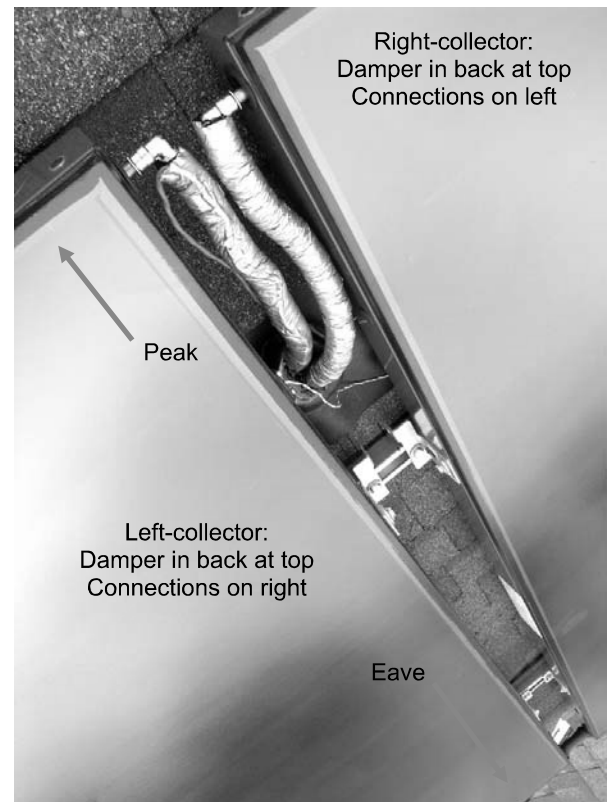


Fig. 6.1.1 – Right and left collectors.

Natural convection can only occur if damper is at top of collector and grill is at bottom.

As line-set connections emerge from only one side of collector, collectors can be described as left- or right-collectors, depending on location of stagnation-control damper (Fig. 6.1.0).

⚠ Warranty is only valid for collectors mounted in “portrait” orientation with damper at top. Collectors mounted in “landscape” orientation are not covered by warranty as stagnation-control device will not operate as designed.

⚠ For convective cooling to occur, a minimum collector-angle of 14° (3:12 pitch) is necessary. Warranty is not valid for collectors installed flat or at an angle less than 14° (3:12 pitch).

6.1.2 Converting Collector(s) From Left To Right

Depending on number of collectors or on installation conditions, it may be necessary to change a left-collector to a right-collector or vice-versa. This is accomplished by swapping thermally actuated damper and intake grill. If this is not necessary, proceed to temperature sensor installation.

⚠ Swapping damper and grill may be accomplished by laying collector, glass down, on a soft and padded surface, such as a blanket or large piece of cardboard, e.g., solar storage tank box. Be extremely careful as broken glass is not covered by warranty. Ensure surface is flat and smooth. It may also be accomplished with collector standing on long side with connections up. Again, it should be resting on a soft surface. Swapping damper and grill should not be attempted in rain.

1. Remove and set aside five screws that hold grill in place at bottom of collector (Fig. 6.1.2). Center screw is self-drilling and different from others (see insert in Fig. 6.1.2). Carefully remove grill by first lifting perforated section and then by gently pulling grill away from aluminum-covered back insulation.

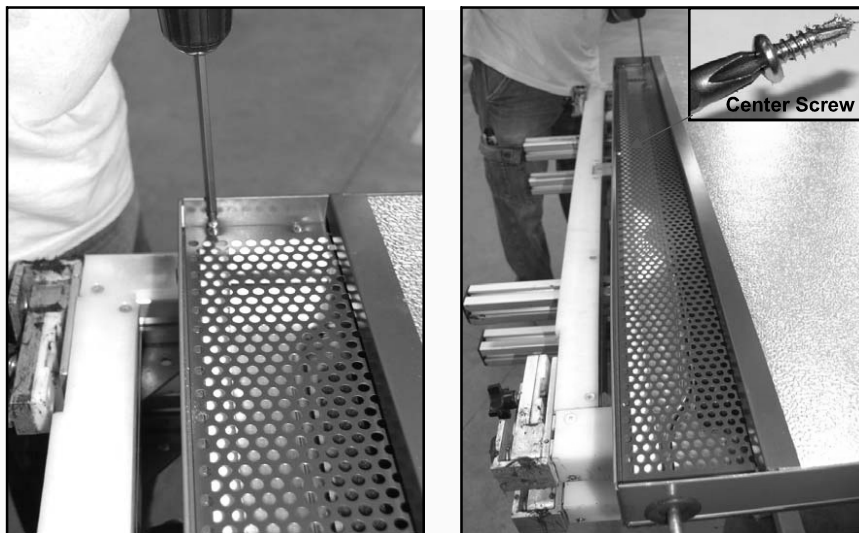


Fig. 6.1.2 – Swapping damper and grill – unscrewing intake grill.

2. Remove and set aside ten screws that hold stagnation-control damper in place at top of collector. Six long self-drilling screws hold damper mechanism to aluminum backing. Four self-threading screws hold white plastic hinge blocks (two screws per block) to frame at each end of damper (Fig. 6.1.2). Note function and orientation of plastic hinge blocks and remove them.

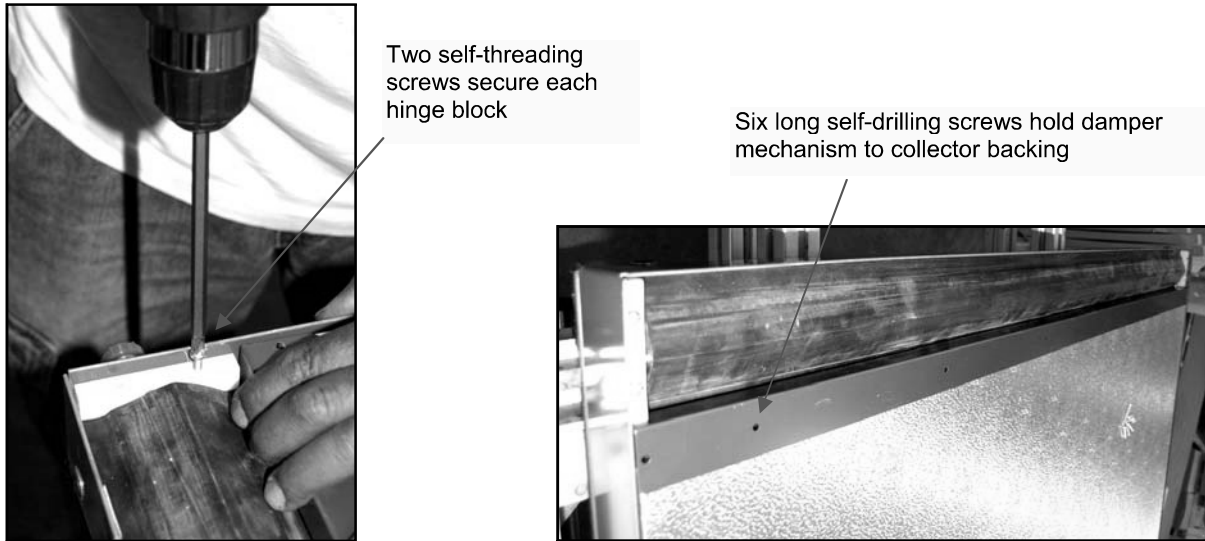


Fig. 6.1.2 – Swapping damper and grill – unscrewing stagnation-control damper.

3. Carefully remove damper assembly by first gently pushing down on damper closest to collector-backing, and then by gently pulling damper assembly out and away from aluminum covered back insulation (Fig. 6.1.3).
4. Install damper in grill's former location and vice versa. Damper must be at top and grill must be at bottom of collector for stagnation control to function. Be sure to firmly seat grill channel and damper assembly channel over aluminum-covered back insulation (Fig. 6.1.3).



Fig. 6.1.3 – Removing and inserting stagnation-control damper.

5. Install white plastic hinge blocks on shaft ends (Fig. 6.1.4). Note that grooved chamfer is down and shaft must be inserted into hole closest to damper channel (Fig. 6.1.4).

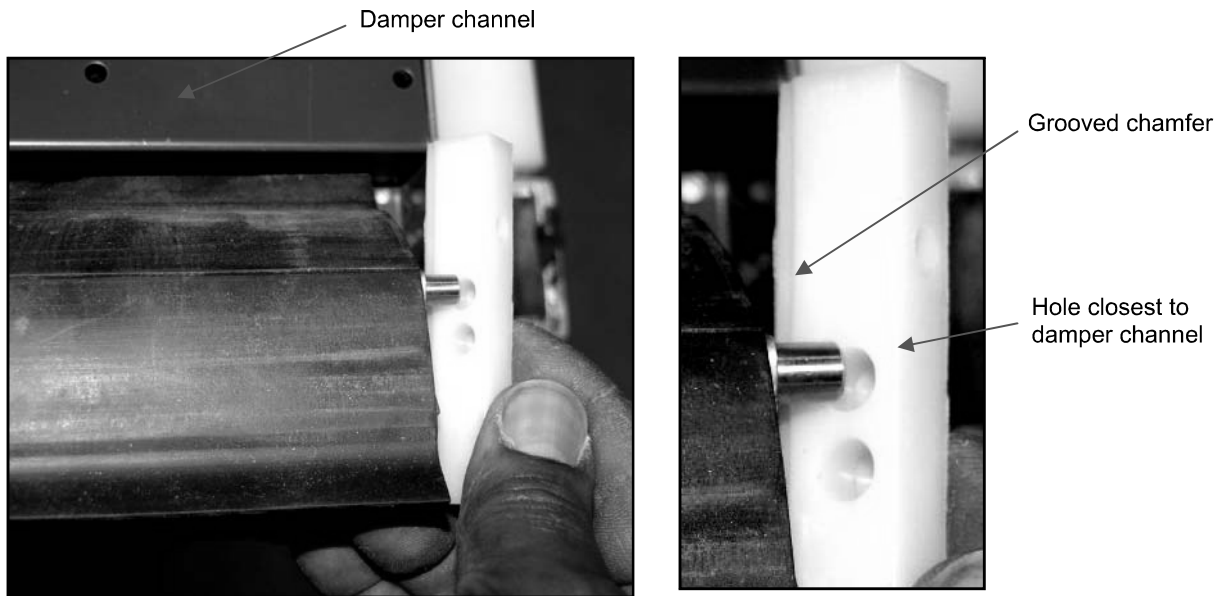


Fig. 6.1.4 – Inserting stagnation-control damper into hinge blocks

6. Ensure damper is properly aligned with collector frame and secure hinge blocks (Fig. 6.1.5). Secure damper channel with long self-drilling screws (Fig. 6.1.5). Note these screws pass through outer and inner walls of damper channel, sandwiching collector backing.

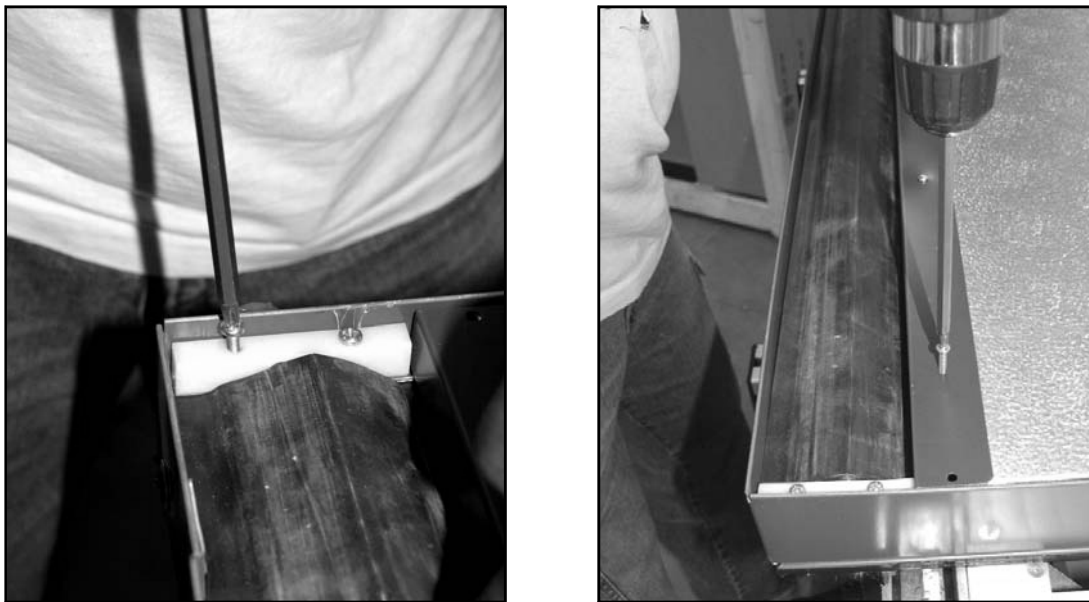


Fig. 6.1.5 – Securing stagnation-control hinge blocks and damper channel.

7. Secure intake grill with included screws. Carefully flip collector over or lay down flat such that glass is facing up. Left-to-right conversion is now complete.

6.1.3 Installing Temperature Sensor (Thermistor)

Temperature inside solar collector is monitored by temperature sensor connected via control wire to Energy Pack Controller. Temperature sensor is a thermistor, a metal probe whose resistance changes with temperature (nominal 10kΩ @ 77°F, 25°C). See Table 6.1.7 for table of resistance vs. temperature. Thermistor is not pre-installed as only one thermistor is needed per collector array.

Thermistor is installed at upper corner close to roof-penetration. Thermistor kit is included with appliance and contains: Thermistor (with high-temperature resistant Teflon wire insulation), plastic cap with rubber 'o'-ring, two self-drilling hex-head (1/4") screws (Fig. 6.1.6), and two IDCs (Insulation Displacement Connectors, not shown).



Fig. 6.1.6 – Thermistor kit.

1. With an ohmmeter or multimeter, test the resistance of thermistor. **Do not hold bare connections between fingers or you will be measuring resistance through your body and through thermistor-alligator clips work best.**

Check associated temperature from table of resistance vs. temperature (Table 6.1.7). If resistance is not as expected, check meter and connections, and test again. If thermistor is faulty, contact your distributor for replacement.

2. Locate thermistor hole approximately 12" (305 mm) from top of one collector (stagnation-control damper is at top) on connection side (label side). Rubber cap is midway between copper connection and bracket mounting point.
3. Remove rubber cap and carefully cut or punch out foil-covered foam insulation. Be careful not to damage absorber or tube inside collector.
4. With flattened portion of thermistor in line with collector edge, insert thermistor such that flattened portion seats between absorber plate and internal tube (Fig. 6.1.8). Thermistor will have to be directed towards glass to contact back of absorber plate. Continue to insert until thermistor is seated firmly between absorber plate and internal tube.

Deg C	Deg F	Ohms	Deg C	Deg F	Ohms
-40	-40	336,450.0	60	140	2,488.0
-35	-31	242,660.0	65	149	2,083.0
-30	-22	176,960.0	70	158	1,752.0
-25	-13	130,410.0	75	167	1,479.0
-20	-4	97,072.0	80	176	1,255.0
-15	5	72,951.0	85	185	1,070.0
-10	14	55,326.0	90	194	915.4
-5	23	42,326.0	95	203	786.6
0	32	32,650.0	100	212	678.6
5	41	25,391.0	105	221	510.6
10	50	19,899.0	110	230	587.6
15	59	15,711.0	115	239	445.2
20	68	12,492.0	120	248	389.6
25	77	10,000.0	125	257	341.9
30	86	8,057.0	130	266	301.0
35	95	6,531.0	135	275	265.8
40	104	5,326.0	140	284	235.4
45	113	4,368.0	145	293	209.0
50	122	3,602.0	150	302	186.1
55	131	2,986.0			

Table 6.1.7 – Thermistor resistance vs. temperature.

5. Insert probe wires through 'o'-ring and black plastic probe cover. Push the cover against the collector frame over the copper end of the probe. Fasten the cover with the two self-drilling screws (Fig.6.1.9).

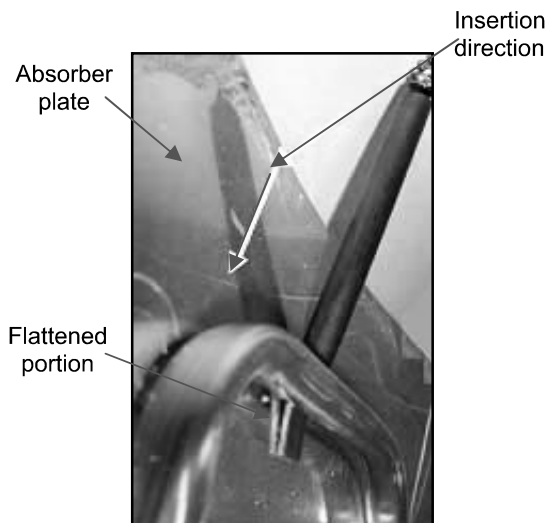
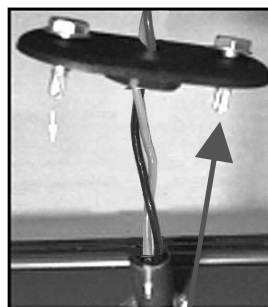


Fig. 6.1.8 – Thermistor seated between absorber and tube.



Self-drilling screws



Fig. 6.1.9 – Thermistor cap.

6.1.4 Installing Collector Mounting Brackets

Mounting brackets secure collectors to C-channel. Two types of mounting brackets are available: hook brackets and L-brackets. Hook brackets are used for mounting to C-channel. L-brackets may be used for rack-mounting (hook brackets may be used for rack-mounting if C-channel is secured to rack). Bracket mounting points are 24" (610 mm) from ends of collector on long sides and 48" (1220 mm) apart, center to center.

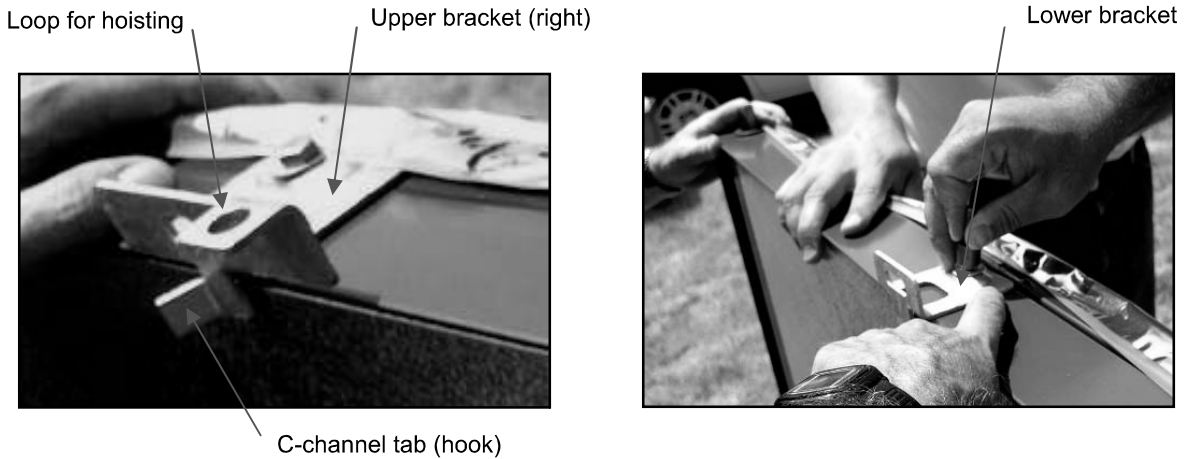
Hook Brackets

Hook bracket kit consists of upper and lower brackets. Upper hook brackets are left and right specific. Lower brackets are not side specific (Fig. 6.1.10).

Upper brackets feature a unique tab that fits into C-channel to support collector weight before securing. Tab also allows collector to slide, side to side, in C-channel. Upper brackets also feature loops for attaching carabiners and/or line to assist with hoisting.

With collector lying flat or on long edge (but not on glass edge), and resting on soft, smooth surface, attach four brackets with bolts and washers (Fig. 6.1.10).

Upper brackets with loop and tab (hook) are towards top (with stagnation-control damper). Loops must be closest to top of collector (Fig. 6.1.10). Use ratchet or driver with a 1/2" socket. Do not overtighten (maximum torque of 9 ft-lb or 12.2 N-m). Lower brackets are towards bottom (with intake grill).



L-Brackets

Fig. 6.1.10 – Upper and lower bracket installation.

L-brackets (Fig. 6.1.11) are used primarily on wood or steel racks that are fabricated to fit collector dimensions and bracket spacing (Fig. 6.1.12). For pitched roof applications, it is often impossible to line up L-brackets with rafters (however 4" x 4" (10.16 cm x 10.16 cm) blocks fixed between rafters could be installed). If use of L-brackets is desired for roof mounting, extra carpentry work may be required to ensure the lag bolts are secure. 4" x 4" (10.16 cm x 10.16 cm) blocking can be used under the roof. Racks without C-channel must be designed specifically to match spacing of the L-brackets.

⚠ Before proceeding with installation of the EnerWorks Solar Collectors, make note of their serial numbers on the Product & Installation Registration Form included with the Owner Manual and in the Appendices. Serial numbers are required for warranty service and are difficult to access once collectors are installed.

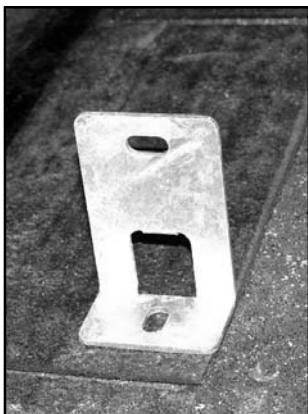


Fig. 6.1.11 – L-bracket.

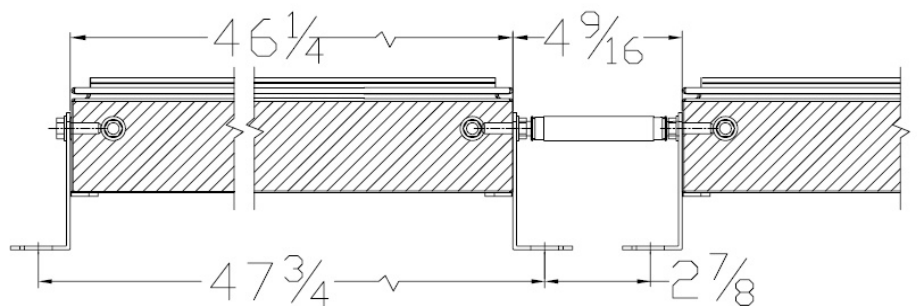


Fig. 6.1.12 – Installation diagram for L-bracket.

6.2 Hoisting And Securing Collectors To Roof

Lifting of collectors requires planning for safety. Collectors are heavy (110 lb, 50 kg) and awkward to maneuver. Different methods are available depending on budget, roof access and number of collectors. A lifting loop is incorporated into upper collector hook-bracket to attach carabiners and lift lines (Fig. 6.2.1).

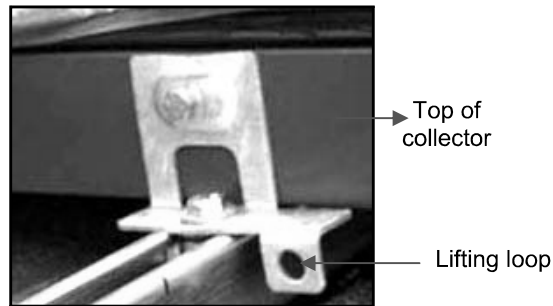


Fig. 6.2.1 – Upper bracket (right) with lifting loop.

6.2.1 Ladder Hoist Or Shingle-Lift

Make sure lift can handle collector weight, and can safely reach desired height (Fig. 6.2.2).



Fig. 6.2.2 – Shingle-lift, articulating boom and scissor lift are all effective tools for hoisting collectors to roof.

6.2.2 Scissor Lift Or Articulating Or Forklift Boom

These lifts typically require a trained and certified operator. These also provide stable platforms for working on steeply-pitched roofs (Figs. 6.2.2 & 6.2.3).

Fig. 6.2.3 – Lifting and securing collectors using forklift boom.



6.2.3 Scaffolding

Scaffolding is inexpensive and very effective for hoisting collectors and for providing a stable work platform. Note in Fig. 6.2.4, installers can face each other and accomplish short lifts of collectors up between deck boards.



Fig. 6.2.4 – Scaffolding used for lifting and as work platform.

6.2.4 Ladder And Lift Line

Using a ladder and lift line is common but requires more than two people. Carabiners and lines should be clipped to lifting loops of upper brackets (Fig. 6.2.5). It is preferable to have two individuals lifting from ground and two on roof to pull collector up and over top of ladder and up and over eave (Fig. 6.2.6).

⚠ Collector is not designed to be levered over ladder or eave. Edges of glass and copper connections should be protected from contact with ladders, walls and eaves. Any damage to collector, including broken glass, due to improper handling is not covered by warranty.

It is recommended to have two ladders in place, side by side, to prevent collector from sliding sideways or pivoting around ladder if it is off center. Strapping or securing collector to plywood or boards may facilitate lift and prevent damage.

⚠ All individuals working on roofs should have completed a fall-safety course and use appropriate safety techniques and equipment. EnerWorks assumes no liability for injury or death during installation or for any damage caused during installation.

⚠ Ensure that angle of ladder is appropriate – ladder rise to run ratio should be between 3.5 : 1 and 4 : 1. Always secure feet and top of ladder. Do not carry objects in hand(s) while climbing or descending – use a tool caddy and lift with a rope.



Raise collector against ladder



Attach carabiners & lines to loops



Hoist & Lift Collector

Fig. 6.2.5 – Lifting collector to roof using ladder and lines.



Fig. 6.2.6 – Lifting collector to roof using ladder and lines.

6.3 Securing Collectors To C-Channel

1. Lift first collector and place its upper bracket hook tabs into C-channel such that weight of collector is fully supported by C-channel.

! TIP: It may be easiest to secure collector with thermistor first. Thermistor wires may then be connected to control wire before other collectors are in place.

2. Slide first collector into position and secure with supplied bolts, washers and twirl nuts (Fig. 6.3.1). **Maximum torque of 9 ft·lb or 12.2 N·m.**
3. Lift second collector (if applicable) into position, placing upper bracket hook tabs into C-channel. Slide second collector far enough away from first collector to install lower push-fitting union.
4. Slide push-fitting union over lower copper tube emerging from side of second (unsecured) collector. Push union-fitting into place firmly, ensuring fitting reaches scored line of tube and “bottoms out”. **Gently pull back on push-fitting union to ensure it has engaged.**
5. Carefully slide unsecured collector towards first (secured) collector such that push-fitting slides over first collector’s lower tube. Ensure fitting reaches scored line of tube and “bottoms out”. **Gently pull back on unsecured collector to ensure fitting has engaged** (Fig. 6.3.2).



Fig. 6.3.1 – Securing collector with ratchet and extension.

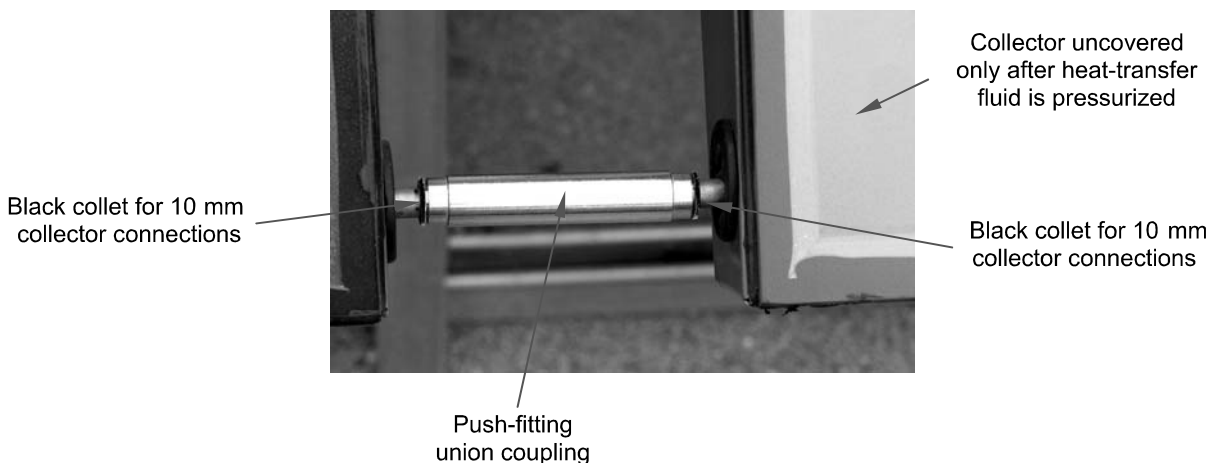


Fig. 6.3.2 – Custom-length push-fitting union connects collectors at lower connections.



6. *Secure second collector with supplied bolts, washers and twirl nuts. **Maximum torque of 9 ft·lb or 12.2 N·m.***
7. *Follow similar procedure for installing third and fourth collectors if applicable. Three- and four- collector appliances do not have push-fitting unions between all collectors. Use center-flashing to ensure appropriate spacing if push-fitting unions are not present.*

6.4 Line-Set And Control-Wire Connections

1. *Cut excess length of control-wire and/or of thermistor wire as needed. Strip about 1½" (3-4 cm) of control-wire sheathing. Do not strip insulation from individual conductor wires.*



Thermistor has very large resistance and thus negligible current flow. Only voltage drop across thermistor is monitored by Controller. No positive or negative connections are necessary – either thermistor conductor can be connected to either control wire conductor.

2. *Insert one unstripped conductor of control-wire into one of three open holes of IDC. Insert one unstripped thermistor conductor into one of remaining holes. Conductors should be inserted completely. Position should be visible through translucent connector body (Fig. 6.4.1a).*
3. *To make connection: with slip-joint pliers, squeeze gel-filled blue cap into body of IDC until it clicks and cap is flush with top edge of connector body (Fig. 6.4.1b).*



Thermistor wire gauge is 2x22AWG. Control-wire gauge is typically 2x18AWG. Due to small and different wire gauges, pliers (and not just fingers) must be used to squeeze IDCs closed and make connections.

4. *Repeat with second IDC (Fig. 6.4.1c). Ensure wires and connectors are not under tension or exposed to UV light. Excess wire should be taped to fluid line-set to keep it off of roof surface and to limit exposure to moisture.*



Fig. 6.4.1 – To make thermistor/control-wire connections, insert unstripped conductors into IDC and squeeze with pliers.

5. With a proper tube-cutting tool, cut off excess line-set tube, leaving enough to reach upper copper connections of collectors. Use a light feed with tube-cutter to limit burr, work hardening and compression of soft-copper tube. Remove burr with de-burring or ream tool but do not remove material from original wall thickness. Do not allow removed burr material to enter tube.
6. Firmly push **3/8" (9.525 mm) stainless steel collet** of 90°-elbow push-fittings onto **line-set tube-ends** until tube "bottoms out". Gently pull back on fittings to ensure they have properly engaged.
7. Carefully bend line-set tubes down between collectors such that 90°-elbow push-fittings will fit onto collector tubes (Fig.6.4.2). A proper tube-bender should be used for tight bends. If line-set needs to be trimmed, push-fittings can be removed by pressing collet towards fitting while pulling fitting from tube. A 7/16" open-ended wrench is good for depressing collet.
8. Firmly push 0.394"(10 mm) black collet of 90°-elbow push-fittings onto **collector tube-ends**. Ensure fittings reach scored lines and "bottom out". **Gently pull back on fittings to ensure they have properly engaged.**

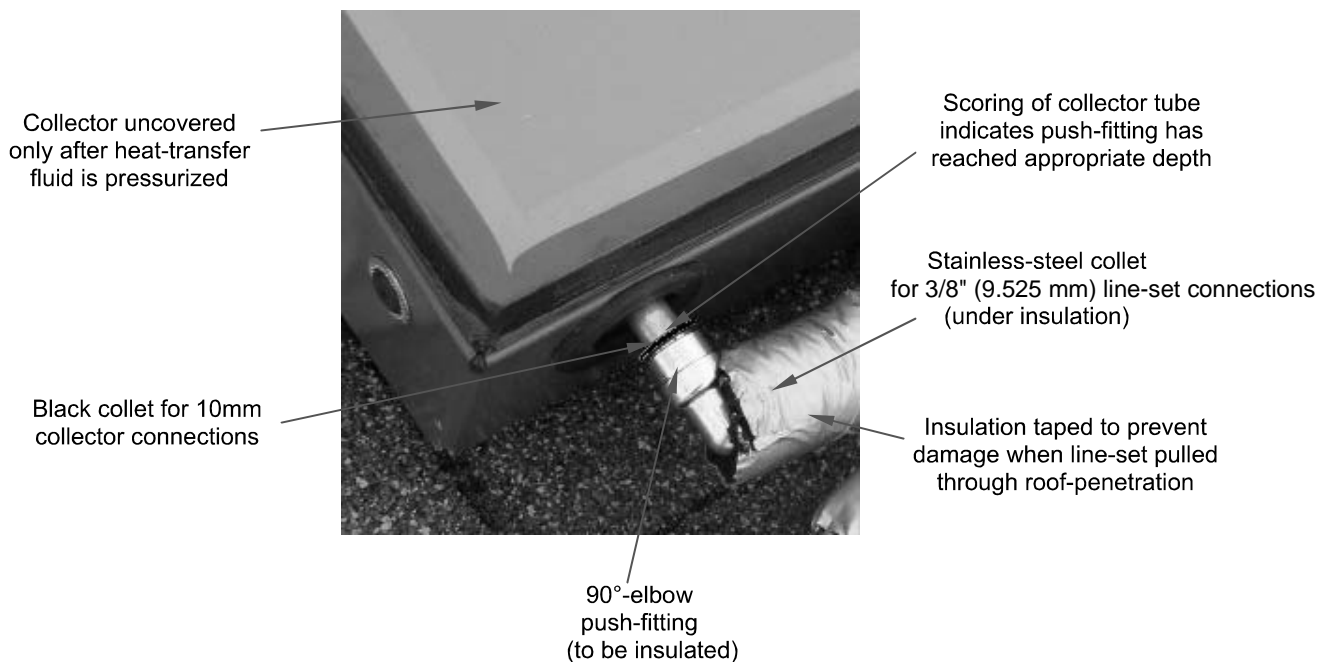


Fig. 6.4.2 – 90°-elbow push-fittings connect line-set to collectors (to be insulated after pressurizing heat-transfer fluid).



Do not insulate fittings and do not install collector flashing or leaf-guards until appliance has been leak-tested, and charged and pressurized with heat-transfer fluid. Leave plastic foil cover in place until appliance is charged and pressurized with fluid.

! When cutting line-set and soft-copper tube, always use a proper tube-cutting tool. Use a light feed to minimize burr, work-hardening and tube compression. Remove burr with a de-burr or ream tool but do not remove material from original wall thickness. Do not allow removed burr material to enter tube.

! To obtain effective and leak-proof connections when using push-fittings, always insert tube-end until fitting reaches scored line (on collector tubes) and/or until tube “bottoms out” in fitting. Gently pull back on fitting to ensure fitting has properly engaged.

! Push-fittings can be removed from tube by depressing collet towards fitting body and by pulling tube and fitting apart. A 7/16” (3.655 cm) open-ended wrench is good for depressing fitting collar.

6.5 Other Collector Configurations

EnerWorks Solar Water Heating Appliances are sized with one, two, three or four solar collectors. See EnerWorks Site Evaluation, Appliance Selection and Sizing manual to determine correct size.

6.5.1 One-Collector Configuration

Connection procedure:

1. *Install collector immediately next to roof-penetration such that line-set can be covered by side-flashing (Fig. 6.5.1).*
2. *Carefully bend line-set to collector connections (if necessary, use a proper tube-bender for tight bends).*
3. *Cut off excess tube with a proper tube-cutter. Use a light feed to minimize burr, work-hardening and compression of tube. Remove burr with de-burr or ream tool.*
4. *Firmly push 3/8” (9.525 mm) stainless steel collets of 90°-elbow push-fittings onto line-set tubes until fittings “bottom out”. Gently pull back on fittings to ensure they have engaged.*
5. *Firmly push first (10 mm) black collets of 90°-elbow push-fittings onto collector tubes. Ensure fittings reach scored line and “bottom out”. Gently pull back to ensure they have engaged.*

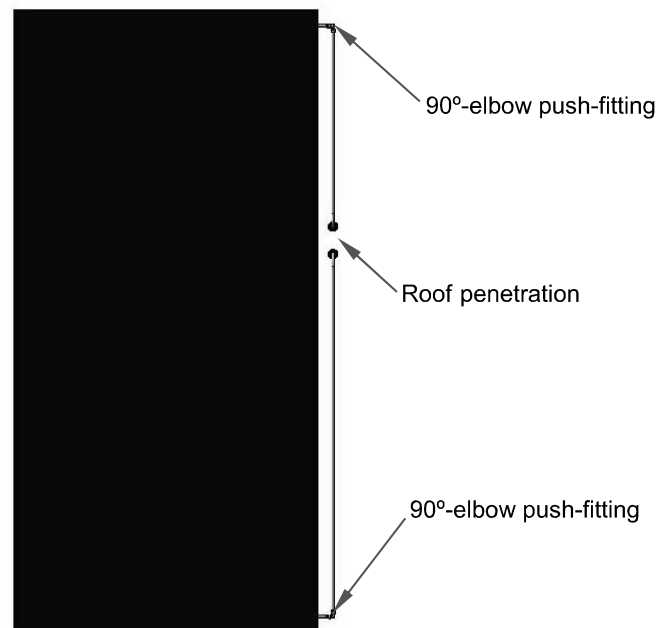


Fig. 6.5.1 – Single-collector configuration.

6.5.2 Three-Collector Configuration

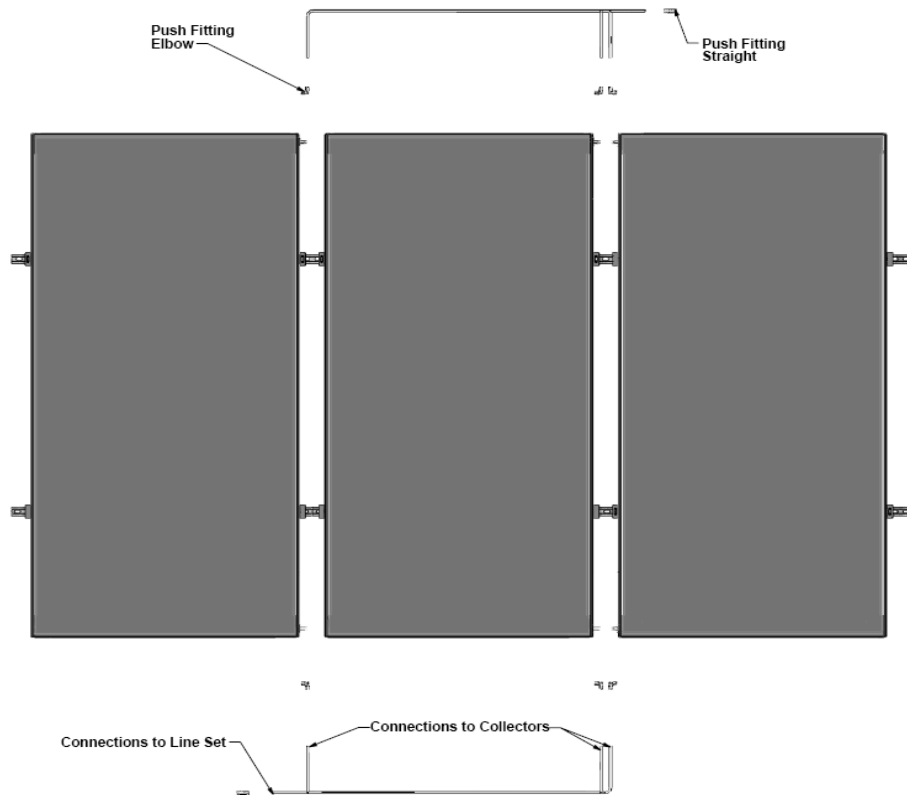
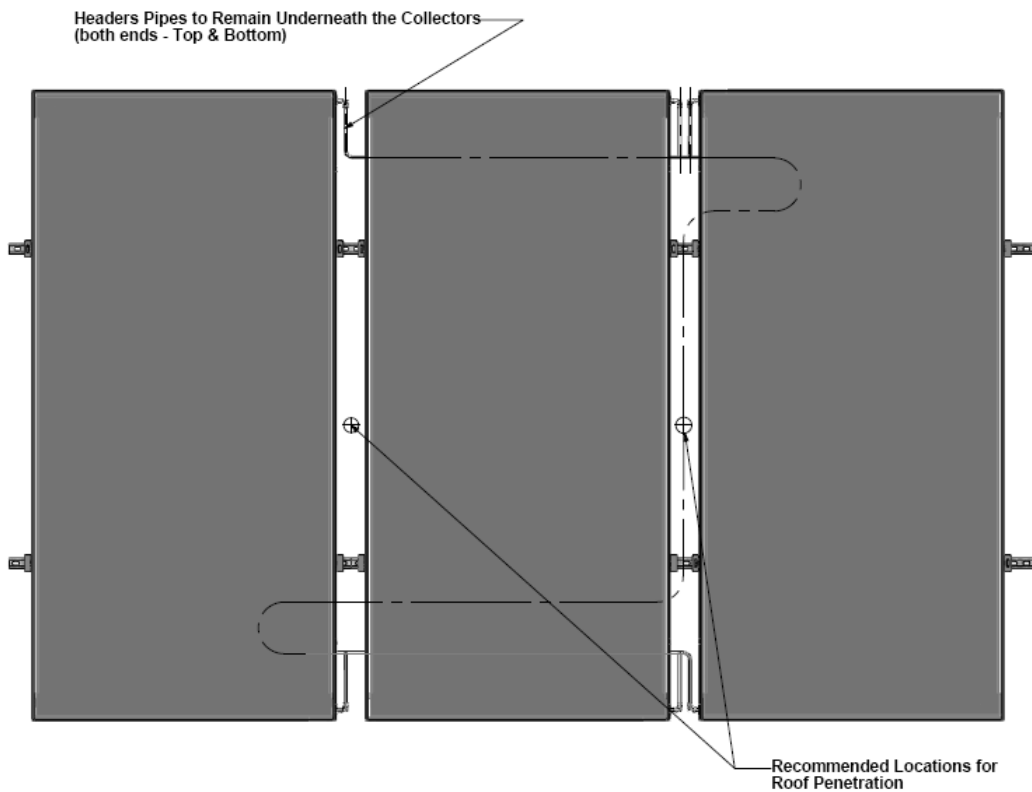


Fig. 6.5.2 – Three-collector configuration.

Three Panel Connection Procedure:

1. Position collectors on either side of roof penetration with connection tubes pointing in (Fig 6.5.2). Space each collector 4-9/16" (116 mm) apart. – Alternatively temporarily use center-flashing to achieve correct spacing of panels and secure it to the c-channel.
2. Line set connection from roof penetration to header will require 9 to 11 ft (2743 to 3353 mm), depending on location of roof penetration
3. A proper tube-bending tool is required for bends around middle collector.
4. Cut off excess tube with a proper tube-cutter. Use a light feed to minimize burr, work-hardening and compression of tube. Remove burrs with de-burr or ream tool.
5. Firmly push 3/8" (9.5 mm) stainless steel collets of 90°-elbow push-fittings onto line-set tubes until fittings "bottom out". Gently pull back on fittings to ensure they have engaged.
6. Insulate header tube with supplied 3/8" (9.5 mm) closed cell insulation.
7. With header tube underneath panel firmly push 3/8" (9.5 mm) header tube connections into Stainless Steel collects of the 90° elbows push fitting until it "bottoms out". Gently pull back on fitting to ensure they have engaged.
8. Firmly push 3/8" (9.5 mm) union fitting onto header tube and line set tubes until fitting bottom out. Gently pull back on fittings to ensure they have engaged.
9. Repeat steps 6, 7, and 8 for opposite header tube.



Note: when inserting all push fitting make sure that the alignment between the tube and the fitting is appropriate. If alignment is not correct there is a risk of damaging the o-ring inside the fitting.

6.5.3 Four-Collector Configuration

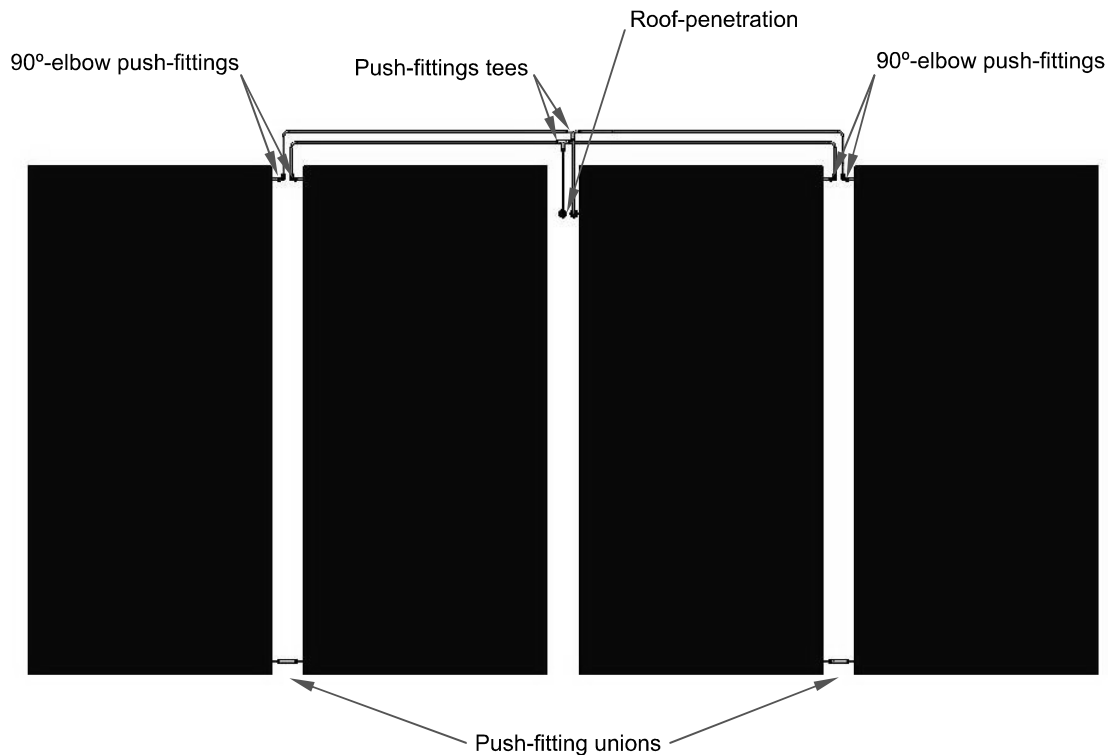


Fig. 6.5.3 – Four-collector configuration.

Connection procedure:

1. Position two collectors on either side of roof-penetration with connection tubes pointing out (Fig. 6.5.3). Temporarily use center-flashing to achieve correct spacing of middle collectors and secure them to C-channel.
2. As described in two-collector procedure, install push-fitting unions to lower tubes and position and secure outermost collectors.
3. Line-set connections from roof-penetration to push-fitting tees each require 1 – 2 ft. (304.8 mm – 609.6 mm) of tube. Four additional insulated sections of tube, each approximately 5 ft. (1524 mm) in length, are required to connect collectors to push-fitting tees.
4. A proper tube-bending tool is required for tight bends.
5. Cut off excess tube with a proper tube-cutter. Use a light feed to minimize burr, work-hardening and compression of tube. Remove burrs with de-burr or ream tool.
6. Push middle stainless steel collet of push-fitting tees onto line-set from roof penetration. Push additional insulated tube into stainless steel side-collets of push-fitting tees. Push 3/8" (9.525 mm) stainless steel collet of 90°-elbow push-fittings onto additional tube ends. Finally, push 10 mm black collet of 90°-elbow push-fittings onto collector tubes. For all push-fitting connections, ensure fittings reach scored lines and/or "bottom out" and gently pull back to ensure they have properly engaged.

7 – Collector Flashing And Leaf-Guard Installation



Collectors must remain covered while charging Appliance with fluid. Uncovered collectors will get very hot. Fluid pumped through uncovered collectors will flash boil, placing installer at risk of scalding. Boiling will also damage heat-transfer fluid and void warranty.



Collector flashing and leaf-guard should be installed after leak-testing and after fitting insulation as access to collectors, fittings and thermistor may be necessary if a leak or problem is detected.



Collector flashing and leaf-guard are designed for pitched roof installations only. Flashing and leaf-guard should not be installed on rack-mounted collectors due to increased wind loads.

7.1 Side-Flashing For 1-Collector Appliances

One-collector Appliance includes side-flashing that must be installed to cover connections, insulated line-set, thermistor and control wires, and roof-penetration. Side-flashing may be installed on left or right of collector but must cover connections and roof penetration. Side-flashing includes two thin lengths of painted, galvanized steel with 90° bends and two end-caps for top and bottom (Fig. 7.1).

Two sets of side-flashing may be installed to make installation symmetrical. Side-flashing may also be used on multi-collector installations to hide C-channel.

1. *Insert edge of side-flashing piece in collector side-wall groove. Align bottom edge of flashing with bottom of collector. Secure lower side-flashing to roof with included roofing screws.*
2. *Insert edge of upper side-flashing into side-wall groove such that it overlaps lower section (for shedding rain and snow). Secure upper side-flashing to roof with included roofing screws.*
3. *Insert rectangular caps into upper and lower holes created by side-flashing and collector (Fig. 7.1.1). Secure to roof with included roofing screws. Secure to upper and lower side-flashing with included self-drilling screws.*
4. *Secure upper side-flashing section to lower section at overlap with included self-drilling screws.*

Upper section overlaps lower section for proper shedding of rain and snow

End-caps in place at top and bottom



Fig. 7.1.1 – Collector side-flashing. Note roof-penetration boot under side-flashing.

7.2 Center-Flashing For 2-, 3- And 4-Collector Appliances

Two-, three- and four-collector Appliances include one, two or three sets of center-flashing. Center-flashing should cover insulated line-set, collector connections, thermistor and control wires and roof penetration. Center-flashing is two thin lengths of painted, galvanized steel that slide between collectors. Side-flashing may also be used on multi-collector installations to hide C-channel.

1. Slide center-flashing between collectors in collector side-wall grooves. Upper length should overlap lower length to ensure proper rain and snow shedding (Fig. 7.2.1).

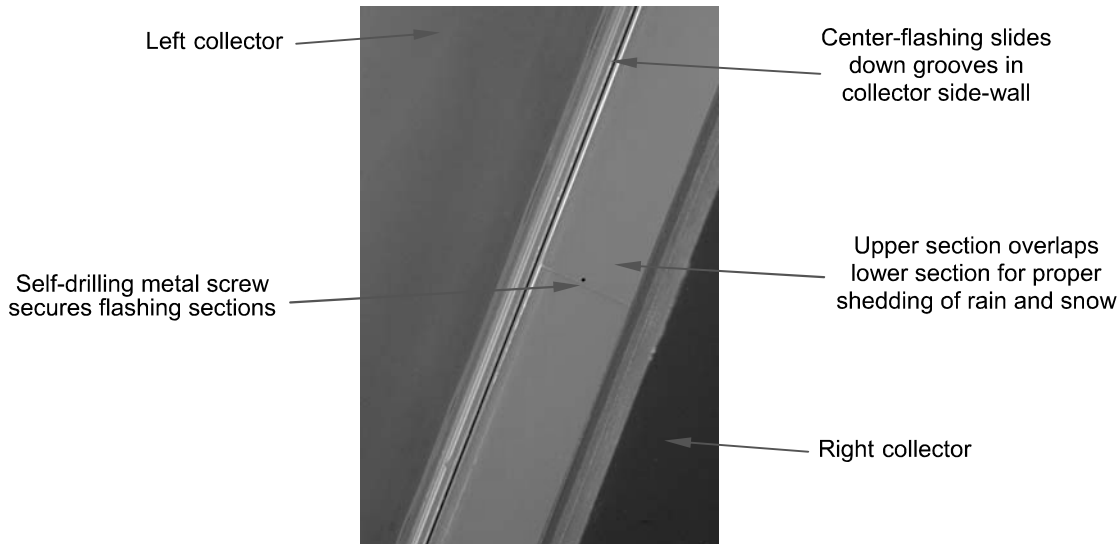


Fig. 7.2.1 – Center-flashing slides between collectors (2-, 3- and 4-collector Appliances).

2. Fold ends of center-flashing sections down such that they are flush with collector side-wall edge. Secure center-flashing sections to upper and lower side-walls with self-drilling screws. If leaf-guard is to be installed, do not fold down upper center-flashing length until leaf-guard is in place (Fig. 7.2.2).



Fig. 7.2.2 – Center-flashing folds down flush with edge of collector (2, 3 and 4-collector Appliances).

3. Secure upper center-flashing section to lower section with a self-drilling screw (Fig. 7.2.1).



TIP: If it is difficult to slide center-flashing between collectors, try loosening C-channel bolts temporarily. Be sure to re-tighten C-channel bolts after center-flashing is “started” in side-wall grooves. It may also help to bow the center-flashing sections slightly upwards to get them “started” in the side-wall grooves.

7.3 Leaf-Guard Installation

Leaf-guard is included with three- and four-collector Appliances to protect and shade insulated line-set. Leaf-guard for one- and two-collector Appliances is optional and is of benefit to prevent leaves and debris from gathering around and beneath collectors. Leaf-guard includes thin lengths of perforated, painted, galvanized steel and triangular end-caps. Perforations ensure proper functioning of patented stagnation-control mechanism. Each section of leaf-guard is slightly longer than collector is wide.

1. Insert lower edge of leaf-guard section into side-wall groove at top of collector. Align side edge of leaf-guard section with outer side of collector or with side-flashing. Leaf-guard sections are overlapped to ensure edges are flush with outer collector side-walls.
2. Secure leaf-guard to roof with included roofing screws.
3. Insert triangular caps into left and right leaf-guard ends. Secure end caps to roof with included roofing screws (Fig. 7.3.1).
4. Secure end-caps to leaf-guard sections and secure sections to each other at overlaps with self-drilling screws.
5. Bend center-flashing down to leaf-guard and secure with self-drilling screws if applicable (Fig. 7.3.1).

Center-flashing folded down and secured flush with leaf-guard



Fig. 7.3.1 – Two collectors with center-flashing and leaf-guard.



EnerWorks



SMART SOLAR ENERGY KINETICS

PRODUCT & INSTALLATION REGISTRATION FORM

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Date of Installation:		Water Hardness:		Energy Pack Serial Number:	
		<input type="checkbox"/> GPG <input type="checkbox"/> ppm <input type="checkbox"/> mg/L		<input type="text"/>	
Customer Name:		Installer Name:		Solar Collector Serial Number: 1	
Installation Address:		Company Address:		Solar Collector Serial Number: 2	
Postal/Zip Code		Postal/Zip Code		Solar Collector Serial Number: 3	
Customer Telephone 1:		Installer Telephone 1:		Solar Collector Serial Number: 4	
Customer Telephone 2:		Installer Telephone 2:			
Customer e-mail:		Installer e-mail:		Thermistor stickers	

LAA063 - 080820

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- Do not add me to your mailing list



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SITE	Name _____ Phone 1 _____	
	Company _____ Phone 2 _____	
Address _____ Fax _____		
City _____ e-mail _____		
State/Prov _____		
Post Code _____ www. _____		
SITE	Name _____ Phone 1 _____	
	Address _____ Phone 2 _____	
City _____ Fax _____		
State/Prov _____ e-mail _____		
Post Code _____		
SITE	Same as above <input type="checkbox"/> Coordinates _____ ° _____ ' _____ N	
	Name _____ ° _____ ' _____ W	
Address _____ Phone 1 _____		
City _____ Phone 2 _____		
State/Prov _____ Fax _____		
Post Code _____ e-mail _____		
WATER	Municipal mains <input type="checkbox"/> Hardness _____ GPG ppm mg/L	
	Community well <input type="checkbox"/> (if >29 GPG or >500ppm, water softener must be in place)	
Private well <input type="checkbox"/> Turbidity _____ GPG ppm mg/L		
Lake/River <input type="checkbox"/> Metals _____		
Rain <input type="checkbox"/> Water analysis _____		
Chlorine shock <input type="checkbox"/> (Energy Pack must be bypassed if water is shocked with chlorine or carbon filter must be in place)		
WATER & ENERGY USE	Adults _____ Total water use _____ US gal Imp gal L daily <input type="checkbox"/>	
	Teenagers _____ (if not known, approx. 16 US gal, 13 Imp gal, or 60 L per person per day) weekly <input type="checkbox"/>	
Children _____ Hot water use _____ US gal Imp gal L monthly <input type="checkbox"/>		
Total _____ (if not known, approximately 1/3 of total hot water use) annually <input type="checkbox"/>		
Existing water-heater _____ Electric <input type="checkbox"/>		
Brand / Model _____ Natural gas <input type="checkbox"/> Storage tank <input type="checkbox"/>		
Size _____ US gal Imp gal L Oil <input type="checkbox"/> On-demand <input type="checkbox"/>		
Age _____ yrs Propane _____		
Energy use _____ kWh BTU therm ft ³ m ³ Cost of Energy \$ _____		
monthly <input type="checkbox"/> annually <input type="checkbox"/> monthly <input type="checkbox"/> annually <input type="checkbox"/>		
Anticipated # of collectors _____ Solar storage tank size _____ US gal Imp gal L		
BUILDING	Age _____ yrs # of stories _____	
	Line-set route _____ roof-penetration, exterior wall <input type="checkbox"/>	
_____ roof-penetration, interior <input type="checkbox"/>		
_____ around eave, exterior <input type="checkbox"/>		
_____ in ground <input type="checkbox"/>		
Access to basement _____		
Sill height above ground _____		
Basement construction <input type="checkbox"/> _____		
Space for solar storage tank <input type="checkbox"/> x _____		
120 VAC available <input type="checkbox"/>		
Plumbing material _____ Size _____		
copper <input type="checkbox"/> 1/2" <input type="checkbox"/>		
PEX <input type="checkbox"/> 3/4" <input type="checkbox"/>		
other _____ other _____		
Roof cladding _____ Asphalt shingle <input type="checkbox"/>		
_____ Metal with raised seams <input type="checkbox"/>		
_____ Tile <input type="checkbox"/>		
Other _____		
Roof/collector direction _____ azimuth _____ °		
_____ magnetic _____ °		
_____ declination _____ °		
_____ true _____ °		
Roof/collector pitch _____ : 12 or _____ °		
Roof condition _____		
Roof access _____		
Safety, Notes & Comments _____		

	Tools and Supplies	Note
	fall-prevention/fall-arrest equipment	observe all local requirements
	ladders or scaffolding	
	rope and carabiners	for hoisting collectors/supplies
	sturdy bag or basket	for hoisting tools/supplies
	work lamps	for attic
	drill with charger and extra battery or extension cord	
	¼" drill bit (long, 6" bit required)	to pre-drill rafters for lag-bolts
	Open-ended wrench, ratcheting box-end wrench, ratchet with extension, and or nut driver (1/2" and 9/16")	for securing C-channel and collectors
	¼" driver bit	for roofing, thermistor cap screws
	5/16" driver bit	for flashing screws
	caulking gun	for roof sealant
	extra roof sealant (polyurethane/silicone)	
	level	
	measuring tape	
	hole saw to make 2 x 1 ¼" or one 2.5" hole	
	hammer / small pry bar	
	tape measure	
	chalk or tape with marker	
	slot-joint pliers	for thermistor wire IDCs (insulation displacement connectors)
	spray bottle with dish soap solution	for leak testing
	Multimeter	to test thermistors, see pg 23 for temp. vs. resistance table
	insulation tape	for taping insulation seams
	3/8" flare tool	for line-set connections to Energy Pack
	3/8" tube-bender	for tight bends (necessary for 3 & 4-collector Appliances)
	copper clips/pipe straps	for securing line-set
	UV protection/wrap for exposed insulation	to protect line-set
	false downspout/electrical conduit/pvc/abs	exterior conduit for line-set
	extra spacers, lag-bolts, washers, roofing screws, etc.	
	hose	to drain existing tank
	standard top or bottom-feed electric hot water tank (pre-heat) 50 US gal / 40 Imp gal / 175 L 80 US gal / 60 Imp gal / 275 L 120 US gal / 100 Imp gal / 455 L	size depends on number of collectors: 1-collector appliance 2-collector appliance 3, 4-collector appliances
	thermostatic anti-scald device (recommended or required)	to prevent scalding, observe local code requirements
	temperature and pressure safety relief valve	to prevent boiling/exploding observe local code requirements
	drip tube	for T&P relief valve, observe local code requirements
	drip pan	main-floor storage tanks, observe local code requirements
	tank blanket	minimize thermal losses, optional
	three ball-valves	solar storage tank bypass, match with existing pipes
	tie-wrap, zip-tie	bypass valve info card
	two sweat tees, 1/2" or 3/4"	for bypass, match with existing pipes
	90° elbow sweat fittings, 1/2" or 3/4"	as required, match with existing pipes
	1/2" or 3/4" copper pipe	as required, match with existing pipes
	pipe-cutter	
	de-burr (ream) tool	
	soldering torch	
	tool to clean copper fittings and pipe	
	lead-free solder	
	thread sealant/teflon tape	seal NPT-fittings, NOT flare-fittings
	adjustable crescent wrenches	
	pipe wrenches	
	combination wrenches	
	level	
	measuring tape	

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	¼" driver bit with 6" magnetic extension	for Energy Pack mounting screws
	adjustable crescent wrenches	for flare-fittings, use two wrenches and counter-torque
	combination wrenches	for flare-fittings, use two wrenches and counter-torque
	level	for Energy Pack, pipe runs
	Phillips #2 screwdriver	for Energy Pack cover screws, tank thermostat
	precision slot/flathead screwdrivers (2.0mm, 2.4mm, 3.0mm)	for controller connections
	4' two-conductor cable suitable for 240VAC service	Space-Saver™ only connect heating element to Controller
	air compressor/bicycle floor pump	to pressurize and leak-test, to pressurize expansion tank
	tire pressure gauge (Schrader)	as accurate as possible (<±1 psi)
	pipe-cutter	
	de-burr (ream) tool	to de-burr copper tube
	measuring tape	
	charging kit	to remove air from and to pressurize heat-transfer fluid loop
	gal (3.78L) distilled, deionized, demineralized water	to mix with propylene glycol to make heat-transfer fluid
	clean bucket, container or reservoir	for heat-transfer fluid
	power bar with extension cord	for operating charge pump
	work lamps	
	fire extinguisher	observe all local requirements
	safety glasses	observe all local requirements
	steel-toed boots	observe all local requirements
	work gloves	observe all local requirements
	fall-prevention/fall-arrest equipment	observe all local requirements



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 Fax: (519) 268-6292 • www.enerworks.com

Module 5

Part Number: KAA105
Ver. 5.0



Overheat Protected Adjustable Rack Installation Manual

1, 2, 3 & 4 Collector Appliances



Solar Water Heating Appliances

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www.enerworks.com

Foreword

Use this installation manual to install the EnerWorks Overheat Protected Collector Adjustable Rack.

The racking system allows for set collector angles ranging from 30° to 60°.

This manual complements installation training available through EnerWorks or approved distributors. EnerWorks training is mandatory to become an EnerWorks-authorized dealer.

EnerWorks encourages installers of EnerWorks products to always keep workmanship, best practices and safety in mind. An organized installation will benefit both installer and end-user.



Before proceeding with installation of the EnerWorks Solar Water Heating Appliance, make note of Energy Pack and Solar Collector serial numbers on the Product & Installation Registration Form included with Owner Manual.



Once installed, rack must not be adjusted in an attempt to enhance seasonal performance.



This manual does not describe or outline how rack is attached to structural members of building. This must be determined and approved locally on a site-specific basis.



Recognize this symbol as an indication of important safety information!



EnerWorks Residential Solar Water Heating Appliances must be installed as directed by this manual by an Energy Kinetics and EnerWorks-authorized dealer or warranty is void.

CALIFORNIA PROPOSITION 65 WARNING: This product contains chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

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Safety



Neither Energy Kinetics nor EnerWorks assume responsibility for damage, loss or injury related to installation of this appliance.



Observe any and all regulations relating to installation of solar appliances and to plumbing to potable water supply. Plumbing and/or building permits may be necessary. EnerWorks Solar Water Heating Appliances utilize a single-wall heat exchanger. Single-wall heat exchangers may not be acceptable in all jurisdictions.



Assemblies and materials used during installation shall meet requirements of local, regional, state, provincial, and federal regulations and fire codes. Any penetrations made in drywall or any other firewall must be fixed to maintain integrity of fire protection.



All persons working on roofs should have successfully completed a fall-safety course and should be properly equipped with appropriate safety equipment.

CARE, HANDLING & STORAGE

EnerWorks Solar Collectors are manufactured with tempered glass. Though extremely resistant to impact, tempered glass can break if an edge is subjected to stress. During storage and installation, protect glass edges. Glass breakage is not covered by warranty.

Store collectors in a dry place, lying flat with glass up, or leaning on long edge with glass facing out and connections at top. Protect collector from scratches and damage by placing it on a soft surface such as a blanket or cardboard. When hoisting collectors to roof, be very careful not to damage glass edge. Collectors must not be levered over ladder or eave or they may be damaged. Be very careful of collector connections as they are soft copper and may be easily damaged. A leak-proof heat-transfer fluid loop can only be achieved if collector connections are not damaged.

Do not store collectors outside with glass face down. Due to EnerWorks's patented stagnation-control device, back of collector is not sealed to atmosphere. Rain may enter collector if it is stored face down. Any damage due to ingress of rain is not covered by warranty.

It is best to store both the EnerWorks Solar Collectors and the EnerWorks Energy Pack in a cool, dry place.

2 – Collector Location, Orientation And Shading

To achieve good performance and a good return on investment, Appliance must be sized correctly and oriented properly. Site evaluation is necessary to determine whether a site is appropriate and to evaluate complexity of installation. It is also necessary to determine the hot water loads, number of individuals in a home, number of collectors and size of solar storage tank.




See EnerWorks Selection, Sizing & Site Evaluation manual.

Tools such as the EnerWorks software, SolSim™, or a Solar Pathfinder may assist in determining best location and orientation of solar collectors. SolSim and its user guide are available to EnerWorks-authorized dealers.

Collector(s) should face close to due south for optimal performance. Within 45° of south is acceptable. Southwest may also be appropriate due to climatic conditions – ambient temperatures are warmest in the afternoon when the sun is in the western sky.

Collector angle for optimal year-round performance is equivalent to latitude of location plus or minus 15°. A steeper angle provides better winter performance as sun is lower in the sky. Collectors also shed snow more effectively. A shallow angle maximizes energy capture in summer when sun is high. **A minimum collector angle of 14° (3:12 pitch) is necessary for stagnation-control device to function.**

Shading of collectors greatly reduces performance. When selecting installation location, consider potential shading by trees and other buildings, especially between peak solar hours of 10:00 and 15:00. A Solar Pathfinder or similar device may be used to determine potential shading throughout the year.

-  **For roof-mounting, installer should ensure that roof cladding or sheathing is in good repair. Also ensure that rafters and trusses are adequate to support weight of solar collector(s) and rack assembly.**
-  **Building and plumbing permits and/or inspections may be necessary to proceed with installation. Follow all code requirements and regulations.**
-  **Racking may require approval or certification by a building engineer and/or local authorities. It is the responsibility of the installer to ensure appropriate design and safety criteria are met.**

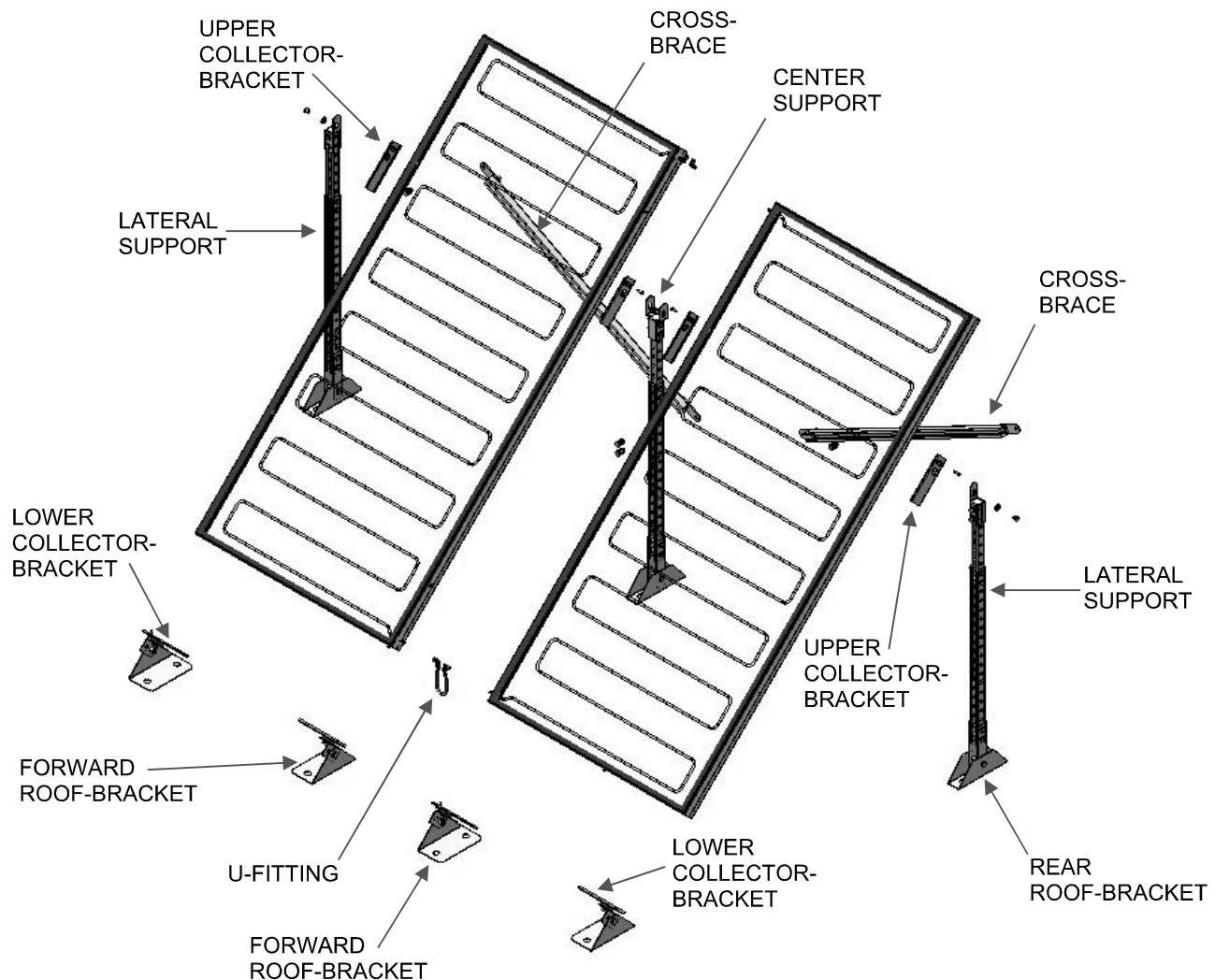
3 – Rack Overview

⚠ Collector angle must be selected before installation. Once installed, rack must not be adjusted in an attempt to enhance seasonal performance.

⚠ Use selected collector angle to determine correct footprint dimensions.

⚠ Follow dimensional drawing and pre-install Forward and Rear Roof Brackets per footprint dimensions.

Two-Collector Layout, Exploded View



Footprint Dimensions

Shown below are forward and rear roof bracket hole dimensions and spacing for a 2-collector rack with collector-angle of 45°. For forward and rear roof bracket hole dimensions and spacing at other collector-angles (30° & 60°) refer to section Roof-Bracket Position and Vertical-Support Height.

Bolt-Hole Dimensions:

- Forward Roof-Brackets (CAA489) – 1" Typ.
- Rear Roof-Brackets (CAA487) – 1" Typ.

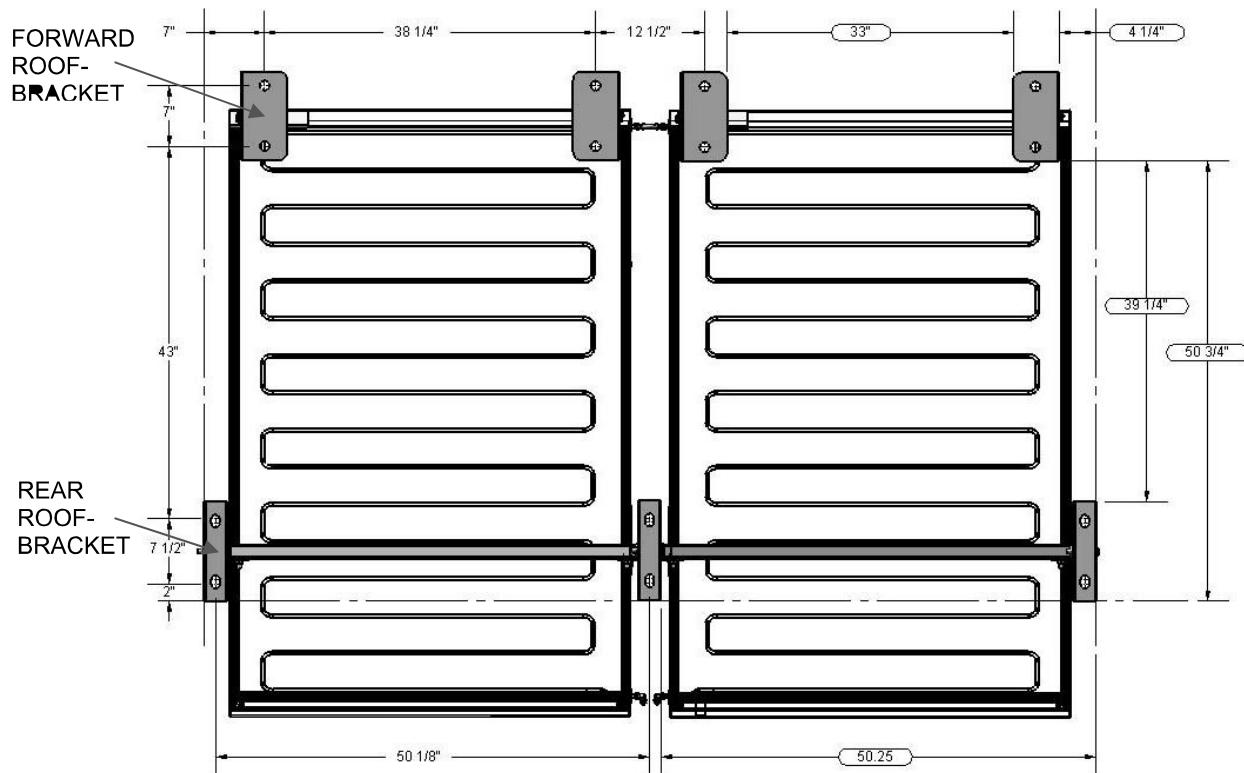


Fig. 1. Roof Brackets.

Roof-Bracket Position and Vertical-Support Height

Using below diagram:

1. Determine horizontal spacing between Forward and Rear Roof-Brackets, depending on desired collector angle (30°, 45°, 60°).
2. Adjust height of Lateral and Center Supports depending on desired collector angle (30°, 45°, 60°).

Lateral and Center Support heights measured from bottom of rear base to top of bracket.

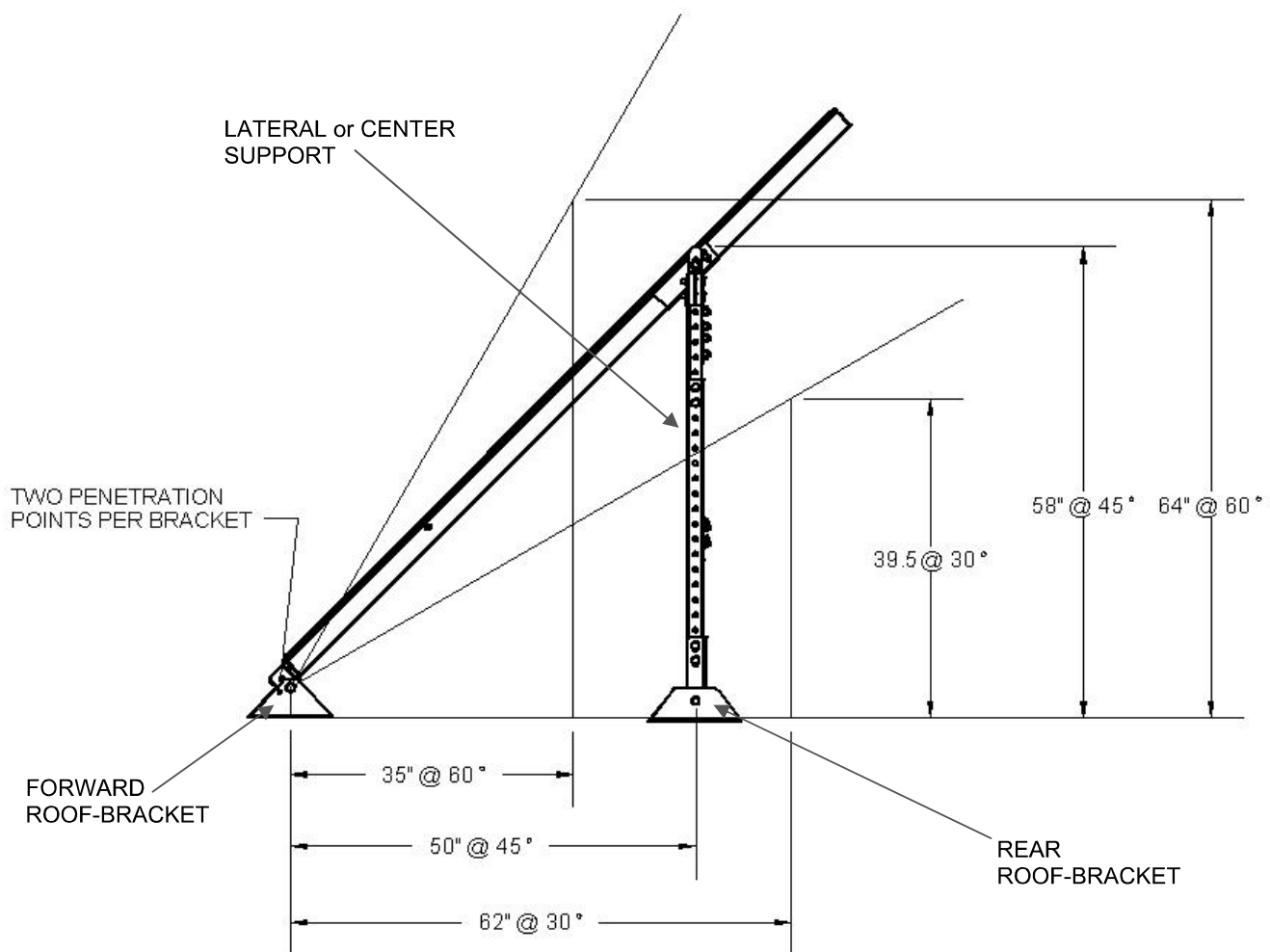


Fig. 2. Lateral and Center Supports.

4 – Sub-Assemblies

It is recommended that all sub-assemblies be assembled prior to arriving at site or in a controlled environment on site. Assemble as described in diagrams that follow.

Residential Center Support(S), if applicable

Lateral Support(S)

Cross-Brace(S)

Quantity of each assembly depends on number of collectors. Please refer to table:

Required Quantity	Number of Overheat Protected Solar Collectors			
	1-Collector	2-Collectors	3-Collectors	4-Collectors
<i>Lateral Support</i>	2	2	2	2
<i>Center Support</i>	-	1	2	3
<i>Cross-Brace</i>	1	2	2	2

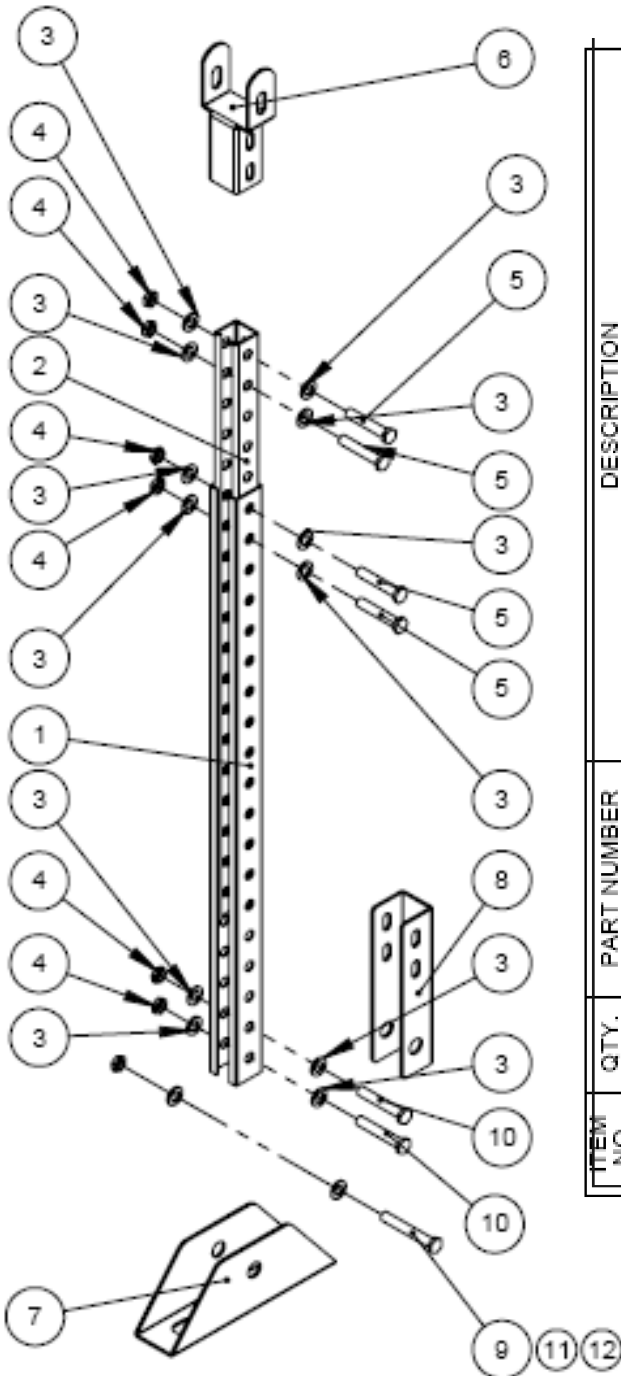
Overheat Protected Collector Center Support for 2-, 3-, 4-Collector Appliances



When attaching upper support bracket (6) to channel, make sure end of C-Channel with hole closer to edge is used as connection point for top attaching brackets.



To set appropriate height of Lateral and Center Supports, refer to diagram in section Roof-Bracket Position and Vertical Support Height.



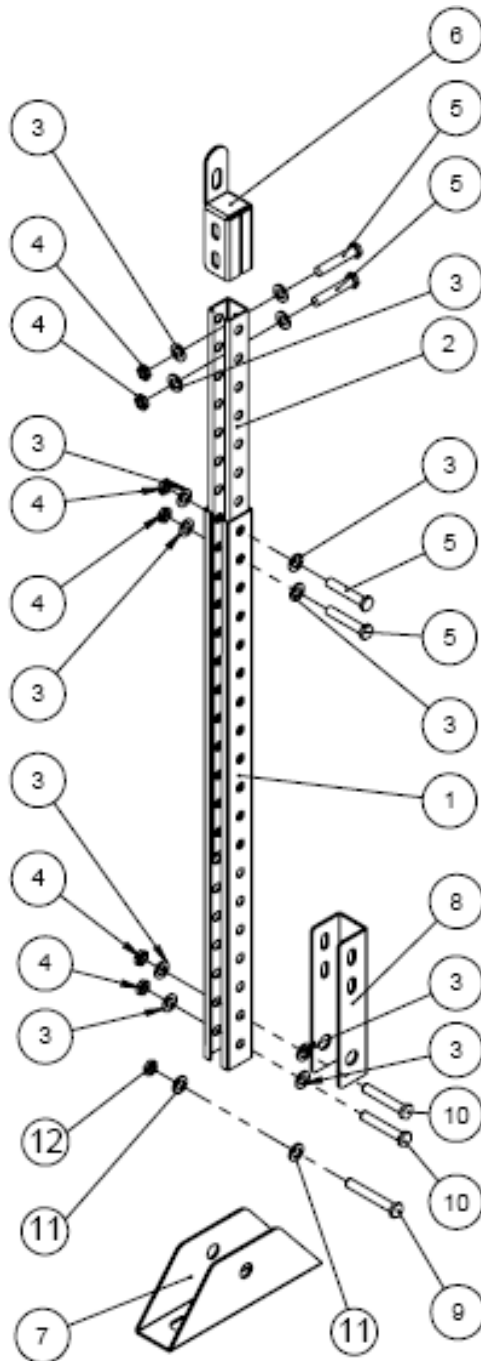
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	XAA232	Tele-Scoping Channel 2, B-Line Part # BTS22TH 38" LG GALVANIZED
2	1	XAA231	Tele-Scoping Channel 1, B-Line Part # B22th 38" LG GALVANIZED
3	12	HAA328	1/2" SAE Flat Washer, Brafasco Part # FISTE1020070
4	6	HAA329	1/2" - 13 Nylon Insert Lock Nut, Brafasco Part # FISTE0220040
5	4	HAA330	1/2"-13 x 2.75 LG, Grade 5 Hex Cap Screws, Zinc Plated, Brafasco Part # FISTE0150405B
6	1	CAA491	Residential Adjustable Racking Centre Bracket
7	1	CAA487	Adjustable Racking Base Bracket
8	1	CAA486	Adjustable Racking Rear Base Bracket
9	1	HAA369	3/4"-10 X 4" LG Bolt, Brafasco Part # FISTE0151800B
10	2	HAA331	1/2"-13 x 3 1/2" LG Grade 5, Hex Cap Screws, Zinc Plated, Brafasco Part # FISTE0150405B
11	2	HAA367	3/4" Flat Washer, Brafasco Part # FISTE1020100
12	1	HAA368	3/4"-10, Nylon Insert Lock Nut, Brafasco Part # FISTE0220055

Fig. 3. Collector Center Support.

Lateral Support, For All Appliances

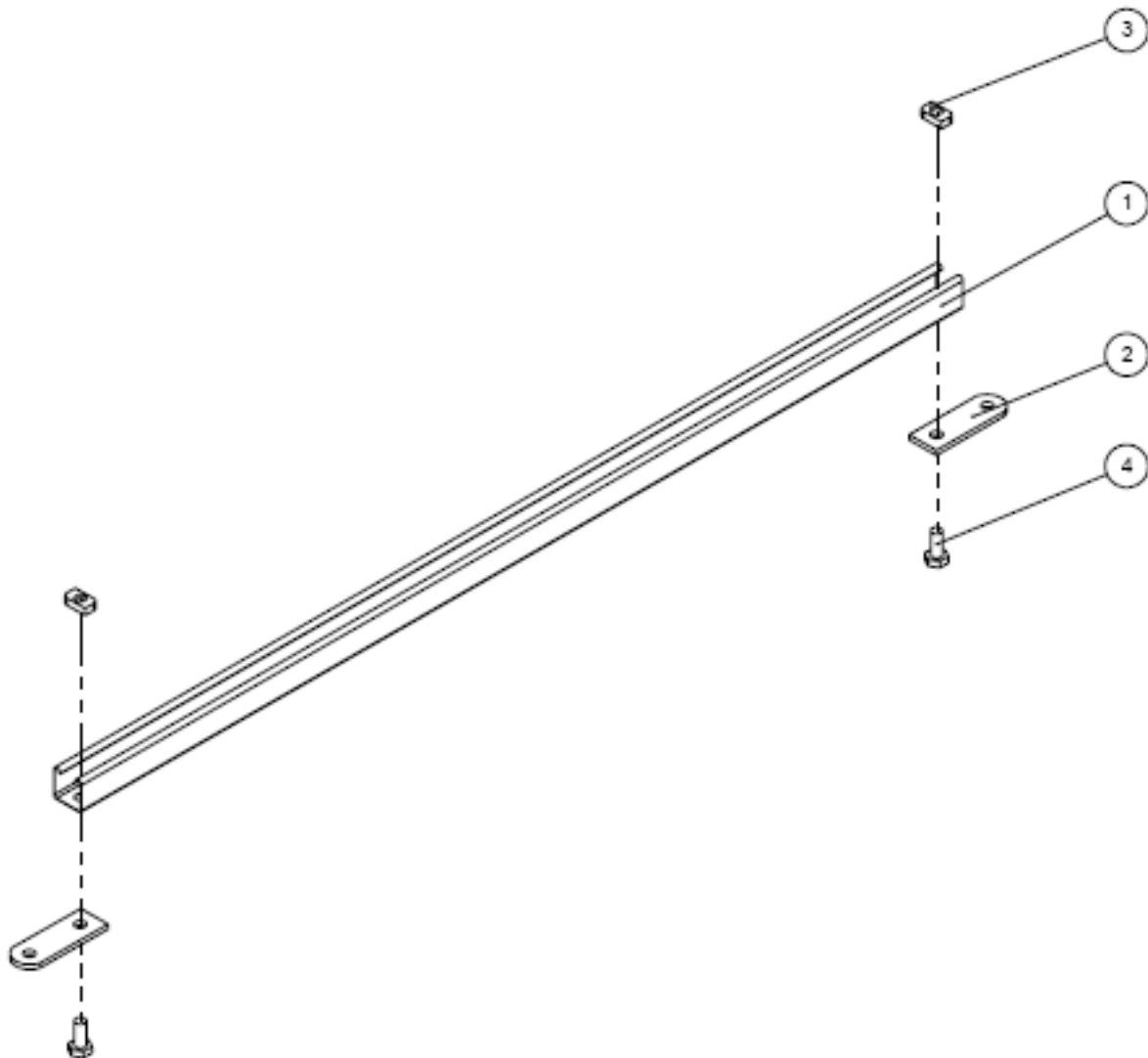
! When attaching upper support bracket (6) to channel, make sure end of C-Channel with hole closer to edge is used as connection point for top attaching brackets.

! To set appropriate height of Lateral and Center Supports, refer to diagram in section Roof-Bracket Position and Vertical Support Height.



ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	XAA232	Tele-Scoping Channel 2, B-Line Part # BTS22TH 36" LG GALVANIZED
2	1	XAA231	Tele-Scoping Channel 1, B-Line Part # B22TH 36" LG GALVANIZED
3	12	HAA328	1/2" SAE Flat Washer, Brafasco Part # FISTE1020070
4	6	HAA329	1/2"-13 Nylon Insert Lock Nut, Brafasco Part # FISTE0220040
5	4	HAA330	1/2"-13 x 2.75 LG, Grade 5 Hex Cap Screws, Zinc Plated, Brafasco Part # FISTE0160405b
6	1	CAA490	Adjustable Racking End Bracket
7	1	CAA487	Adjustable Racking Base Bracket
8	1	CAA488	Adjustable Racking Rear Base Bracket
9	1	HAA368	3/4"-10 X 4" LG Bolt, Brafasco Part # FISTE0151800B
10	2	HAA331	1/2"-13 x 3 1/2" LG Grade 5, Hex Cap Screws, Zinc Plated, Brafasco Part # FISTE0160405b
11	2	HAA367	3/4" Flat Washer, Brafasco Part # FISTE1020100
12	1	HAA369	3/4"-10, Nylon Insert Lock Nut, Brafasco Part # FISTE0220055

Fig. 4. Lateral Supports.



ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	XAA093-R0-52	P300T Uni-Strut Slotted/Galvanized
2	2	XAA291	B138 Cross Bracing Link
3	2	HAA383	1/2"-13 Zinc Lock Nut B-Line Part # N525
4	2	XAA292	HHC 1/2" x 1 1/4" LG Bolts

Fig. 5. Cross-Brace.



2 bolts (XAA292) and 2 channel nuts (HAA383) are supplied with each Cross-Brace to attach to Lateral and Center Supports.

5 – Securing L-Brackets To Lower Collector-Brackets

! Pre-installed on each collector are two Upper Collector-Brackets and two Lower Collector-Brackets. Nut on bracket is used as attachment point.

To complete Lower Collector-Bracket Assembly, attach L-Bracket with:

- 1 5/8"-11 UNC x 5/8" LG Screw
- 1 5/8" Flat washer, Zinc-plated
- 1 FRAME SPACER

! Spacer is installed with chamfered edge of hole facing collector

! L-Bracket must be installed with holes (for attaching to Lower Roof-Bracket) facing out (see diagram).

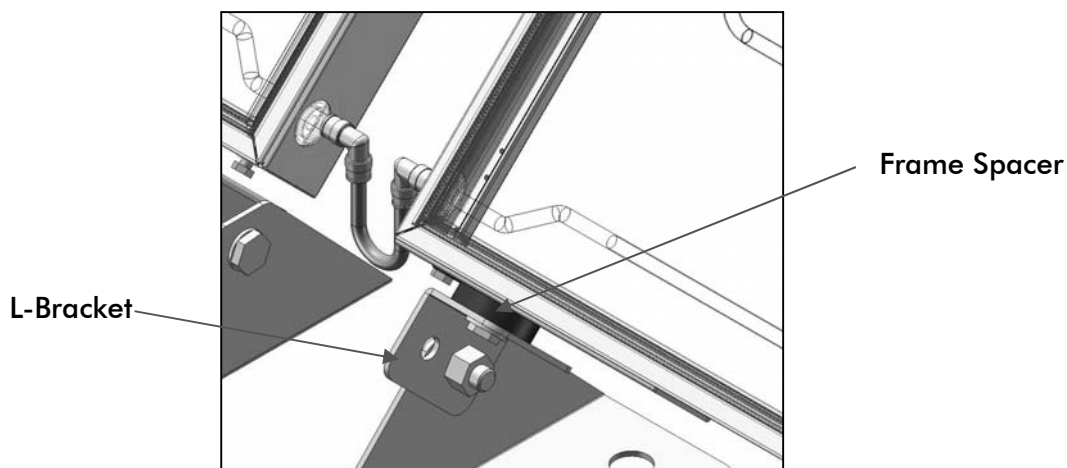


Fig. 6. Lower Collector Brackets.

6 – Raising Collector Bank

Attach Lateral and Center Supports loosely as shown below and lay flat.



Starting at one end of collector bank, attach Lower Collector-Bracket Assembly (L-Bracket) of first collector to Forward Roof-Bracket using for each: one (1) 5/8" x 1 1/4" (15.875 mm x 31.75 mm) LG 11-UNC bolt, one (1) 5/8" (15.875 mm) flat washer (Zinc-plated), and one (1) 5/8" (15.875 mm) -11 UNC, nylon-insert lock-nut.



Lift rear of collector as shown. Use 5/8" x 5/8" (15.875 mm x 15.875 mm) LG 11-UNC bolt, and 5/8" (15.875 mm) flat washer (zinc-plated) to attach Lateral and Center Supports to Upper Collector-Bracket bolts (one bolt and one nut for each upper collector-bracket – no Frame Spacer is used with Upper

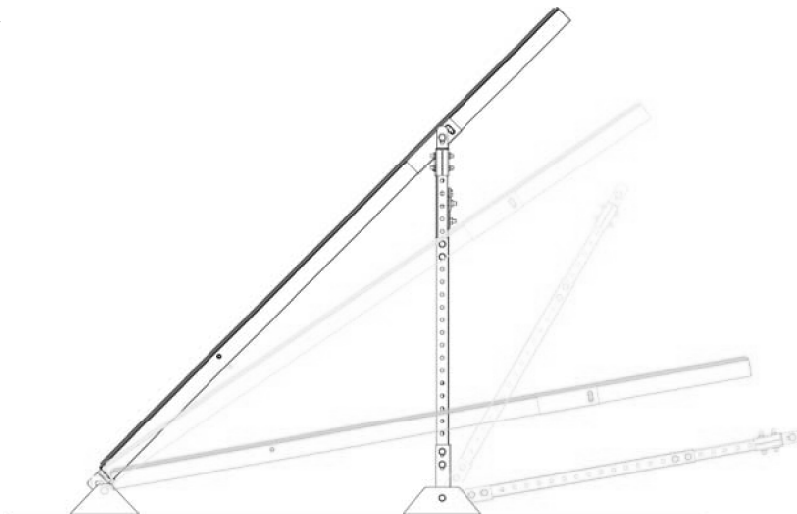


Fig. 7. Collector Bank.

With HHC 1/2" x 1 1/4" (38.1 mm x 31.75 mm) LG Bolts and 1/2" (38.1 mm) -13 zinc lock-nuts, attach diagonal Cross-Brace between vertical supports, as shown.

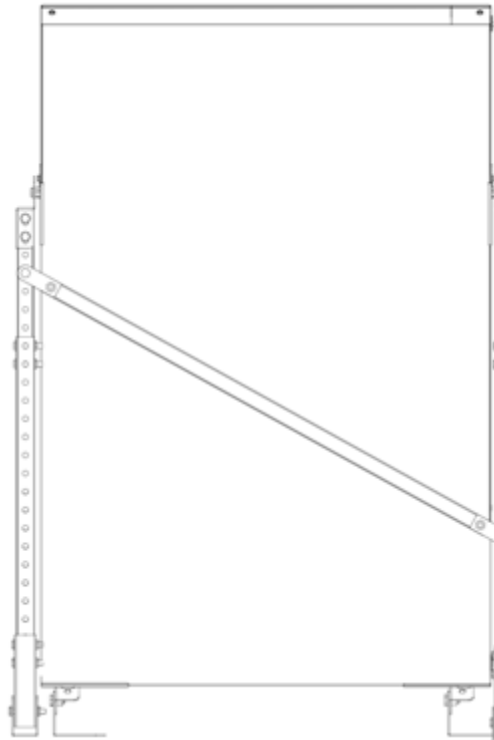


Fig. 8. Cross-Brace Installation Diagram

7 - Completing Collector-Bank Assembly

Repeat procedure as described previously for securing remaining. Only outside (lateral) collectors will have a diagonal Cross-Brace (and Lateral Supports).

Shown below is a bank of four Overheat Protected Collectors.

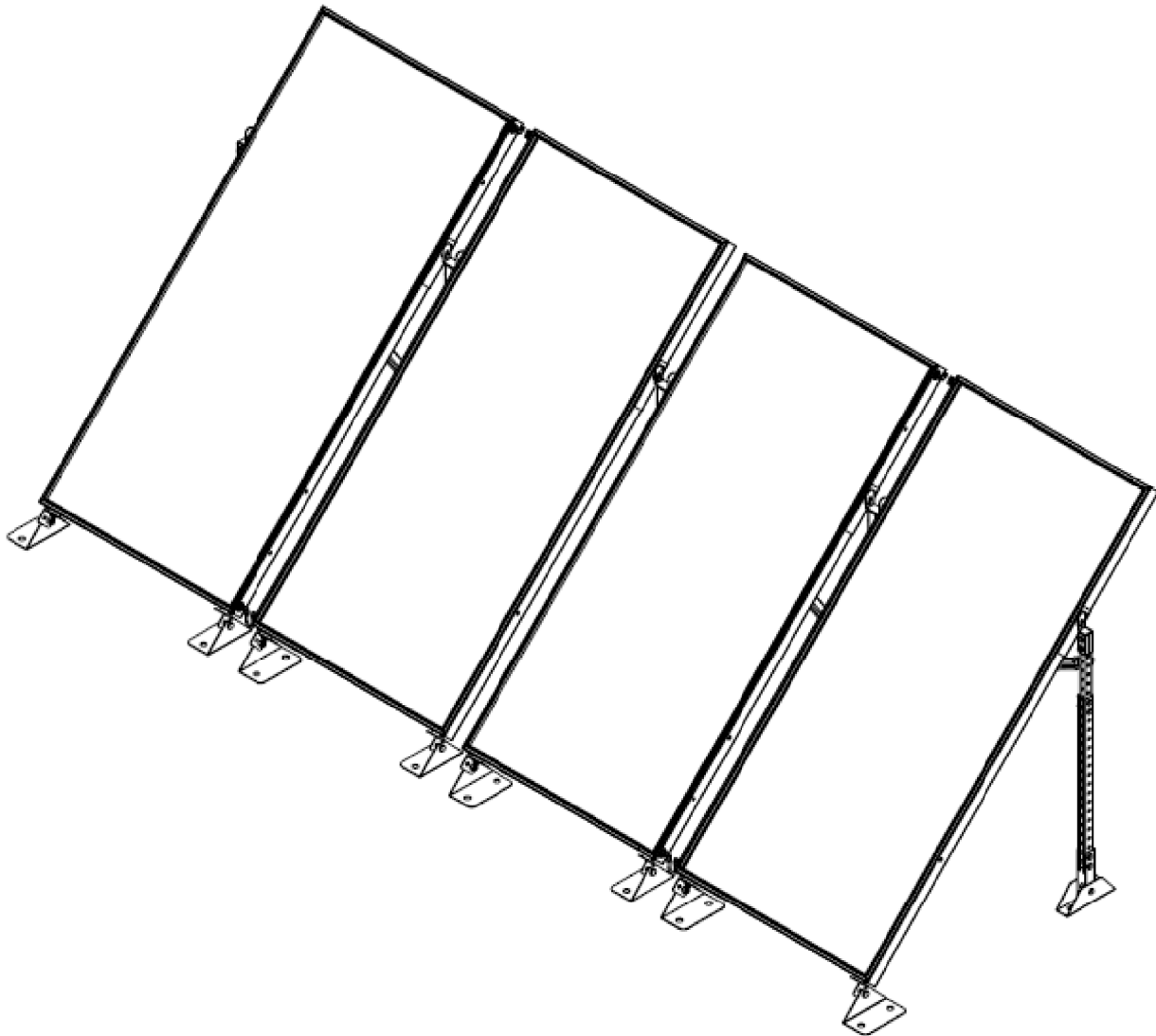


Fig. 9. Collector Bank Assembly.

Collector Connections

Line-set connections for rack-mounted collectors are similar to line-set connections of collectors mounted on sloped roofs.

Rather than a straight push-fitting union, rack-mounted collectors are connected to each other by one (1) 3/8" (15.875 mm) U-tube and two (2) 90°-elbow push-fittings.

Push 10 mm end (with black-collet) of each push-fitting elbow onto lower tube of each panel. Push firmly to ensure fitting "bottoms out". Tug back gently on fitting to ensure teeth have properly engaged.

Insert 3/8" (15.875 mm) U-tube ends into 3/8" (15.875 mm) openings (stainless collet) of push-fitting elbows. Push firmly to ensure fitting "bottoms out". Tug back gently on fitting to ensure teeth have properly engaged.

 **Do not install collector flashing on rack-mounted installations. Center-flashing, side-flashing and leaf-guard are not designed for wind loads of rack-mounted installations.**

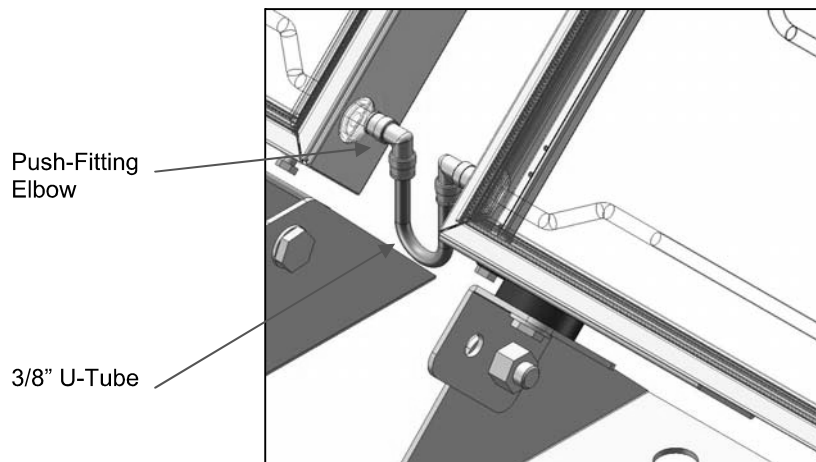
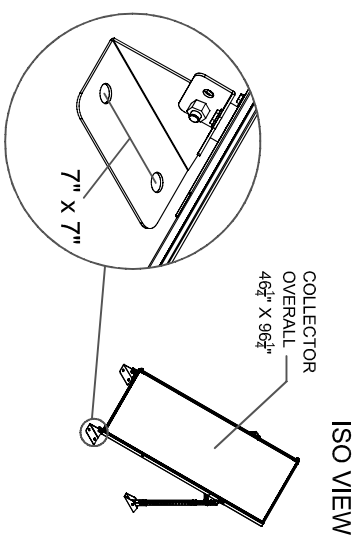
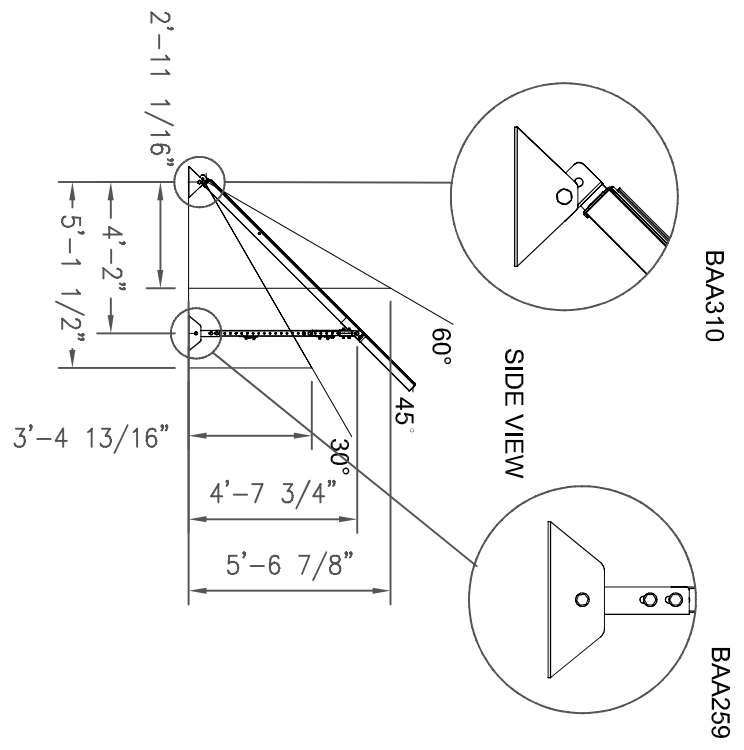
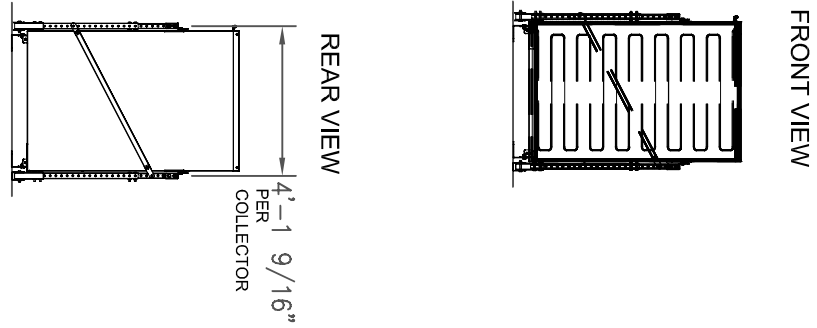


Fig. 10. Collector Connections.

Appendices

Tool and Supply Checklist

- 1 x 3/4" (25.4 mm x 19.05 mm) socket with ratchet
- 1 x 3/4" (25.4 mm x 19.05 mm) wrench
- 1 x 15/16" (25.4 mm x 23.825 mm) socket with ratchet
- 1 x 15/16" (25.4 mm x 23.825 mm) wrench
- 1 x 1-1/8" (25.4 mm x 28.575 mm) Socket with ratchet
- 1 x 1-1/8" (25.4 mm x 28.575 mm) wrench
- Tools required to secure rack to mounting surface (roof, ground etc...)
- Tools to appropriately seal roof penetrations
- Personal protective equipment



NOTE: TOTAL WEIGHT OF 1 COLLECTOR ARRAYS IS 230 LBS.

Part No.	Qty	Part No.	Qty
CHASSIS	204113	CHASSIS	204113
FLYING LEAD	204113	FLYING LEAD	204113
WINDSTOPPER	204113	WINDSTOPPER	204113
BASELINE	204113	BASELINE	204113
STRUTS	204113	STRUTS	204113
40T COLLECTORS		40T COLLECTORS	

EnerWorks

Adjustable Racking 1 Collector Layout (Residential)

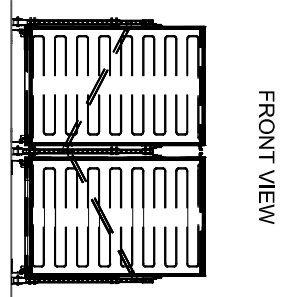
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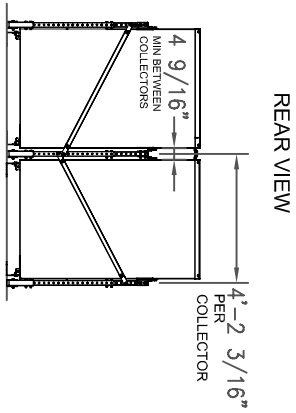
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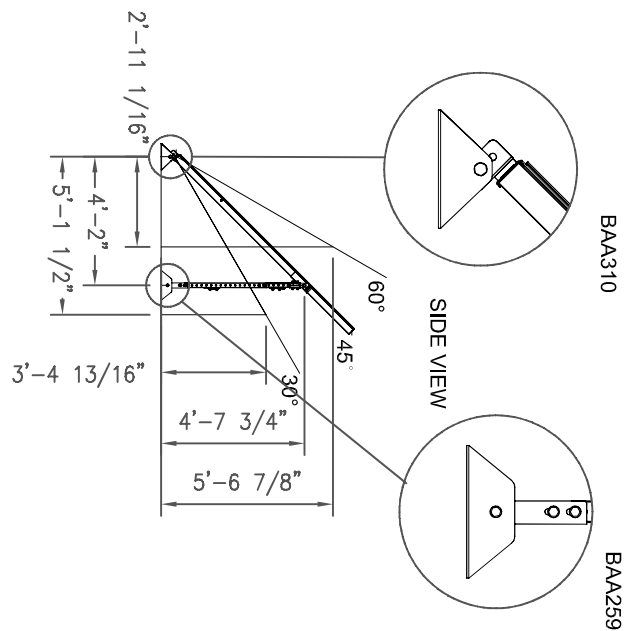
NOTE: TOTAL WEIGHT OF 2 COLLECTOR ARRAY IS 400 lbs.



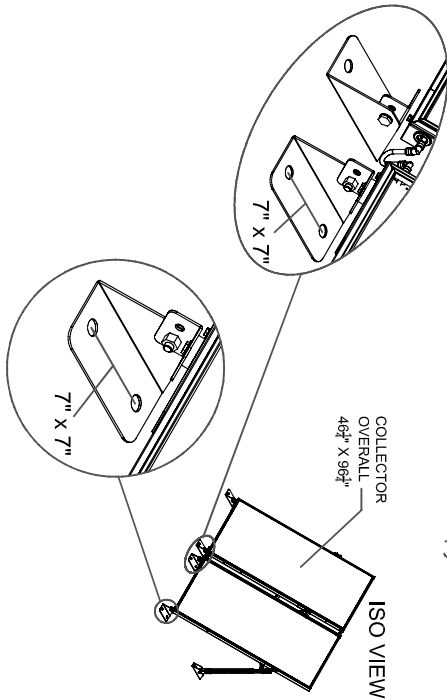
FRONT VIEW



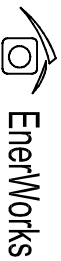
REAR VIEW



SIDE VIEW



ISO VIEW

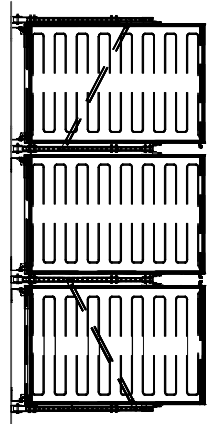


Adjustable Racking 2 Collector Layout (Residential)

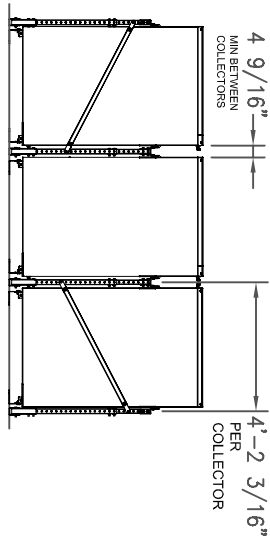
Designed By:	ADWIN ZUBAIRI	Date:	2008.03.15
Checked By:	EJUN HAJJAN	Date:	2008.03.15
Approved By:	EJUN HAJJAN	Date:	2008.03.15

Notes: THIS DESIGN IS SUBJECT TO THE PRELIMINARY STAGE

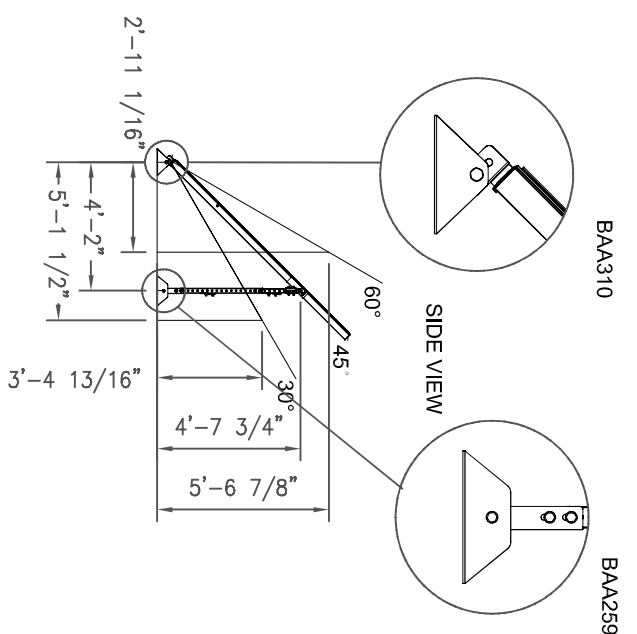
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FRONT VIEW



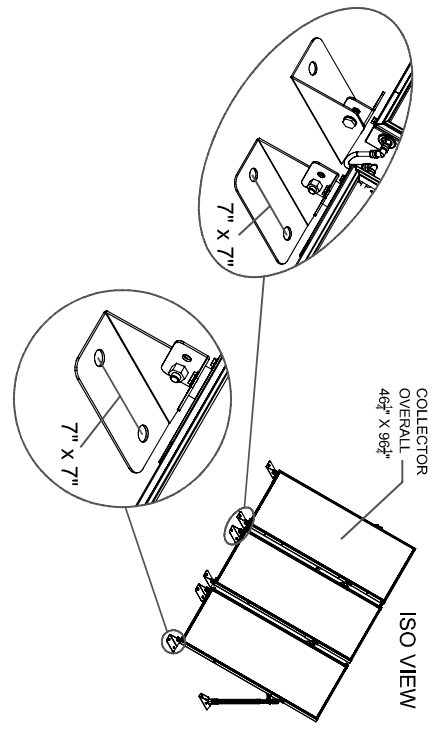
REAR VIEW



BAA310

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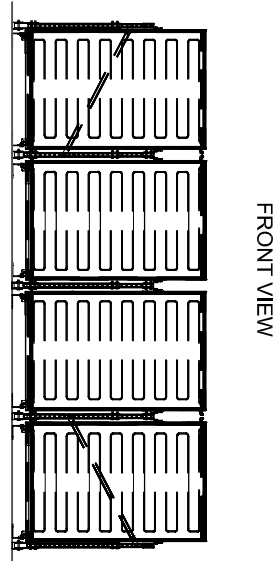
SIDE VIEW



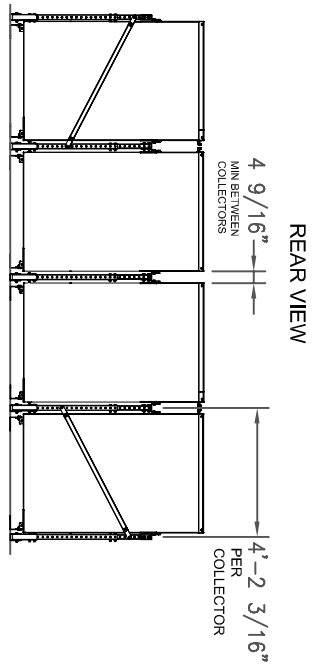
ISO VIEW

NOTE: TOTAL WEIGHT OF 3 COLLECTOR ARRAY IS 544 lbs.

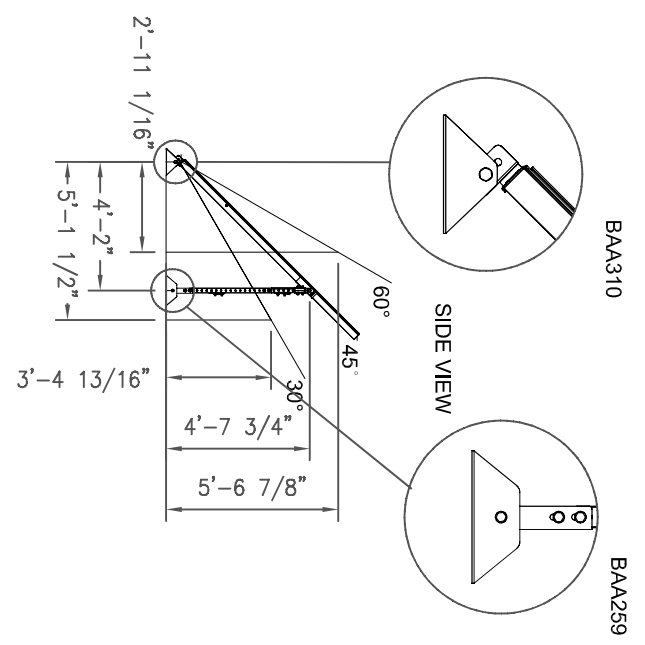
Designed By: JULIAN ZIEGLER	Date: 2008.08.15	Title: Adjustable Racking 3 Collector Layout (Residential)
Checked By: FORNIA HANSEN	Date: 2008.08.15	
Approved By: FORNIA HANSEN	Date: 2008.08.15	Notes: THIS DESIGN IS STRUCTURE IN THE PRELIMINARY STAGE
BUILDING ORIENTATION: # OF COLLECTORS:		
		Scale:
		Pages:
		Rev/#:



FRONT VIEW



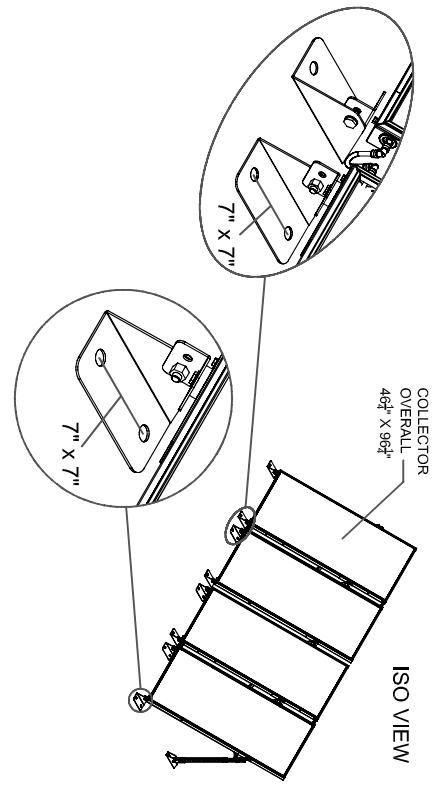
REAR VIEW



BAA310

BAA259

SIDE VIEW



ISO VIEW

NOTE: TOTAL WEIGHT OF 4 COLLECTOR ARRAY IS 700 lbs.

Designed By: JOHN VASINA	Date: 2008.06.15	Title: Adjustable Racking 4 Collector Layout (Residential)
Checked By: FORNIA AVISIN	Date: 2008.06.15	
Approved By: FORNIA AVISIN	Date: 2008.06.15	Notes: THIS DESIGN IS STRICTLY IN THE PRELIMINARY STAGE
BUILDING ORIENTATION:		
# OF COLLECTORS:		Scale:
		Pages:
		Rev #





Solar Water Heating Appliance

Installation Manual Pre-Heat Appliance

1, 2, 3 & 4-Collector Pre-heat Appliances
(EWRA1, EWRA2, EWRA3, EWRA4)



Master Contract # 232023

1, 2, 3 & 4-Collector Pre-heat Appliances
(EWRA1-DWHX, EWRA2-DWHX, EWRA3-DWHX, EWRA4-DWHX)



Master Contract # 232023



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Tel: (908) 735-2066
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Fax: (908) 735-2068
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Woodstock, ON N4V 1C1
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Fax: (519) 268-6292
info@enerworks.com
www.enerworks.com



Recognize this symbol as an indication of important safety information!



EnerWorks Residential Solar Water Heating Appliances must be installed as directed by this manual by an EnerWorks authorized dealer or warranty is void.

CALIFORNIA PROPOSITION 65 WARNING: This product contains chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

Foreword

Use this installation manual to install *EnerWorks Pre-Heat Solar Water Heating Appliances* (product codes EWRA1, EWRA2, EWRA3 and EWRA4). This manual complements installation training available through EnerWorks or approved distributors. EnerWorks training is mandatory to become an EnerWorks authorized dealer.

EnerWorks encourages installers of EnerWorks products to always keep workmanship, best practices and safety in mind. An organized installation will benefit both installer and end-user.

The *EnerWorks Solar Collector* is one of the highest rated in North America. This assessment was carried out by third-party testing under the supervision and scrutiny of the Solar Rating and Certification Corporation (SRCC). The *EnerWorks Solar Collector* has SRCC OG-100 certification and the *EnerWorks Residential Solar Water Heating Appliances* are certified to OG-300 standards. This certification does not imply endorsement or warranty of these products by SRCC.

The *EnerWorks Pre-Heat Appliance* is certified by the International Association of Plumbing and Mechanical Officials (IAPMO) as meeting the standards of the Uniform Solar Energy Code (USEC®). This certification does not imply endorsement or warranty by IAPMO.

The *Pre-Heat Appliance* described in this manual, when properly installed and maintained, meets or exceeds the standards established by the Florida Solar Energy Center (FSEC), in accordance with Section 377.705, Florida Statutes. This certification does not imply endorsement or warranty of this product by the Florida Solar Energy Center or the State of Florida.

The *EnerWorks Pre-Heat Appliance* is the first system in North America to achieve the Canadian Standards Association (CSA) certification (CSA F379.1). This certification does not imply endorsement or warranty by CSA.



Appliance must only be installed by an EnerWorks authorized installer or warranty is void.



Recognize this symbol as an indication of important safety information!



EnerWorks Residential Solar Water Heating Appliances must be installed as directed by this manual by an EnerWorks authorized dealer or warranty is void.



Before proceeding with installation of the EnerWorks Solar Water Heating Appliance, make note of Energy Station and Solar Collector serial numbers on the *Product & Installation Registration Form* included with the Owner Manual and in the Appendices.

***EnerWorks Solar Water Heating Appliance Installation Manuals:
Selection, Sizing and Site Evaluation
Collector Installation Manual
Pre-Heat Appliance Installation Manual
Single Tank Appliance Installation Manual (USA only)
Controller and Monitor Programming Guide***

CARE, HANDLING & STORAGE

EnerWorks Solar Collectors are manufactured with tempered glass. Though extremely resistant to impact, tempered glass can break if an edge is subjected to stress. During storage and installation, protect glass edges. Glass breakage is not covered by warranty.

Store collectors in a dry place, lying flat with glass up, or leaning on long edge with glass facing out and connections at top. Protect collector from scratches and damage by placing it on a soft surface such as a blanket or cardboard. When hoisting collectors to roof, be very careful not to bang glass edge. Collectors must not be levered over ladder or eave or they may be damaged. Be very careful of collector connections as they are soft copper and may be easily damaged. A leak-proof heat transfer fluid loop can only be achieved if collector connections are not damaged.

Do not store collectors outside with glass face down. Due to EnerWorks' patented stagnation-control device, back of collector is not sealed to atmosphere. Rain may enter collector if it is stored face down. Any damage due to ingress of rain is not covered by warranty.

It is best to store both the EnerWorks Solar Collectors and the EnerWorks Energy Station in a cool, dry place.

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1 – Safety



EnerWorks assumes no responsibility for damage, loss or injury related to installation of this appliance.



Observe any and all regulations relating to installation of solar appliances and to plumbing to potable water supply. Plumbing and/or building permits may be necessary. EnerWorks residential Water Heating Appliances utilize a single-wall or double wall heat exchangers. Single-wall heat exchangers may not be acceptable in all jurisdictions. Back flow prevention device or assembly may be required on water supply to home or upstream from solar water heater.



Ensure that power or gas supply and water supply to existing water heater and to EnerWorks Solar Water Heating Appliance are off during the installation.



Do not modify any electrical connections in the EnerWorks Energy Station.



Cover on Energy Station is designed to protect components from damage, and to protect users from injury. Do not operate with Energy Station cover removed.



Assemblies and materials used during installation shall meet requirements of local, regional, state, provincial, and federal regulations and fire codes. Any penetrations made in drywall or any other firewall must be fixed to maintain integrity of fire protection.



Use of heat transfer fluid other than a 50/50 mix by volume of Propylene Glycol USP and distilled or de-mineralized water is not permitted. Use of any heat transfer fluid other than that specified by appliance manufacturer will void warranty, and may result in poor performance, equipment damage, and risk to health and safety.



All persons working on roofs should have successfully completed a fall-safety course and should be properly equipped with appropriate safety equipment.

2 – EnerWorks Pre-Heat Solar Water Heating Appliance

2.1 Appliance description

The EnerWorks Solar Water Heating Appliance has four main parts (*Fig.2.2*) – the solar collectors, the line-set, the Energy Station and the solar storage tank.

The Energy Station uses a pump to circulate a heat transfer fluid through the “collector loop”. This collector loop includes the solar collectors, the fluid lines or “line-set” and a heat-exchanger. The collector loop is a “closed loop”, meaning there is no contact of the heat transfer fluid with your potable water or with the atmosphere. The collector loop contains only a small volume of heat transfer fluid which is food-grade and freeze-protected. Though freeze-protection may not be necessary in all areas, the heat transfer fluid also has an elevated boiling point and so is suitable throughout North America.

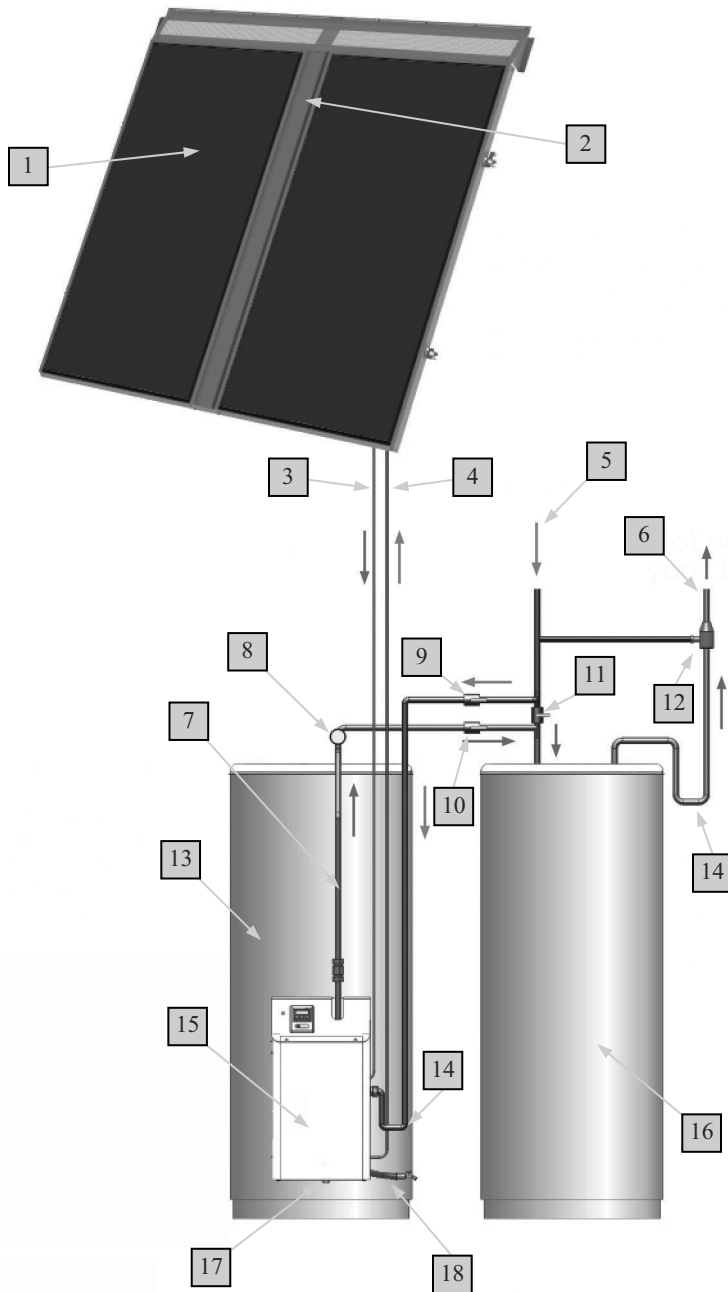
When exposed to sunlight, the solar collectors get hot. As the heat transfer fluid passes through the collectors, it absorbs heat and then travels down the line-set to the Energy Station. The hot fluid passes through the heat-exchanger and heat is transferred to the potable water. After giving up its heat to the potable water, the cool heat transfer fluid is pumped back to the solar collectors to be heated again. Hot potable water is stored in the solar storage tank.

In the *Pre-Heat Solar Water Heating Appliance (Fig.2.2)*, the solar storage tank is a standard North American electric hot-water tank. No power is connected to this tank – it only stores solar-heated water. The solar storage tank is plumbed in series with the original water heater (electric or fossil fuel). Whenever hot water is used in the home, solar-heated water leaves the solar storage tank and enters the original water heater. The original water heater now requires much less energy for water heating.

Thus, the Appliance displaces energy, but it does not replace the original water heater. The original heater guarantees hot water even under poor solar conditions (at night or when very cloudy). It also ensures that hot water is stored or supplied at an appropriate temperature to kill harmful bacteria. The acceptable temperature set point is specified in local plumbing codes. Do not turn off or bypass the back-up water heater. Even in summer months, additional heat from the back-up heater may be required.

For more information on Appliance components and function, please see the *Owner Manual*.

2.2 Appliance schematic



- 1 Solar collectors (1 to 4)
- 2 Line-set roof-penetration (behind flashing)
- 3 Heat transfer fluid line from collectors to Energy Station (red – carries hot fluid)
- 4 Heat transfer fluid line from Energy Station to collectors (blue – carries cool fluid)
- 5 Cold mains water supply (blue)
- 6 Hot water supply to home (red)
- 7 Thermosiphon loop, solar-heated water to storage tank (red)
- 8 Thermometer
- 9 Bypass valves (to isolate Appliance for service)
- 10
- 11
- 12 Anti-scald valve (not included, may be required by code)
- 13 Solar storage tank
- 14 Heat trap (U-bend limits heat loss)
- 15 Energy Station
- 16 Pre-existing or auxiliary hot water tank or on-demand heater
- 17 Pressure relief valve (inside cover)
- 18 Thermosiphon loop feed (from storage)

Fig.2.2 – EnerWorks Pre-Heat Solar Water Heating Appliance (with optional leaf-guard).

2.3 Appliance selection and sizing

To achieve good performance and a good return on investment, Appliance must be sized correctly and it must be oriented properly. Site evaluation is necessary to determine whether a site is appropriate and to evaluate complexity of installation. It is also necessary to determine hot water load, number of individuals in home, number of collectors and size of solar storage tank (see *Site Evaluation, Appliance Selection and Sizing*).

A site survey (see Appendix – *Residential Site Survey*) has been developed to assist installers in evaluating potential installation locations. This can be removed from Appendices and copied as needed. Other tools such as the EnerWorks software, SolSim™, and Solar Pathfinder are recommended in determining best location and orientation of solar collectors. SolSim™ and its user guide are available to EnerWorks authorized dealers.

The *EnerWorks Pre-Heat Solar Water Heating Appliance* is a pre-heat system (often referred to as a two-tank system). It is installed to pre-heat water that enters existing water heater (electric or fossil fuel hot-water tank, or on-demand water heater). When hot water is needed in home, solar-heated water from solar storage tank enters existing water heater. Existing water heater thus requires less energy. The pre-heat *EnerWorks Pre-Heat Solar Water Heating Appliance* provides exceptional performance due to additional hot water storage capacity.

Solar storage tank size does not depend on size of existing water heater but on number of solar collectors. Number of collectors depends on hot water use and on number of individuals in home. Solar storage tank must be certified by a nationally recognized standard (e.g. UL or CSA).

2.4 Solar storage tank considerations

2.4.1 Line-set

Line-set carries heat transfer fluid from collectors to Energy Station and back again. Line-set must be flexible, refrigeration-grade 3/8" soft-copper tube. A proper and dedicated bending tool must be used for tight bends. Line should be as smooth as possible with no unnecessary fittings or bends. Site evaluation should include examining location and difficulty of roof and wall penetrations. Appropriate techniques and materials for sealing penetrations are necessary.

New homes may choose to run line-set prior to closing in walls, or alternatively, running a 3" chase from attic to mechanical room for later use. A line-set inside building may be shorter and will lose less heat. Outside line-sets must be covered as insulation is not UV-stable. Line-set may be covered by a false downspout that matches siding or existing eavestrough, or through electrical conduit. Installer should consult homeowner regarding aesthetics and complexity of installation.

2.4.2 Heat trap nipple or gasket must be removed

Some water heater tanks have a heat trap valve, gasket or flapper in hot-outlet nipple. Hot water is less dense and more buoyant than cold and tends to migrate up and out of storage tanks. Denser cool water from household pipes tends to sink into storage tanks. Tank manufacturers install heat trap valve, gasket or flapper to limit this convective flow and associated heat losses (*Fig.2.4.2.1*).

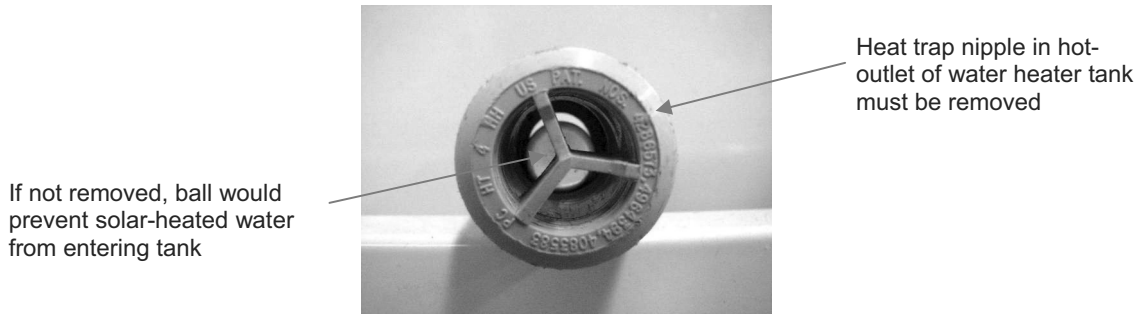


Fig.2.4.2.1 – Heat trap nipple or gasket must be removed from solar storage tank.

 **Heat trap device must be removed to allow solar-heated water to enter hot-outlet port. If heat trap device is not removed, solar energy cannot be captured and stored. Not removing heat trap device may lead to degradation of heat transfer fluid and to damage of Appliance. Damage to heat transfer fluid or to Appliance due to heat trap device not being removed is not covered by warranty.**

Once heat trap device is removed, a standard 2½” or 3” x ¾” - MNPT brass or di-electric nipple with appropriate thread sealant must be threaded into hot-outlet.

2.4.3 Tank size

If a home requires hot water regularly throughout the day, the minimum solar storage tank size (see **Selection, Sizing and Site Evaluation** guide) is a good solution, providing good value and taking up a minimum of space.

If a home’s hot water use is concentrated at the beginning and at the end of the day, a solar storage tank larger than the minimum required size will provide greater storage capacity of hot water and better performance.

A smaller family may benefit from a larger tank. With less hot-water use, more storage may limit the occurrence of stagnation and maximize daily energy gain.

2.4.4 Space requirements

Energy Station and solar storage tank will be located in mechanical or utility room. Stairway and doorway clearance must be examined. Additional floor space is required for solar storage tank and Energy Station. Consideration must be given to location and complexity of wall and ceiling penetrations, and to plumbing of Appliance to water distribution network.

Allow sufficient space around solar storage tank for installation and maintenance procedures.


Space may be required for a 2 gal US (7.8 L) expansion tank to be mounted on side of solar storage tank or on wall (**4.9.2 Supplemental expansion tank**).

 **Follow tank manufacturer's instructions and all electrical, building, fire and plumbing codes regarding placement and installation of hot-water tanks.**

2.4.5 AC power required

EnerWorks Energy Station requires 120 VAC and should be installed in proximity to a 120 VAC electrical outlet. Total draw from Energy Station is approximately 23 W.

Surge protection is recommended as any damage to Energy Station components due to power surge is not covered by warranty.

 **A licensed electrician may be required to make electrical connections. Follow all codes and regulations.**

 **Follow tank manufacturer's instructions and all electrical, building, fire and plumbing codes regarding placement and installation of hot-water tanks.**

2.4.6 Drain Pan

Tank should be placed in an area that will prevent damage to floors, ceilings, and furniture in the event of a leak. If this is not possible, a drain pan must be installed under water heater. Pan must have a pipe to a drain or other outlet for water.

 **Follow all code requirements regarding drain pans, proximity to drain and draining procedures.**

2.4.7 Minimizing heat loss, maximizing performance

Improved performance and value for homeowner can be achieved by installing a better insulated tank or a lifetime-warranty tank. A tank wrap or blanket on both solar storage and on pre-existing water heater tank will minimize heat loss and improve performance.

Rigid foam board insulation placed under water heater tanks can further reduce heat loss. About two inches of extruded polystyrene (XPS) board is recommended as it resists compression and does not absorb water.

All piping, hot and cold, should be insulated to limit heat loss and to limit condensation.

3 – Recommended Work Sequence

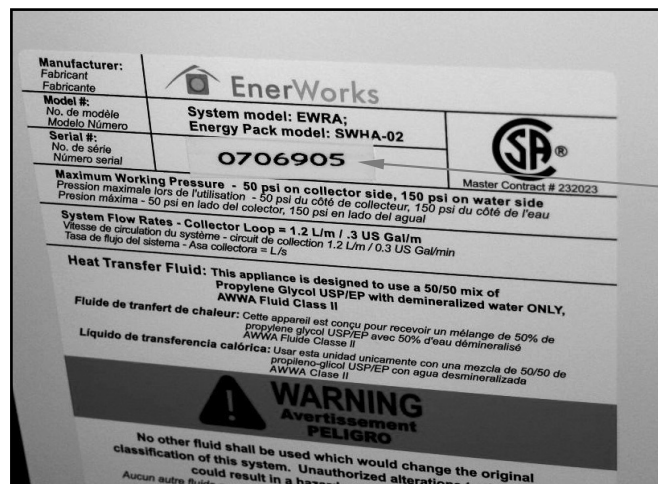
- Power or gas supply to existing water heater is turned off; tank is drained as required.
- Solar storage tank is positioned.

- Energy Station is mounted to solar storage tank and thermosiphon loop connections are completed.
- Mains water connections are completed. Hot outlet and anti-scald valve (if applicable – highly recommended) connections to home hot-water distribution network are completed.
- Source and Storage wires are connected to Controller.
- Tanks are filled with water and purged of air. Power or gas supply to pre-existing water heater may be turned back on.
- Collector(s) are installed as per *Collectors Installation Manuals*.
- Line-set is connected to Energy Station. Collector loop is leak tested, charged with heat transfer fluid and purged of air.
- Fittings are insulated and collector flashing is installed.
- Controller and Monitor are programmed and Appliance is commissioned.
- Installer discusses Appliance operation and maintenance with homeowner and completes and submits *Product & Installation Registration Form* included with *Owner Manual* and in Appendices.

It may be possible to mount Energy Station to solar storage tank and to complete thermosiphon loop connections prior to on-site installation. Energy Station may be installed to top-feed or to bottom-feed storage tank.



Before proceeding with installation of EnerWorks Energy Station, make note of serial numbers (Fig.3.1) on *Product & Installation Registration Form* included with *Owner Manual* and in Appendices. Serial numbers are required for warranty service.



Serial number

Fig.3.1 – Energy Station Label.

4 – Pre-Heat Appliance Installation

4.1 Energy Station schematic

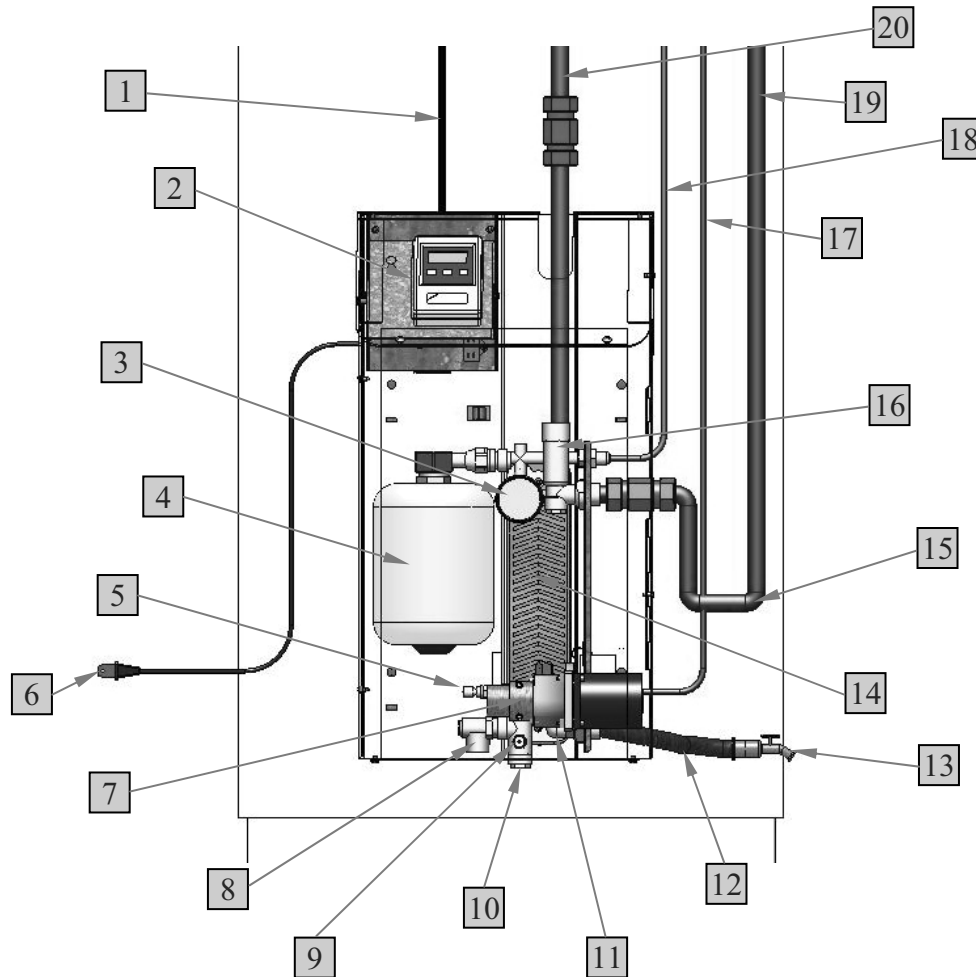


Fig.4.1.1 – Energy Station mounted to solar storage tank.

1	Over-temperature control wire	11	Lower manifold (behind pump assembly)
2	Differential Temperature Controller	12	Flexible corrugated water pipe, supply from storage to Energy Station
3	Pressure gauge (0 – 60 psi)	13	Solar storage tank drain
4	Expansion tank	14	Heat-exchanger
5	Charging port, return from system to reservoir	15	Heat trap
6	120 VAC, three-prong to grounded, surge protected outlet	16	Upper manifold with anti-fouling valve
7	Heat transfer fluid pump (positive-displacement gear pump)	17	Cold heat transfer fluid from heat-exchanger to collector(s)
8	Pressure relief valve (50psi)	18	Hot heat transfer fluid from collector(s) to heat-exchanger
9	Charging port, supply to system from charging pump and reservoir	19	Cold (mains) water inlet
10	Heat transfer fluid filter (in lower manifold)	20	Thermosiphon loop, hot water to storage from Energy Station



Noise is to be anticipated from a pump with moving parts. Pump will operate during daylight hours. Homeowner must be aware of anticipated noise and be involved in determining best location for Appliance. Noise is not a manufacturing defect and does not affect operation of Solar Water Heating Appliance.



Installation of EnerWorks Energy Station requires plumbing to domestic potable water distribution network. A plumbing permit may be necessary. An anti-scald valve may be necessary and is highly recommended. It is the responsibility of the homeowner and of the installer to obtain any necessary permits and to follow all applicable codes and regulations.



Connections to domestic potable water distribution network may have to be performed by a licensed plumber. It is the responsibility of the homeowner and of the installer to follow all applicable codes and regulations.



Electrical connections to Energy Station and to solar storage tank may have to be done by a licensed electrician. Do not attempt unless fully qualified.



This installation may have to be inspected. Follow all codes and regulations.



EnerWorks assumes no liability for any damage to property or injury or death resulting from improper installation or from modification of the EnerWorks Solar Water Heating Appliance.



EnerWorks Appliance includes supplies and fittings specific to Energy Station connections. Additional materials (copper or PEX and fittings) are required to connect water mains to appliance and to connect appliance to hot-water distribution network.



MNPT (Male National Pipe Thread), and FIP (Female Iron Pipe) connections all require thread sealant or Teflon tape. Do not apply sealant or tape to the first thread as it may contaminate water and clog taps and appliances. Do not apply thread sealant or Teflon tape to Energy Station flare connections as it may contaminate and damage the heat transfer fluid. Degradation of fluid and/or damage to appliance due to contamination of fluid is not covered by warranty.



A back flow prevention device may need to be installed on water supply to home and/or upstream of solar storage tank. Follow all codes and regulations.



Before installing the EnerWorks Energy Station, shut down power or gas to existing hot-water heater and drain tank.

4.2 Energy Station installation

1. Shut off power or fuel supply to existing water heater. Shut off water supply to existing water heater. Drain tank as needed for top-feed connections, or drain fully for bottom-feed connections.
2. Position solar storage tank. A drain pan may be desirable or required by code. Extruded polystyrene board is recommended to insulate tank from floor. Ensure enough space is left around tank for proper ventilation and access for maintenance.



If installing Energy Station on BOTTOM-FEED TANK ONLY, Energy Station will block access to lower thermostat cover – lower thermostat connections must be completed before Energy Station is mounted (see 4.10.1 Over-temperature control connection).

3. **[BOTTOM-FEED TANK ONLY]** Remove lower thermostat cover plate from side of storage tank. Remove insulation and/or plastic plate covering element/thermostat. Disconnect wires from heating element – not from thermostat. Connect black wire descending from top to vacant terminal of thermostat (*Fig. 4.10.5*). Set lower thermostat setting to 120 °F (50 °C) (*Fig.4.10.5*). Carefully stow wires. Re-install insulation and cover plate to hide connections (*see 4.10.1 Over-temperature control connection*).
4. **[TOP-FEED TANK ONLY]** Remove plastic dip tube from cold port (inlet) at top of tank (optional). If no fitting is in cold port, apply thread sealant or Teflon tape to supplied 3/4" MNPT square-head brass plug. Thread plug into cold port at top of tank and tighten (5/8" open-ended wrench, 3/4" 12-point combination wrench or socket). If a 3/4" MNPT nipple is already installed in cold port, it may be removed or simply capped with supplied 3/4" FIP cap. (This may be used as an air-bleed when tank is filled.)
5. **[ALL TANKS]** Check hot water port (outlet) at top of storage tank for anti-siphon or heat trap valve, gasket or flapper. If present – remove it. If anti-siphon or heat trap valve, gasket or flapper is not removed, solar-heated water will not enter storage and Appliance will not function as designed. If 3/4" MNPT nipple is damaged during removal, replace with new 2 1/2" x 3/4" MNPT nipple.
6. Remove Energy Station from box. Unscrew Phillips screws that hold outer case to Energy Station. Remove cover and set aside where it will not get damaged. Remove protective cap from water port at right of lower manifold.
7. With Energy Station lying flat on floor or on work bench, connect and tighten flexible corrugated copper pipe to water port at right of lower manifold (*Fig.4.2.1*). Thread sealant or Teflon tape is not required as gasket ensures water-tight seal. Do not over-tighten or gasket may be damaged.

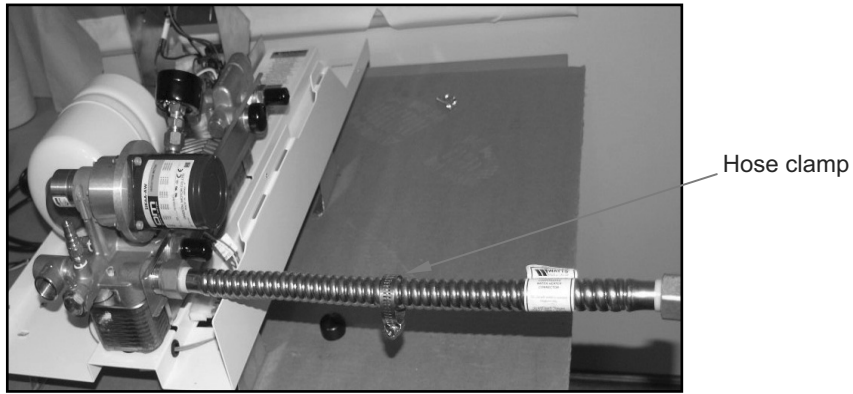


Fig.4.2.1 – Flexible pipe connected to Energy Station. Hose clamp ready to attach thermistor.

8. Storage tank temperature sensor, or thermistor, is taped to inside of Energy Station housing at lower right and connected to Controller by two blue wires. Slide hose-clamp over corrugated copper pipe and fasten thermistor to smooth surface of corrugated pipe, close to manifold (Figs.4.2.2). Do not over-tighten as thermistor may dent and damage corrugated pipe.

9. Using an accurate pressure gauge, check expansion tank air pressure. Blue cap must be unscrewed from Schrader valve before checking pressure (Fig.4.2.3). Pressure should be **25 psi**. Adjust as necessary (with a bicycle pump or compressor, or by releasing air from expansion tank).

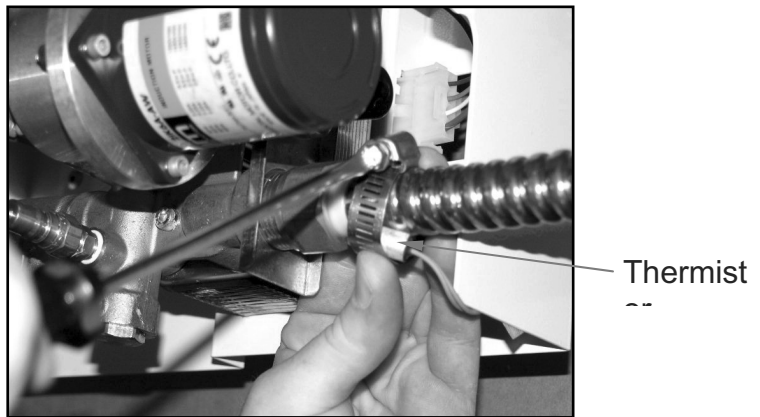


Fig.4.2.2 – Thermistor clamped to corrugated copper pipe close to lower manifold.



Pressure gauge

Expansion tank Schrader valve



Fig.4.2.3 – Expansion tank Schrader valve and pressure measurement

- [TOP-FEED TANK ONLY]** Remove drain valve from bottom port of tank. Apply thread sealant or Teflon tape to both ends of supplied 2½” x ¾” MNPT nipple. Thread into bottom port. Thread middle port of supplied ¾” FIP-FIP-MNPT street-tee onto nipple and tighten such that MNPT points to front of tank where Energy Station will be mounted (*Fig.4.2.4*).

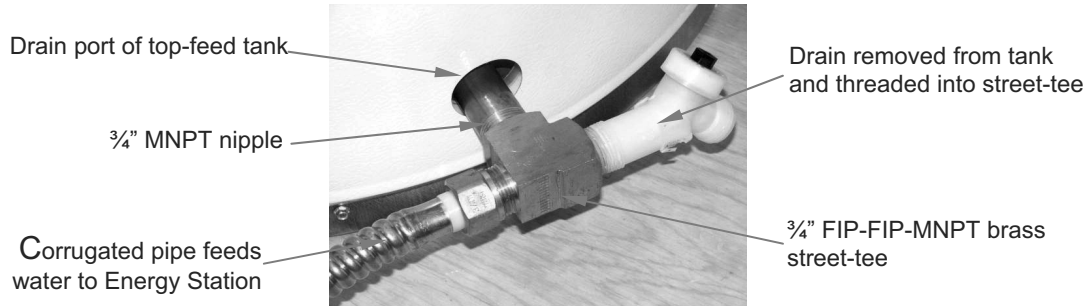


Fig.4.2.4 – Top-feed tank connection includes ¾” MNPT nipple and street-tee.

- [TOP-FEED TANK ONLY]** Apply thread sealant or Teflon tape to removed drain valve. If plastic is damaged, a metal replacement is recommended. Thread into remaining FIP port of street-tee and tighten (*Fig.4.2.4*).
- With Energy Station upright (vertical) and corrugated copper pipe straight, thread un-connected end of corrugated pipe onto MNPT port of street-tee on top-feed tank (*Fig.4.2.4*), or directly to cold inlet port of bottom-feed tank (*Fig.4.2.5*). Tighten, but do not over-tighten as gasket may be damaged.

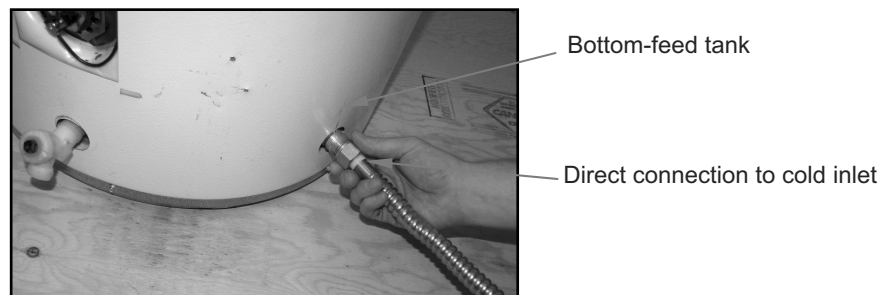


Fig.4.2.5 – Direct connection for bottom-feed tank.

- Lift Energy Station and “walk” it in to tank, such that Energy Station mounting brackets are in contact with storage tank wall and corrugated copper pipe has smooth bend (*Figs.4.2.6 & 4.2.7*). Place Energy Station as lower as possible, keeping at least (1¾”) (50mm) off floor). Place it on block or on boot such that bottom of heat exchanger is higher than drain. This will allow water to drain from Energy Station if storage tank is drained. It also ensures access for charging and maintenance (e.g., cleaning of heat transfer fluid filter.)



Access to hex-cap on underside of lower manifold must be maintained for removal, cleaning and re-insertion of heat transfer fluid filter. Energy Station must be at least 1¾” (50mm) off floor to allow for service. See, 9 – Scheduled Maintenance.



Fig.4.2.6– Positioning Energy Station.

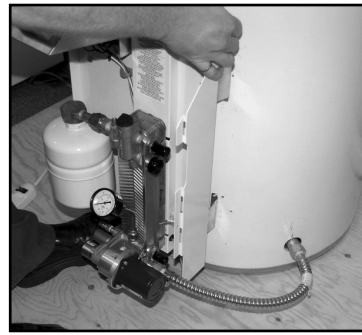


Fig.4.2.7 – Securing Energy Station.

- Using one included ¼” hex-head self-drilling screw, secure one upper Energy Station bracket to storage tank (¼” nut-driver, 6” magnetic extension recommended for electric drill). Ensure Energy Station is level and secure opposite bracket to tank with another self-drilling screw. Insert remaining self-drilling screws into brackets to secure Energy Station to solar storage tank.



Regular maintenance of solar storage tank will include draining to remove sediment (see tank manufacturer’s instructions). Ensure proper access to drain. Modify street-tee orientation or replace with ¾” FIP tee and ¾” MNPT nipples if necessary.

4.3 Thermosiphon loop installation



Thermosiphon loop must be copper pipe. Temperature rating of PEX tubing may be exceeded and must not be used.

- Visually inspect hot-outlet nipple for heat trap valve or gasket. **Insert a screw driver into hot-outlet to determine presence of heat trap valve or gasket. If a heat trap device is present, remove it (see 2.4.1 Heat trap valve or gasket must be removed).**
- Apply thread sealant or Teflon tape to both ends of ¾” MNPT nipple x 2½” and thread into hot-outlet port of solar storage tank. If ¾” MNPT nipple without heat trap device is already installed in hot-outlet port, apply thread sealant or Teflon tape.
- Thread side port of supplied ¾” FIP brass tee to hot-outlet nipple (Fig.4.3.1). Tighten such that middle port of brass tee points in direction of soon-to-be installed thermosiphon loop (in direction of water port at top of upper manifold of Energy Station).
- Remove protective plug from top port of upper manifold. Loosely thread ¾” MNPT x ½” sweat fittings into ¾” FIP port at



Fig.4.3.1 – Brass tee connected to top of solar storage tank

top of upper manifold and into middle port (horizontal) of hot port $\frac{3}{4}$ " FIP brass tee (Fig.4.3.2).

5. Insert lengths of $\frac{1}{2}$ " rigid copper pipe into $\frac{1}{2}$ " sweat fittings in upper manifold and in brass tee such that they meet at top edge of tank

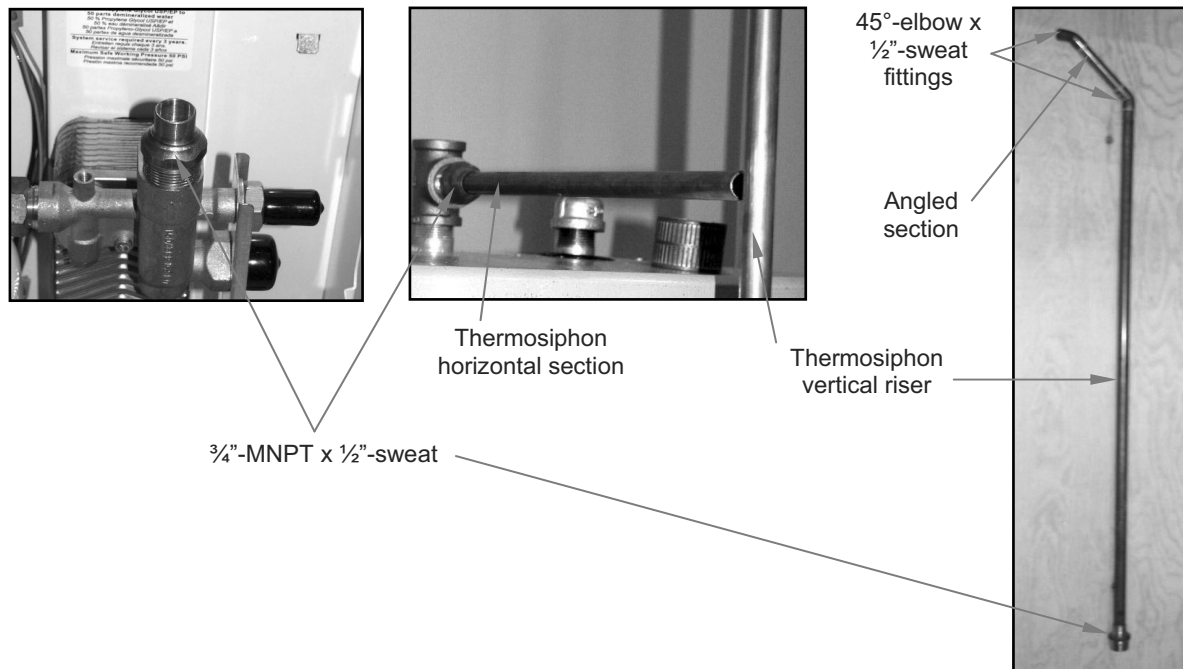


Fig.4.3.2 – Thermosiphon loop – horizontal and angled sections and vertical riser.



TIP: Using flexible copper water tube (certified for domestic water use) may facilitate installation. Do not solder tube into upper manifold fitting in place as hot solder and flux may damage anti-fouling (back flush) valve. Solder unbent tube and fitting first, and then install in upper manifold. Bend tube and solder into hot-outlet fitting.

6. Thermosiphon loop requires two 45°elbow bends to facilitate natural convection. One 90° elbow is not acceptable. Cut pipe lengths to accommodate two 45°elbow x $\frac{1}{2}$ " sweat fittings with an angled pipe length between them. Thermosiphon loop will consist of vertical riser and horizontal section with angled (45°) section in between (Fig. 4.3.2). Adjust orientation of hot port $\frac{3}{4}$ " FIP brass tee to ensure a thermosiphon riser is vertical.
7. Cut vertical thermosiphon riser and insert $\frac{1}{2}$ " sweat x $\frac{1}{2}$ " sweat union coupling (not included) (remove small section of pipe if necessary). Union coupling will facilitate maintenance and/or removal of Energy Station if necessary. Union coupling will facilitate dry fitting and should be close to top of thermosiphon riser splitting it into an upper and a lower section.
8. With thermosiphon loop fitted, remove pipe, union coupling, 45°-elbow fittings and unthread, $\frac{3}{4}$ " MNPT x $\frac{1}{2}$ " sweat fittings.



Anti-fouling back flush valve should be visible in top port of upper manifold. Back flush valve is made of plastic. Damage to back flush valve may occur if hot solder or flux drips down into valve – do not perform any soldering of copper in place

above back flush valve. Damage to back flush valve during installation may prevent proper operation of system and is not covered by warranty.

9. On floor or on workbench, fit lower section of vertical thermosiphon riser together with union coupling half and lower $\frac{3}{4}$ " MNPT x $\frac{1}{2}$ " sweat fitting. Solder thermosiphon assembly with lead-free solder using appropriate plumbing techniques and standards. Potable water connections may have to be completed by a licensed plumber – check local codes.
10. Fit upper section of thermosiphon riser with angled and horizontal sections of thermosiphon loop using union coupling half, both 45°-elbow x $\frac{1}{2}$ " sweat fittings and $\frac{3}{4}$ " MNPT x $\frac{1}{2}$ " sweat fitting. Solder with lead-free solder and using appropriate plumbing techniques and standards.
11. Install $\frac{1}{2}$ "ID x $\frac{3}{8}$ " wall refrigeration insulation to length and slide it onto upper and lower sections of thermosiphon loop. This can be purchased with the Energy Station Thermosiphon installation Kit (EPTK).



Thermosiphon loop must be insulated. If thermosiphon loop is not insulated, exposed pipes will lose heat to surroundings. Water in thermosiphon will cool and sink, drawing more hot water out of insulated storage tank. A “reverse” thermosiphon effect will occur during times of low solar radiation, transferring heat from hot water tank to surrounding room. Benefit of solar will be lost and air-conditioning may have to compensate for added heat.

12. Apply thread sealant or Teflon tape to threads of thermosiphon $\frac{3}{4}$ " MNPT fittings. Thread thermosiphon riser into top port of upper manifold and tighten. Thread horizontal section of thermosiphon loop into $\frac{3}{4}$ " FIP brass tee and tighten so union coupling can be joined.
13. Using two wrenches join union coupling to complete thermosiphon loop.
14. Remove thermometer from $\frac{3}{4}$ " sweat thermometer well (Fig.4.3.3). Fit well to middle port of $\frac{3}{4}$ " sweat tee. Fit $\frac{3}{4}$ " MNPT x $\frac{3}{4}$ " sweat fitting to $\frac{3}{4}$ " sweat tee with a short section (about 1") of $\frac{3}{4}$ " rigid copper pipe. Solder with lead-free solder and using appropriate plumbing techniques and standards.
15. Apply thread sealant or Teflon tape to $\frac{3}{4}$ " MNPT threads of thermometer well assembly. Thread assembly into remaining port of $\frac{3}{4}$ " FIP tee at top of tank such that thermometer will be visible when installed in well. Do not install thermometer until all soldered fittings are complete and thermometer well is cool.
16. Hot outlet of solar storage tank (remaining port of $\frac{3}{4}$ " sweat tee) is to be fitted to cold inlet of existing water heater. $\frac{3}{4}$ " copper pipe may be used or install supplied $\frac{3}{4}$ " x $\frac{1}{2}$ " sweat reducer to use $\frac{1}{2}$ " copper pipe (Fig.4.4.3).



Fig.4.3.3 – Remove thermometer from well



Remove thermometer from well before soldering. Do not install thermometer until soldering is complete and well is cool.

4.4 Water connections – bypass valves

1. Cut cold mains supply to existing water heater. Insert ball valve into cold supply line with tee fittings upstream and downstream (either $\frac{3}{4}$ " or $\frac{1}{2}$ " depending on existing pipe sizes) (Fig.4.4.1). Tee fitting and line upstream from ball valve may be PEX or copper pipe. Tee fitting and line downstream of ball valve must be rigid copper as temperature of solar-heated water may exceed PEX ratings.
2. Tee fitting above ball valve will direct mains water supply to cold mains inlet of Energy Station ($\frac{3}{4}$ " MNPT at right of upper manifold). A second ball valve should be connected downstream from this tee (Fig.4.4.1).
3. Tee fitting below initial ball valve will direct solar-heated water into existing water heater (Fig.4.4.1). A third ball valve should be connected upstream from this tee.
4. Solder lines and fittings with lead-free solder if applicable and using accepted plumbing techniques and standards.
5. Tie *Valve Positioning Label* to pipe in proximity to ball valves to indicate *Running* and *Maintenance* valve positions (Fig.4.4.1).

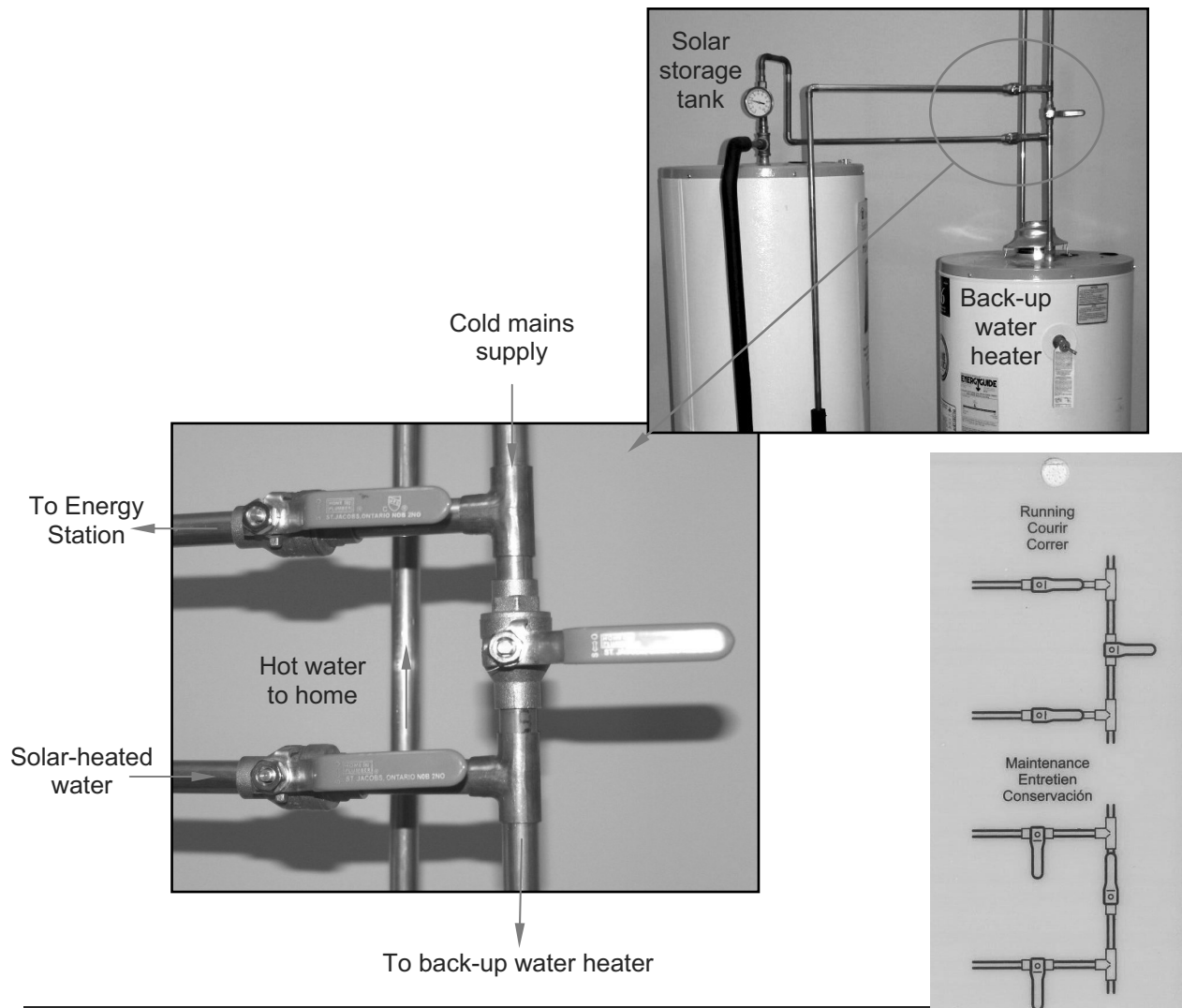


Fig.4.4.1 – Bypass valve configuration.

4.5 Water connections – cold mains supply

1. Cold mains supply line must contain heat trap (made from corrugated copper pipe or rigid copper pipe – not included).

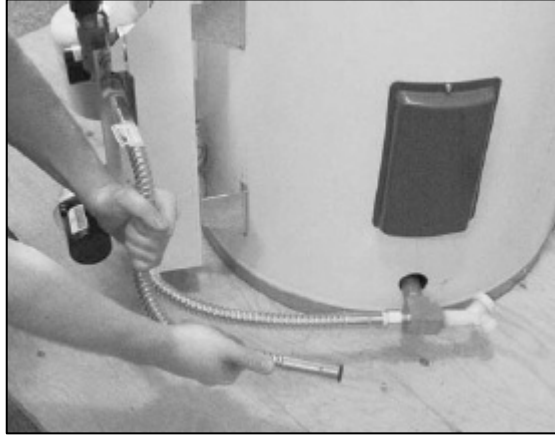


Fig. 4.5.1 – Fabrication of heat trap using a flexible corrugated pipe to cold mains inlet. Using two hands bend pipe down and back (not included).

2. Connect to cold mains water supply from bypass valve assembly to heat trap. Sweat connections using lead-free solder and appropriate plumbing techniques. If supply is PEX, use installer-supplied fittings for connection.
3. To maintain system certification, SRCC requires 5' of insulation on cold mains water inlet. This practice limits heat loss and prevents condensation. 6' x 7/8" ID x 3/8" wall insulation is included to be installed on Energy Station cold mains inlet. Install insulation before final connections are completed or split insulation, install on pipe and tape. Insulation should also be added to corrugated copper pipe at lower manifold.



EnerWorks recommends that all water lines, hot and cold be insulated to minimize heat loss and condensation.

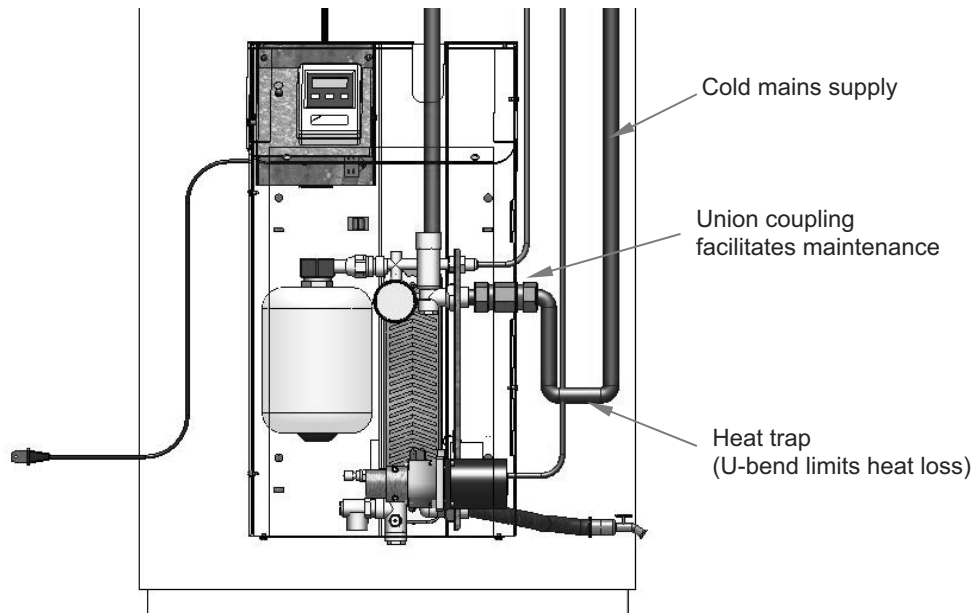


Fig.4.5.2 – Energy Station connections.

4.6 Water connections – solar storage hot outlet

Hot water outlet of solar storage tank is to be connected to existing water heater cold inlet (through third ball valve and into tee below initial ball valve). Using dealer-supplied materials (copper pipe and sweat fittings), fit hot water outlet of solar storage tank (open port of thermometer assembly tee at top of tank) to “cold” inlet of existing water heater (*Fig.4.4.1*). **Do not use PEX as solar water heating appliance can produce very hot water that exceeds PEX temperature ratings.**

4.7 Water connection to hot water distribution network

1. Ensure hot water outlet of pre-existing (now back-up) water heater is connected to home hot water distribution network.
2. Hot water outlet to home may require anti-scald valve. EnerWorks highly recommends anti-scald valve (such as *Honeywell AMX Series Thermostatic Mixing Valve AMX101-US-1*) to be installed on all new and retro fit installations. Check local codes and regulations regarding installation of anti-scald valves and set point requirements.



This installation may have to undergo inspection – check local codes and regulations.

4.8 Filling tanks with water

1. Fill and pressurize tanks with water. Ensure ball valves are in “running” position such that water is directed to solar storage tank Energy Station and from solar storage tank hot outlet into cold inlet of pre-existing water heater. Open hot water taps throughout home to purge system of air. If no leaks are present, insulate pipes and fittings, especially *FROM COLLECTOR* tee. Otherwise, drain tank and fix leaky connections. Insulate hot and cold water pipes to limit heat loss and prevent condensation (*Fig.4.6.1*).
2. If anti-scald valve is installed (highly recommended or required – check local code), adjust set point if required by code or to homeowner’s specifications.
3. Do not turn on power or gas to pre-existing water heater until tanks are filled with water.



Fig.4.6.1 – All pipes and fittings insulated to limit heat loss and prevent condensation.

4.9 Appliance heat transfer fluid line-set connections

4.9.1 Energy Station connections

1. Carefully and neatly bring line-set tube ends (and control wire) to Energy Station flare connections. A proper tube bending tool must be used for tight bends. Ensure straps are not in contact with copper lines due to risk of galvanic corrosion (copper or plastic straps are recommended). Do not compress insulation when bundling or securing lines.

2. Cut off excess line-set and insulation. Use a proper tube cutting tool and use a light feed to minimize burr, work-hardening and tube compression. To obtain maximum sealing surface, remove burr with de-burring or reaming tool. Remove only burr, do not remove material from original wall thickness.
3. Place flare nuts over line-set tube ends. Flare ends of line-set with compression or generating type flaring tool. Follow tool manufacturer's instructions regarding positioning and correct number of turns on feed handle.
4. Inspect flare. Flare-cone should be checked for smooth surface on ID. Measure with calipers or micrometer over largest OD for proper size (0.471-0.487" for 3/8" OD tube).
5. Seat flare-cone onto Energy Station manifold connection. Thread flare-nut onto manifold and tighten (*Fig.4.9.1.1*). Do not over-tighten as soft copper flare may be ripped or damaged.



Fig.4.9.1.1 – Line-set connections to Energy Station. Note: For clarity, line-set is not insulated. Proper installation must have insulated line-set to prevent heat loss and to limit burn risk.

4.9.2 Supplemental expansion tank

A supplemental expansion tank may be required due to additional fluid volume in long line-sets or in Appliances with large vertical elevation between collectors and Energy Station. Two, three and four-collector systems require supplemental expansion tanks. Kit KAA098 includes 2 gal US (7.6L) expansion tank, connection assembly and mounting hardware.



Supplemental expansion tank should be in heat transfer fluid line supply hot fluid from collectors (from upper manifold). To prevent air from getting trapped in expansion tank, it must hang below line with Schrader air valve at bottom, pointing down. Do not remove smaller expansion tank from EnerWorks Energy Station.



With supplied self-drilling screws, expansion tank can be mounted to solar-storage tank or to hot-water tank. Expansion tank may also be attached to wall with appropriate screws (not included). Ensure access to expansion tank and to Schrader valve is maintained for charging and maintenance procedures.



Every attempt should be made to maintain a smooth and continuous fluid line without unnecessary bends or disruptions. Ensure that supplemental expansion tank is not at a local high point in fluid line.

1. Find a suitable location to mount supplemental expansion tank to solar storage tank, to hot-water tank (Fig.4.9.2.1) or to wall. Level expansion tank, and secure with included screws (for storage tank mount) or with appropriate wood or masonry screws (not included). Ensure that access to expansion tank and to its Schrader air valve is maintained for charging and maintenance procedures.



Fig. 4.9.2.1 – Supplemental expansion tank mounted to tank with self-drilling screws.



Fig. 4.9.2.2 – Supplemental expansion tank in line from top of heat exchanger to collector.

2. Cut a 3/8" flexible, refrigeration-grade copper line to an appropriate length such that it will connect supplemental expansion tank tee flare to flared port on upper manifold of Energy Station. Install a smooth and continuous line without unnecessary bends. Slide on line insulation and cut insulation to appropriate length. Slide flare-nuts onto each end of copper line. De-burr cut ends and then flare tube ends (see **4.9.1 Energy Station connections** for flare guidelines). Connect line with flare nuts to supplemental expansion tank flare and to upper manifold flare (Fig.4.9.2.2). Tighten flare nuts with wrench while counter-torquing manifold or expansion tank tee.
3. Follow a similar procedure to join supplemental expansion tank's other flared port to collector outlet with a smooth, continuous and insulated 3/8" flexible, refrigeration-grade copper line. Insulate line and de-burr ends. Slide flare nuts over ends before flaring. Connect line and tighten flare nuts while counter-torquing expansion tank tee or collector fitting (Fig.4.9.2.2).
4. Unscrew plastic caps at bottom of supplemental expansion tank and at bottom of smaller Energy Station expansion tank. Using a pressure gauge, ensure that air pressure in expansion tanks is 25 psi. Adjust, if necessary, with a bicycle pump or air compressor.

4.10 Controller connections

4.10.1 Over-temperature control connection

Over-temperature control is a safety feature that prevents water in solar storage tank from boiling and limits risk of scalding to the homeowner (this does not discount use of an approved temperature and pressure [T&P] relief valve required by code).

Solar storage tank is typically a standard North American electric hot-water tank as Pre-Heat Appliance makes use of tank's factory installed thermostat. No power is hooked up to electric heating elements of solar storage, but Energy Station Controller must be connected to lower tank thermostat.

1. Uncoil cords at upper left of Energy Station. Black cable with two black and one yellow and green wire is over-temperature cable.
2. Unscrew and remove connection cover plate on top of solar storage tank (*Fig.4.10.1.1*).
3. Punch out one round insert (if necessary) and install $\frac{3}{4}$ " cable clamp (*Fig. 4.10.1.2*).
4. Insert over-temperature wire through connector nut. Feed enough wire through to make wire connections. Cut off excess and strip wire ends.
5. With Energy Station unplugged, insert over-temperature wire through cable clamp. Feed enough wire through to make wire connections. Cut off excess and strip wire ends.
6. Connect ground (yellow and green wire) to green ground screw inside connection cavity or to ground screw of cover plate.
7. Using wire nuts (Marrettes, Marr connectors), connect black over-temperature wires to red and black tank wires (*Fig.4.10.1.3*).
8. Carefully stow wires and connections into cavity. Reinstall cover plate to hide connections. Tighten screws of cable clamp to firmly hold over-temperature wire.
9. Remove upper cover plate from side of storage tank. Remove insulation and/or plastic plate covering element/thermostat. Disconnect all wires from thermostat and heating element.
10. Use a wire-nut (Marrette, Marr connector) to connect black wire descending from top of tank to black wire descending to lower element/thermostat. Similarly, connect red wire descending from top of tank to red wire



Fig.4.10.1.1 – Remove connection cover plate

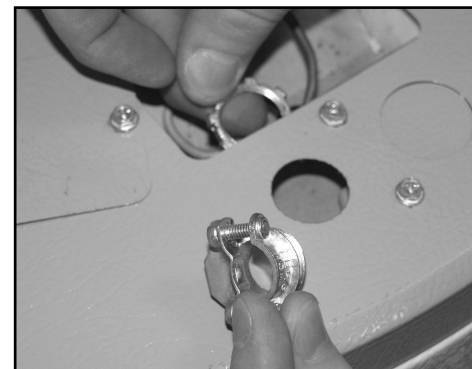


Fig.4.10.1.2 – Punch out insert and install connector nut



Fig.4.10.1.3 – Connect over-temperature wire to tank wires.

descending to lower element/thermostat (Fig. 4.10.4). If necessary, use short wires that connect thermostat to element (blue/yellow) as jumpers to complete connections.

- Carefully stow wires and connections into upper element/thermostat compartment. Replace insulation and cover plate.



Fig. 4.10.1.4 – Connect wires to bypass upper thermostat.



Fig. 4.10.1.5 – Connect red and black wires to Lower thermostat terminals. Set thermostat to 120 °F (50 °C).

- Remove lower cover plate from side of storage tank. Remove insulation and/or plastic plate covering element/thermostat. Disconnect wires from heating element – not from thermostat. Connect black wire descending from top to vacant terminal of thermostat (Fig. 4.10.1.5).
- Set lower thermostat setting to 120 °F (50 °C) (Fig. 4.10.1.5). Carefully stow wires. Reinstall insulation and cover plate to hide connections.



TIP: If over-temperature control shuts down pump, it may have to be manually reset. Show homeowner how to unplug Energy Station, remove tank cover plate and push red button to reset thermostat. After cover is replaced, Energy Station can be plugged in.

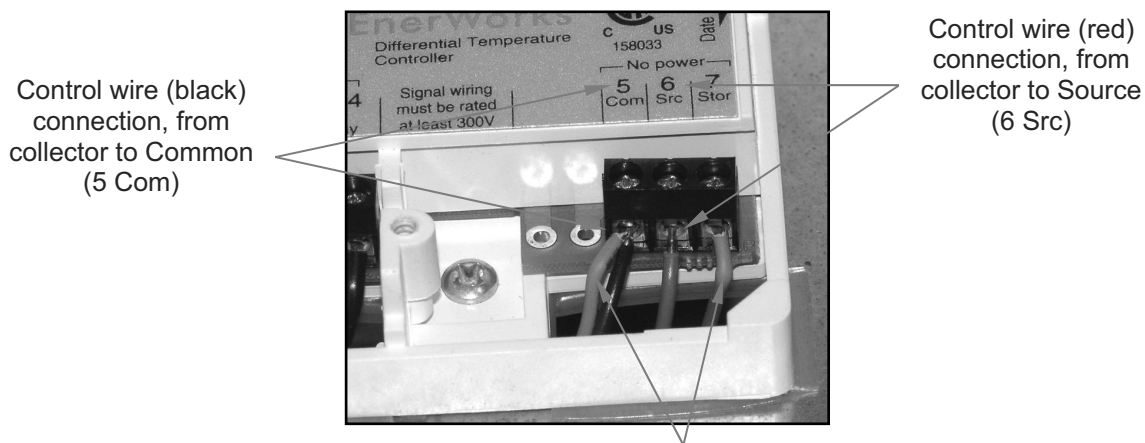
4.11 Appliance control wire connections

- Double check control wire connections and collector thermistor resistance with an ohmmeter/multimeter and alligator clips. If resistance and associated temperature is expected and reasonable (even though collectors are covered, they will be hot), proceed with Energy Station Controller connections (Fig. 4.11.1). If a short or open connection is perceived, check for and correct faulty connections.

2. Carefully and neatly bring control wire into Energy Station. It is possible for control wire to enter Energy Station from back and to follow other wires up to Controller.
3. Remove Controller “snap-on” cover. Remove Controller connection cover by unscrewing small Phillips screw.
4. Lift Controller assembly plate up such that Controller is horizontal.
5. Feed control wire up into lower right opening of Controller.
6. Cut off excess and strip control wire conductor ends.
7. Using small flat-head or Phillips screwdriver, connect control wire conductors to terminals 5 and 6, to Common (Com) and to Source (Src) (Fig. 4.11.2).
8. Replace connection cover. Replace “snap-on cover and push Controller assembly down.
9. Temporarily plug in Energy Station. LCD screen default display is temperature difference (ΔT) between Source (collector) and Storage (bottom of solar storage tank). If ΔT is displayed, thermistor and control wires are connected correctly. If an error signal flashes (Err), check display for whether it is a Source or Storage error. Double check Source and/or Storage connections.
10. If thermistors are connected correctly, unplug Energy Station.



Fig. 4.11.1 – Controller with cover removed



Factory-installed storage tank thermistor wire connections (blue) to Common (5 Com) and to Storage (7 Stor)

Fig.4.11.2 – Controller thermistor connections

5 – Charging Appliance

5.1 Leak testing with air



Expansion tank air pressure must be 25 psi before leak testing and Appliance charging. (Section 4.2, Step 9) If expansion tank air pressure is too low, pressurizing heat transfer fluid loop could damage or rip expansion tank diaphragm. Damage to diaphragm due to low expansion tank air pressure is not covered by warranty.

1. Connect fluid line out from charge pump to forward-facing male quick connect, located below Energy Station pump on lower manifold (Fig.5.1.1). Supply connection assembly includes female hydraulic quick connect coupling, ball valve and Schrader air valve.

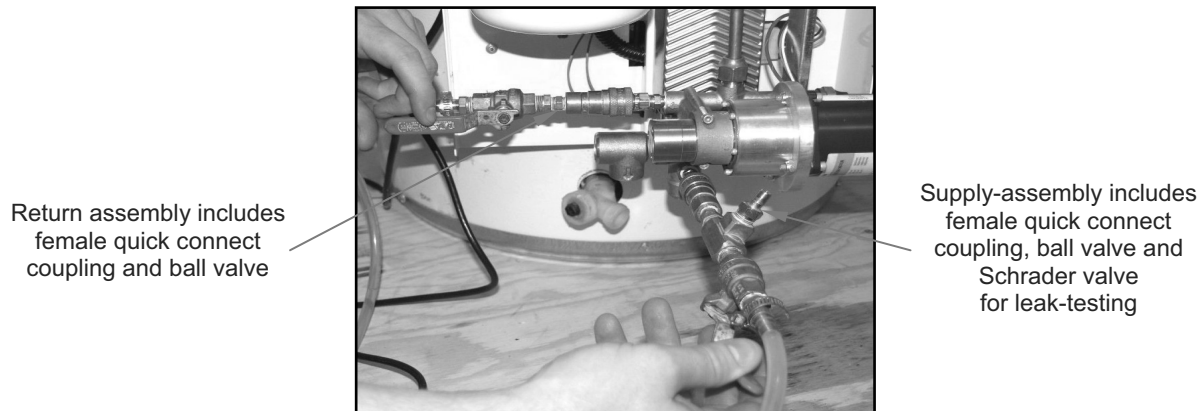


Fig.5.1.1 – Charge Kit supply and return assemblies.

2. Connect return line (that will return fluid from appliance to reservoir) to left pointing male quick connect (when facing Energy Station) on lower manifold (Fig.5.1.1). Return connection assembly includes female hydraulic quick connect coupling and ball valve.
3. Close ball valves. Connect a compressor or bicycle pump to the supply connection assembly Schrader valve and pressurize heat transfer fluid loop with air to 40 psi (pressure gauge installed on upper manifold) (Fig.5.1.2).
4. Let stand for 30 minutes.



Fig.5.1.2 – Leak-test: pressurize appliance to 40 psi and wait 30 minutes.



Leak test must not be rushed. Take this time to prepare the heat transfer fluid, to educate homeowner on Appliance operation, to complete *Product & Installation Registration Form*, and/or to begin clean up.

5. If the pressure has dropped after 30 minutes, there may be a leak. Spray dish soap solution on connections (flares at Energy Station, fittings at collectors) and look for bubbling to identify leak(s). Tighten flares or re-flare if necessary. Remove and re-seat push fittings if necessary. Ensure that tube “bottoms out” in push fitting. Gently pull back on push fittings to ensure they have properly engaged. Repeat leak test.



Air pressure could fluctuate slightly due to changing ambient outdoor temperatures or changing weather conditions.

6. If heat transfer fluid loop is free of leaks, carefully release air pressure by slowly opening return assembly ball valve. Some fluid may be present in Energy Station from factory testing and will be forced out return line. Appliance may now be charged and pressurized with heat transfer fluid. Insulating collector fittings and installing collector flashing and leaf guard (if applicable) may also be completed.

5.2 Preparation of heat transfer fluid

One collector appliances include a 1-gal US (3.8 L) jug of 100% Propylene Glycol. Two jugs are included with two, three and four-collector appliances.

Pour 100% propylene glycol USP into EnerWorks Charge Pack reservoir or into a large *clean* bucket. Add an equivalent amount of distilled or de-mineralized water and mix for a 50/50 solution by volume.

Heat transfer fluid must be a 50/50 mix by volume of Propylene Glycol USP and distilled or de-mineralized water. Distilled or de-mineralize water is often available from grocery stores and drugstores. This solution provides freeze protection down to -30°F (-34°C) and burst protection down to -60°F (-51°C). If ambient temperatures at the installation location reach these temperatures or lower, contact EnerWorks for dilution specifications.



Use of any other fluid other than a 50/50 mix by volume of 100% propylene glycol USP and distilled or de-mineralized water is not permitted and will void the warranty, and may lead to damage and/or risk to health and safety.

5.3 Charging Appliance with heat transfer fluid

PLEASE READ ENTIRE SECTION BEFORE PROCEEDING WITH CHARGING PROCEDURE

KEY POINTS:

- Expansion tank air pressure set to 25 psi.
- System fluid pressure set to 30 psi.
- Air must be completely purged from system.



Collectors must remain covered until charging is complete. Uncovered collectors will get very hot. Fluid pumped through uncovered collectors will flash boil, placing

installer at risk of scalding. Boiling will also damage heat transfer fluid and void warranty.

1. Supply line from charge pump should be connected to forward-facing male quick connect on lower manifold. Return line from Appliance to fluid reservoir should be connected to left pointing quick connect of lower manifold.



Clamping or fixing return line to reservoir is recommended as fluid flowing through return line is hot and under pressure and may cause hose end to thrash about and spray fluid – WEAR YOUR SAFETY GLASSES.

2. Ensure pump suction hose is in heat transfer fluid reservoir, below fluid surface. Sufficient fluid must be in reservoir to maintain fluid level above inlet such that air does not enter Appliance (Fig.5.3.1).
3. Open ball valves on supply and return assemblies. Plug charge pump into a power bar with switch – it is much easier to start and stop charge pump by using a switch. Switch on charge pump to circulate fluid and remove air from appliance.
4. With charge pump operating, observe clear line returning fluid to reservoir. Air bubbles will be visible passing through return line. It takes a few minutes for fluid to circulate through entire appliance. Wait until no air is visible in the line before proceeding to next step.



Fluid speed through Appliance is only a few feet per second (<1 m/s). Depending on length of line-set and on number of collectors, it will take a few minutes for fluid and entrained air to move through entire Appliance and out to reservoir. Always allow sufficient time for air to pass through and exit Appliance.



If fluid is immediately discharge ensure Energy Station pump is not turning, short circuiting the collector loop.

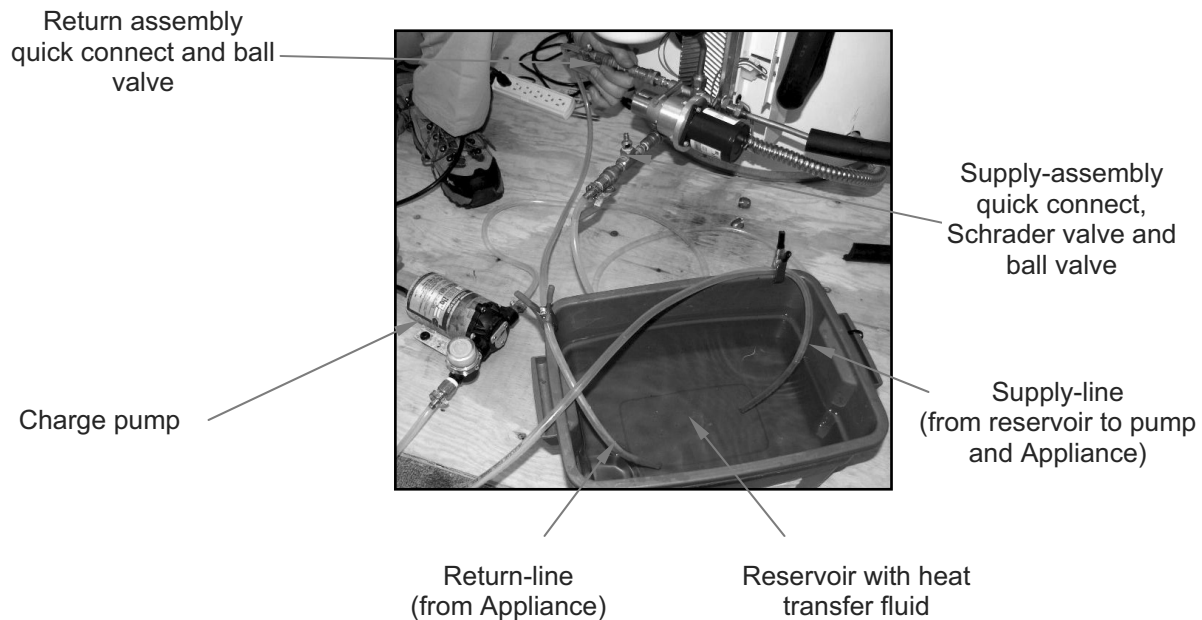


Fig.5.3.1 – Charging Kit and fluid reservoir

5. As expansion tank is manufactured and installed dry, a small volume of air remains inside, on fluid-side of diaphragm. It is very important to remove this air from appliance:
 - a) With charge pump operating and fluid circulating, close ball valve on return assembly (line returning fluid to reservoir). Fluid is prevented from leaving appliance and a rapid pressure increase is visible on pressure gauge until fluid pressure matches expansion tank air pressure of 25 psi.
 - b) At this point, Appliance pressure rises more slowly – heat transfer fluid is now entering expansion tank. Allow Appliance pressure to reach 40 psi. Quickly open closed ball valve, allowing fluid to once again exit Appliance and return to reservoir. Fluid and any trapped air in expansion tank are forced out into line-set. Fluid pressure will drop to 0 psi.
 - c) Wait a few minutes for air expelled from expansion tank to circulate through entire appliance and exit into reservoir. Fine air bubbles may be observed in clear line.
 - d) Repeat the above at least three times to ensure all air has been removed from expansion tank.

6. With charge pump operating, plug Energy Station into power supply. Controller LCD will turn on for 3 seconds and temperature difference, ΔT , is displayed (see Appendix – *Controller Operation*). Energy Station circulation pump is a positive displacement gear pump. When not operating, gear pump acts as check-valve, preventing fluid (and air) from passing through it. Small amount of air will be trapped in manifold at suction and discharge of Energy Station pump and must be purged.

7. If temperature difference between collector (Source) and water tank (Storage) is 18°F (10°C) or greater, Energy Station pump will start automatically. This will clear Energy Station pump of air. If it starts automatically, allow Energy Station pump to run for 10 seconds, then unplug Energy Station and proceed to next step. Fluid should still be circulating by charge pump. If temperature difference between source and storage is less than 18°F (10°C), Energy Station pump will not turn on automatically and must be started manually:
 - a) Hold all three Controller buttons down until it enters program mode (*Fig. 5.3.2*).
 - b) Screen should read “AU”; this is default automatic setting. Press down (right) button once; screen will switch to “ON” (*Fig. 5.3.2*).
 - c) Wait for 20 seconds. Controller exits program mode and Energy Station pump will start, clearing pump of air.
 - d) Let pump run for 10 seconds and then unplug Energy Station.

(An alternative is to apply a 4.5-5 k Ω resistor to Source and Common terminals at bottom right of Controller, under cover. This will simulate a hot collector and unit should turn on.)

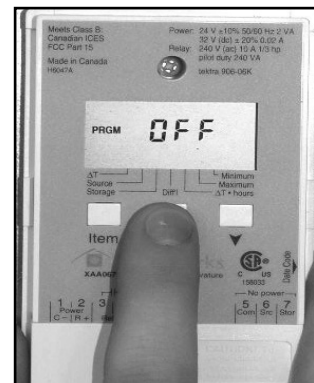
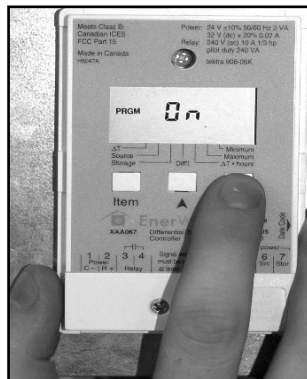


Fig.5.3.2 – Manually start pump by pushing all three buttons to enter program (PRGM) mode then push down button. To shut off, enter PRGM mode and push up button.



TIP: Alternate over pressurizing fluid to purge expansion tank and manual starting pump to purge pump and manifold. Repeat four or five times, allowing for purged air to move through and exit system to ensure all air has been purged.

8. Appliance should now be charged to a fluid pressure of 30 psi.
 - a) With charge pump operating and fluid circulating, close ball valve on line returning fluid to reservoir (at return assembly). A rapid increase in pressure will again be observed on pressure gauge, until appliance pressure reaches 25 psi – the expansion tank air pressure. Pressure then increases more slowly.
 - b) When appliance pressure reaches 30 psi, switch off charging-pump and quickly close ball valve at appliance fluid inlet.
 - c) If pressure is below 30 psi, open inlet ball valve and switch on charge pump momentarily. Switch off pump and close valve as before. If pressure is above 30 psi, let very small volume of fluid out of appliance outlet.

9. Disconnect supply and return charging hoses from appliance. Open ball valves, and allow fluid in charging lines to drain back into reservoir.



If small bits of copper from de burring enter line-set, they may get lodged in charging port (Parker hydraulic quick connect nipple of lower manifold). This may cause quick connect to leak. If quick connect leaks, drain system of fluid and remove quick connect. Back flush quick connect, reinstall, and recharge Appliance.



Pour remainder of fluid back into glycol jug and label “50/50 propylene glycol – water”. This fluid may be re-used in charging other appliances. Fluid will react with air over time. Transferring fluid to a smaller container will limit contact with air. Do not use if fluid becomes cloudy or discolored.



Check and follow all local environmental regulations regarding storage and disposal of food-grade propylene glycol heat transfer fluid.

6 – Collector Flashing and Leaf guard Installation



Collector flashing and leaf guard are designed for pitched roof installations only. Flashing and leaf guard should not be installed on rack-mounted collectors due to increased wind loads.



**Before installing flashing and leaf guard confirm no leaks at panel(s),
insulate line-set, and record collectors Serial Number(s))**

6.1 Side flashing for 1-collector Appliances

One collector Appliance includes side flashing that must be installed to cover connections, insulated line-set, thermistor and control wires, and roof penetration. Side flashing may be installed on left or right of collector but must cover connections and roof penetration. Side flashing includes two thin lengths of painted, galvanized steel with 90° bends and two end caps for top and bottom (*Fig.6.1.1*).

Two sets of side flashing may be installed to make installation symmetrical. Side flashing may also be used on multi-collector installations to hide C-channel.

1. Insert edge of side flashing piece in collector side-wall groove. Align bottom edge of flashing with bottom of collector. Secure lower side flashing to roof with included roofing screws.
2. Insert edge of upper side flashing into side-wall groove such that it overlaps lower section (for rain and snow shedding). Secure upper side flashing to roof with included roofing screws.
3. Insert rectangular caps into upper and lower holes created by side flashing and collector (*Fig.6.1.1*). Secure to roof with included roofing screws. Secure to upper and lower side flashing with included self-drilling screws.
4. Secure upper side flashing section to lower section at overlap with included self-drilling screws.

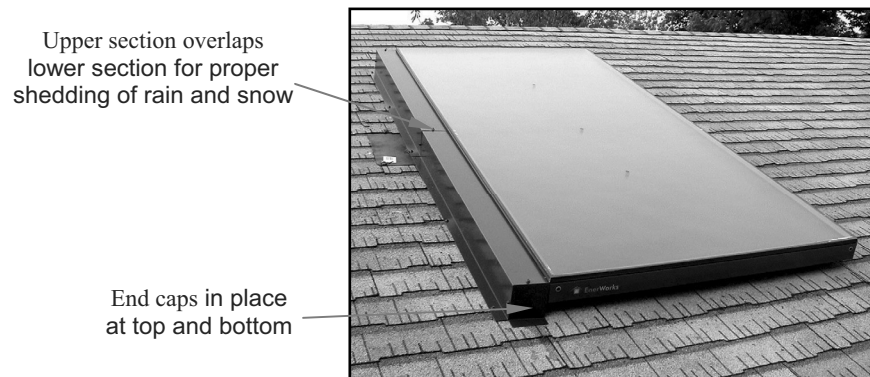


Fig.6.1.1 – Collector side flashing. Note roof-penetration boot under side flashing.

6.2 Center-flashing for 2, 3 and 4-collector Appliances

Two, three and four-collector Appliances include one, two or three sets of center-flashing. Center-flashing should cover insulated line-set, collector connections, thermistor and control wires and roof-penetration. Center-flashing is two thin lengths of painted, galvanized steel that slide between collectors. Side flashing may also be used on multi-collector installations to hide C-channel.

1. Slide center-flashing between collectors in collector side-wall grooves. Upper length should overlap lower length to ensure proper rain and snow shedding (*Fig.6.2.1*).

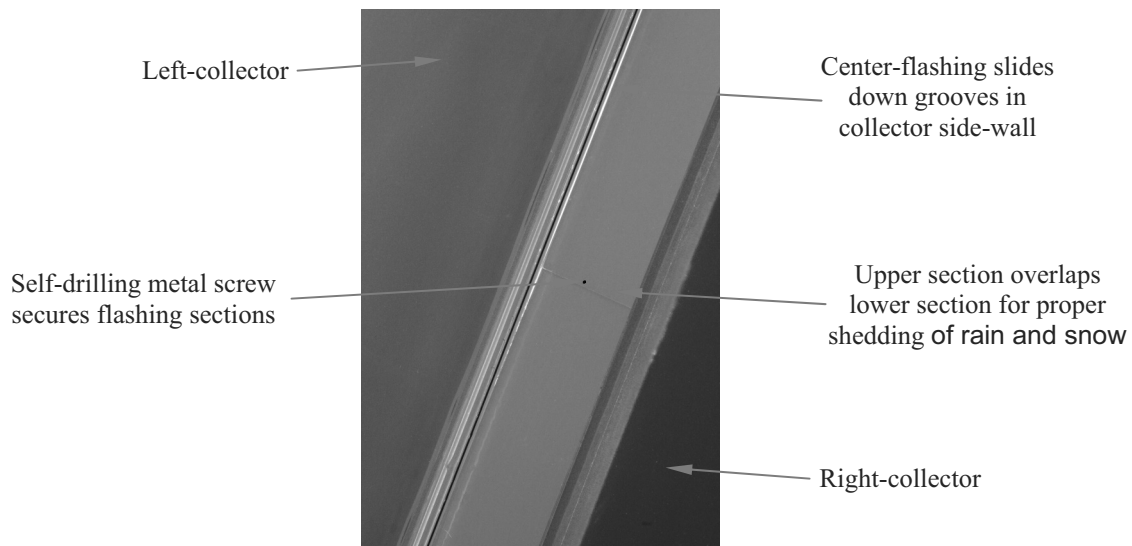


Fig.6.2.1 – Center-flashing slides between collectors (2, 3 and 4-collector Appliances).

2. Fold ends of center-flashing sections down such that they are flush with collector side-wall edge. Secure center-flashing sections to upper and lower side-walls with self-drilling screws. If leaf guard is to be installed, do not fold down upper center-flashing length until leaf guard is in place (Fig.6.2.2).
3. Secure upper center-flashing section to lower section with a self-drilling screw (Fig.6.2.1).

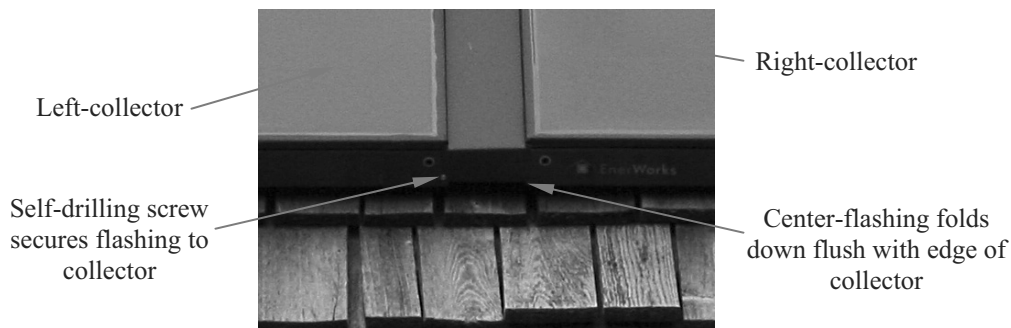


Fig.6.2.2 – Center-flashing folds down flush with edge of collector (2, 3 and 4-collector Appliances).



TIP: If it is difficult to slide center-flashing between collectors, try loosening C-channel bolts temporarily. Be sure to re-tighten C-channel bolts after center-flashing is “started” in side-wall grooves. It may also help to bow the center-flashing sections slightly upwards to get them “started” in the side-wall grooves.

6.3 Leaf guard installation

Leaf guard is included with three- and four-collector Appliances to protect and shade insulated line-set. Leaf guard for one and two-collector Appliances is optional and is of benefit to prevent leaves and debris from gathering around and behind collectors. Leaf guard includes thin lengths

of perforated, painted, galvanized steel and triangular end caps. Perforations ensure proper functioning of patented stagnation-control mechanism. Each section of leaf guard is slightly longer than collector is wide.

1. Insert lower edge of leaf guard section into side-wall groove at top of collector. Align side edge of leaf guard section with outer side of collector or with side flashing. Leaf guard sections are overlapped to ensure edges are flush with outer collector side-walls.
2. Secure leaf guard to roof with included roofing screws.
3. Insert triangular caps into left and right leaf guard ends. Secure end caps to roof with included roofing screws (*Fig.6.3.1*).
4. Secure end caps to leaf guard sections and secure sections to each other at overlaps with self-drilling screws.
5. Bend center-flashing down to leaf guard and secure with self-drilling screws if applicable (*Fig.6.3.1*).

Center-flashing folded down and secured flush with leaf-guard

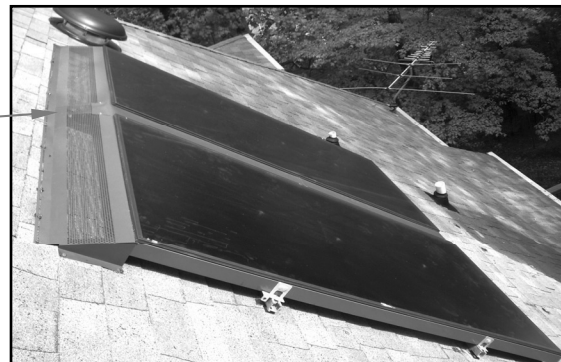


Fig. 6.3.1 – Two collectors with center-flashing and leaf guard.

7 - Appliance Start-Up

1. Install Energy Station cover and secure with supplied screws.
2. Plug in Energy Station. Ensure Energy Station is surge protected. Observe that temperature differential (ΔT) is displayed.
3. Insulate any exposed fittings, heat transfer fluid line or water line. Ensure temperature set points of solar storage tank, water heater and anti-scald valve are properly set and meet local codes and regulations.
4. Remove plastic foil cover from collectors.
5. Check Energy Station operation and Controller display to ensure Appliance is working properly.

6. Determine if homeowner wants display units in degrees Fahrenheit (°F) or degrees Celsius (°C). To change, push all three buttons at once to enter program (PRGM) mode. Push item button eight times such that °F or °C is flashing (Fig.7.1). Use “up” or “down” button to select desired units. Do not modify any other settings. Controller will revert to automatic mode after a few seconds. See Appendix - *Controller Operation* for more details.

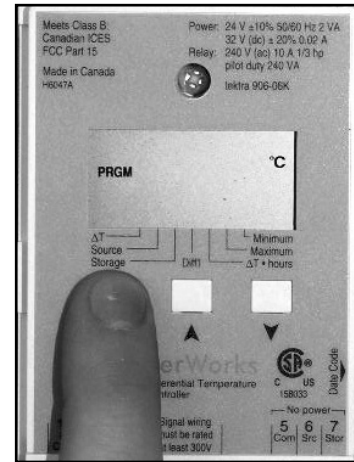


Fig.7.1 – Changing display between Fahrenheit (°F) and Celsius (°C)

8 - Final Steps

1. With reference to Owner Manual, discuss Energy Station, Controller and Appliance operation and maintenance with homeowner.
2. Fully complete *Product & Installation Registration Form* included with Owner Manual and in the Appendices. Homeowner and installer/dealer contact details should be included. Serial numbers of Energy Station and collectors and thermistor sticker are necessary for timely and effective service.
3. Provide homeowner with Owner Manual and a copy of *Product & Installation Registration Form*. Keep a copy of *Product & Installation Registration Form* for your records. Mail, fax or email a copy to EnerWorks.

9 - Scheduled Maintenance

Heat transfer fluid MUST be changed at least every three years. Temperature cycling causes fluid to break down over time and become acidic. Heat transfer properties will diminish and fluid can become corrosive to lines and fittings. After draining fluid, check wire mesh filter in lower manifold of Energy Station (Fig. A.3). Clean and replace before recharging with new fluid.

Check acidity (pH) of heat transfer fluid with litmus strips. If pH is below 6, fluid must be changed. After draining fluid, check wire mesh filter in lower manifold of Energy Station (Fig.A.3). Clean and replace before recharging with new fluid.

Follow charging procedure as outlined in sections 5.2 *Preparation of heat transfer fluid* and 5.3 *Charging Appliance with heat transfer fluid*.

10 - Troubleshooting

10.1 Controller

Controller LCD screen is blank:

- Check power to Energy Station. Contact EnerWorks before proceeding to check any other wiring.

“Err” on Controller LCD screen (*Fig. 10.1.1*):

- If ▼ points to Source, collector thermistor circuit is shorted or open, or thermistor is faulty.
- If ▼ points to Storage, storage tank thermistor circuit is shorted or open or thermistor is faulty.
- Check and fix connections or replace thermistor if necessary (see below).

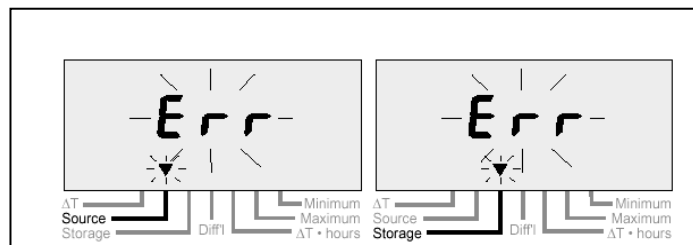


Fig. 10.1.1 – Error message – problem with thermistor(s)

10.2 Thermistor

1. Check connections between thermistors and Controller.
2. Ensure storage thermistor is installed in Common (Com) and Storage (Stor) terminals of Controller and collector thermistor is installed in Common (Com) and Source (Src) terminals.
3. Check resistance of thermistor with (*Table 10.2.1*). If resistance is 0 Ω, there is a short circuit, if resistance is infinite or if there is an error reading, there is an open circuit – check for broken wires or connections.

Deg C	Deg F	Ohms	Deg C	Deg F	Ohms
-40	-40	336,450.0	60	140	2,488.0
-35	-31	242,660.0	65	149	2,083.0
-30	-22	176,960.0	70	158	1,752.0
-25	-13	130,410.0	75	167	1,479.0
-20	-4	97,072.0	80	176	1,255.0
-15	5	72,951.0	85	185	1,070.0
-10	14	55,326.0	90	194	915.4
-5	23	42,326.0	95	203	786.6
0	32	32,650.0	100	212	678.6
5	41	25,391.0	105	221	510.6
10	50	19,899.0	110	230	587.6
15	59	15,711.0	115	239	445.2
20	68	12,492.0	120	248	389.6
25	77	10,000.0	125	257	341.9
30	86	8,057.0	130	266	301.0
35	95	6,531.0	135	275	265.8
40	104	5,326.0	140	284	235.4
45	113	4,368.0	145	293	209.0
50	122	3,602.0	150	302	186.1
55	131	2,986.0			

Table 10.2.1 – Thermistor resistance vs. temperature

10.3 Pump

Pump operates when cloudy or at night:

1. Check to ensure thermistors are connected and working properly.
2. Difference in temperature between collectors at night and cold mains water may be adequate for collecting energy, i.e., nighttime ambient outdoor air temperature may be more than 18°F (10°C) hotter than mains ground water temperature – and pump will operate.

Pump is not operating:

1. If LCD screen on Controller is blank, check power to Energy Station.
2. If “Err” shows on Controller, refer to Controller section of troubleshooting.
3. Solar storage tank may be fully charged and over-temperature control has shut down pump. Check thermometer for temperature of water in solar storage tank. Open hot water tap for a few minutes - this will cool storage tank and pump should come back on.
4. Thermostat of over-temperature control may have to be manually reset. Remove solar storage tank upper element cover and push red reset button on thermostat.

5. Thermostat may be faulty. DISCONNECT POWER TO ENERGY Station. Disconnect over-temperature wires from thermostat connections. Short over-temperature wires with a wire-nut (Marrette, Marr connector). Reconnect power to Energy Station. If pump runs, thermostat is faulty. Disconnect power, replace thermostat and all connections.

10.4 Noisy pump

1. Drain appliance. Inspect and clean wire mesh filter in lower manifold of Energy Station. Re-charge appliance and purge all air from heat transfer fluid loop.
2. Ensure line-set is well secured.

10.5 Heat transfer fluid pressure drop

Static fluid pressure should be between 20-40 psi depending on weather conditions. If pressure is low, check for and fix any leaks.

1. Identify location of fluid leak – wetness or discoloration may indicate source of leak.
2. Quick connects fluid ports may be dirty or faulty – copper shavings, from deburring line-set, may be lodged in quick connect preventing it from seating and sealing. Depress quick connect momentarily to clean. If unsuccessful, drain system of fluid, remove quick connect, clean and back flush quick connect, reinstall and recharge Appliance. Replace quick connect if necessary.
3. Check function of pressure relief valve by pressurizing system to 50psi. Note pressure that PRV open. Replace if necessary and recharge Appliance.
4. If line-set is very long or a large vertical height is present between collectors and Energy Station, additional expansion capacity may be necessary. Install supplemental expansion tank (**4.9.2 Supplemental expansion tank**).
5. Check operation of stagnation-control damper.
6. Recharge with fluid and purge air.

Exploded Views

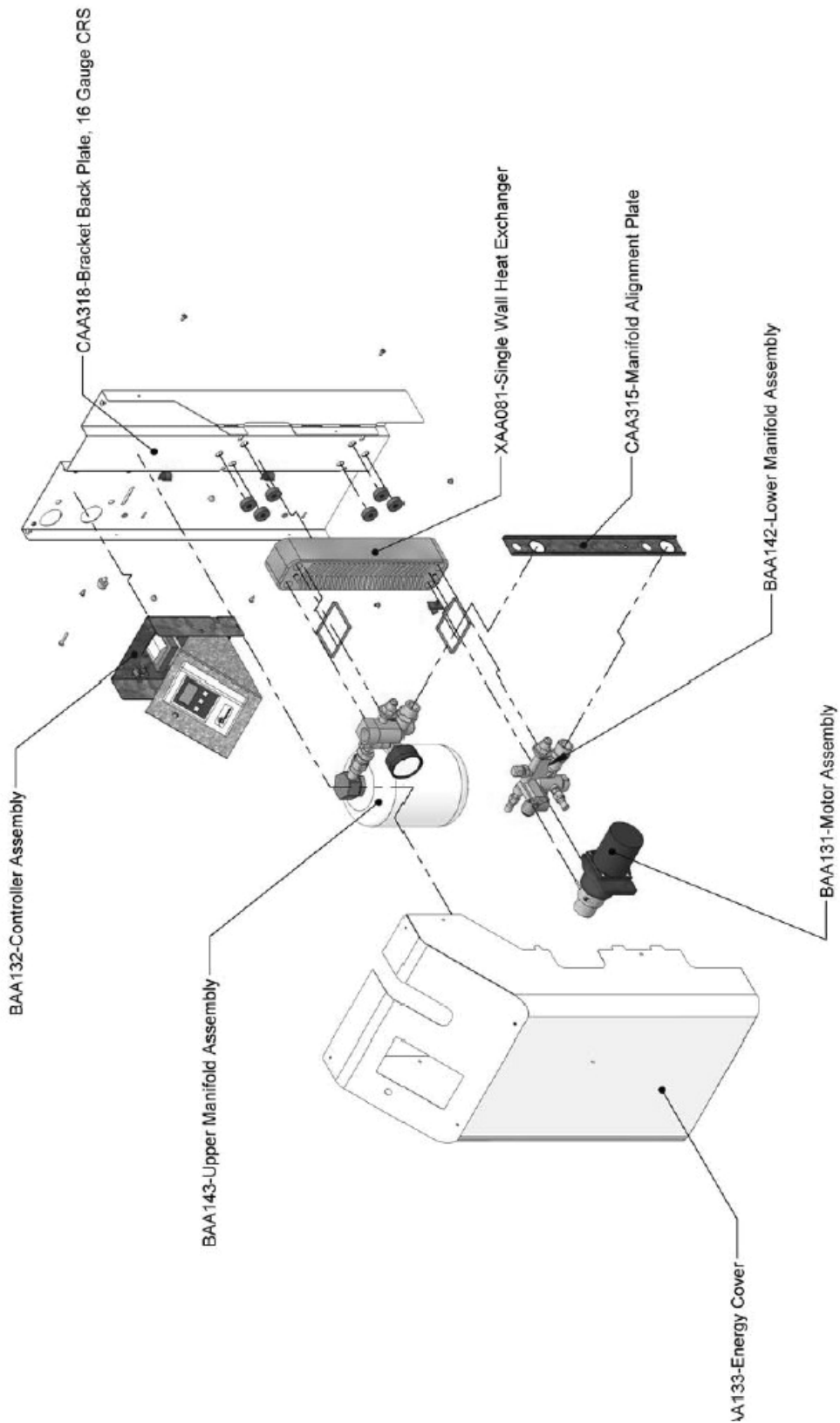


Fig.A.1 – Energy Station – exploded view

Fig. 85 – Energy Station – exploded

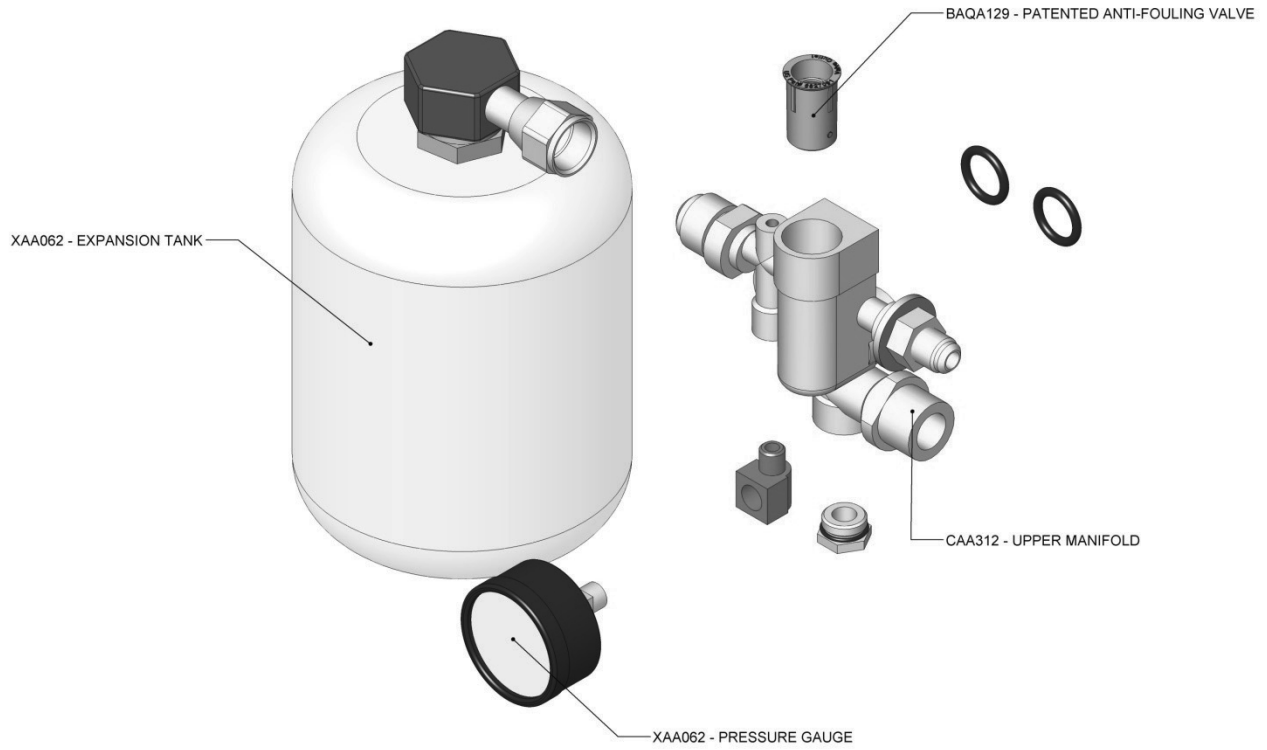


Fig.A.2 – Expansion tank & upper manifold – exploded view

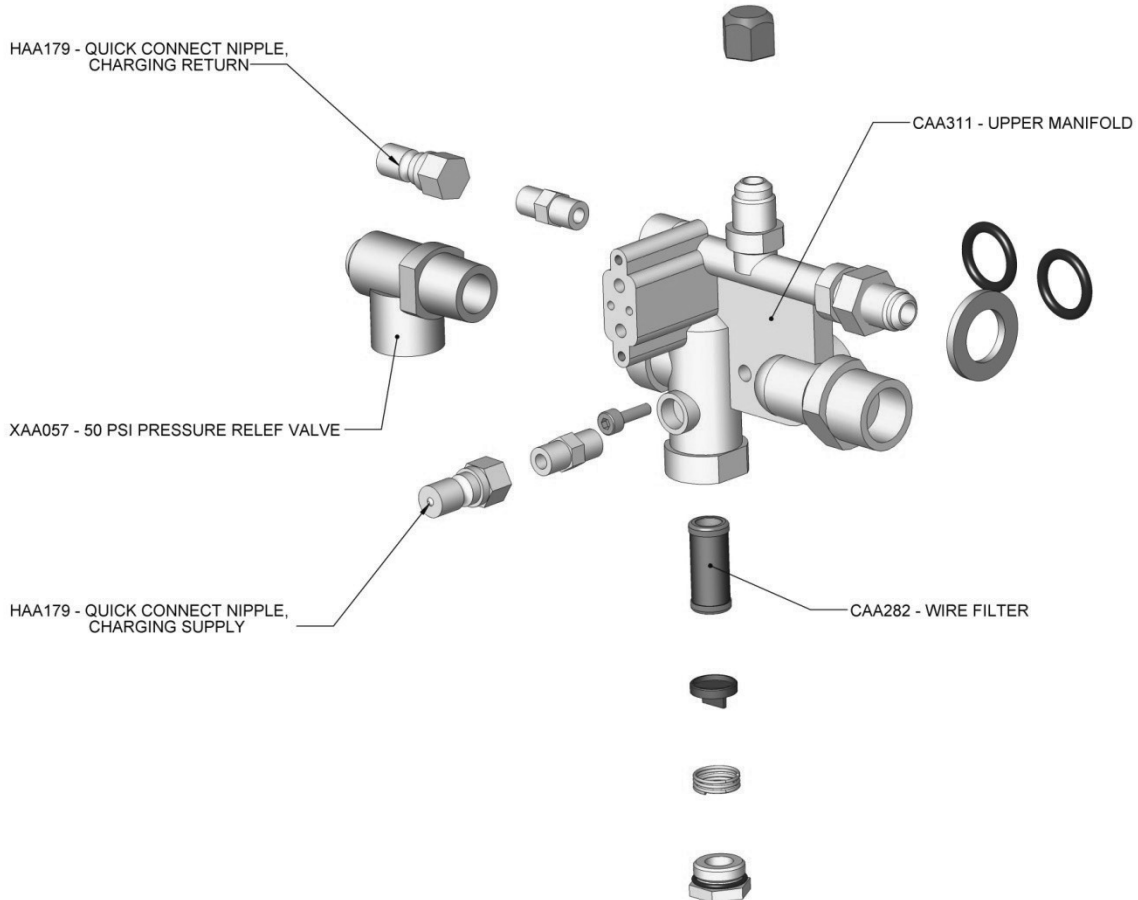


Fig.A.3 – Lower manifold – exploded view

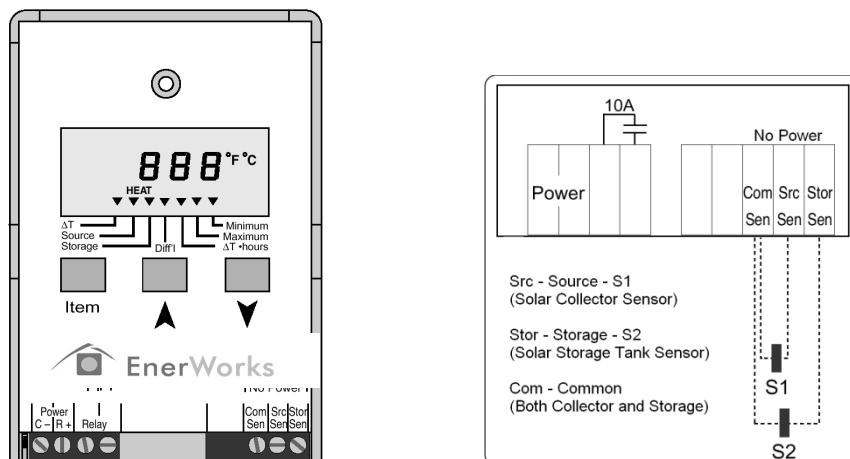
Controller operation

Differential Controller is a microprocessor-based control that monitors temperatures of solar collector and of solar storage tank. If sufficient temperature difference for energy collection exists, Controller starts pump. If sufficient temperature difference for energy collection no longer exists, Controller stops pump.

Temperature sensor, or thermistor, that measures temperature of water at bottom of solar storage tank has two blue wires factory-connected to Common (*Com*) and Storage (*Stor*) terminals at lower right of controller. Thermistor installed in solar collector must be connected via an 18-gauge two-wire control wire that follows line-set to Energy Pack, and is connected to Common (*Com*) and Source (*Src*) terminals.

Thermistors are metal resistors with nominal 10 k Ω resistance at 77°F (25°C). Thermistor resistance changes with temperature. As controller only monitors voltage drop across thermistor, negligible current flows through thermistor. Any connections to Controller should be done with Energy Pack unplugged. Do not connect or disconnect any wires to terminals at lower left of controller. Current flows through these connections and there is a danger of shock and of damaging Controller.

Wired to storage tank's upper thermostat (High-Performance (pre-heat) Appliances only), controller also ensures that solar storage will not reach scalding or boiling temperatures. If thermostat setpoint is reached, Controller will shut down pump and any further heat transfer.



Powering up:

After Energy Pack is plugged in, LCD segments turn on for 3 seconds.

Settings:

By pushing *Item* button, Controller cycles through following settings (controller continues to monitor and control Energy Pack functions):

Item	Description
ΔT (default)	Current temperature difference between Source (solar panel) and Storage (bottom of solar storage tank) temperatures
Source	Current Source (solar panel) temperature
Storage	Current Storage (bottom of solar storage tank) temperature
Maximum Source	Maximum Source temperature since item was last cleared
Minimum Source	Minimum Source temperature since item was last cleared
Maximum Storage	Maximum Storage temperature since item was last cleared
Minimum Storage	Minimum Storage temperature since item was last cleared
HEAT	Number of relay running hours since item was last cleared

ΔT·hours	°F·hours (or °C·hours) since item was last cleared
----------	--

Clearing an *Item*, or resetting Maximum and Minimum displays:

Scroll through to setting to be cleared or reset. Press and hold “Up” and “Down” buttons at the same time for 1 second. “Clr” is displayed and value is reset to current sensor measurement.

Estimate of energy production:

An estimate of energy transfer from Source (solar panels) to Storage (solar storage tank) can be determined by multiplying ΔT·hours by associated constant below.

ΔT·hours is displayed with alternating numbers. When °F or °C segment is off, thousands are displayed. When °F or °C segment is on, units are displayed.

Unit of measure	Multiply (ΔT·hours) by	To obtain
°F	128.7	BTU
°F	0.00129	therm
°F	0.0377	kWh
°C	0.0679	kWh

Ex. Energy Transfer = ΔT·hours x K
 ΔT·hours = 005 (thousands) 225 °F(units) = 5225 °F·hours
 Energy Transfer = 5225 x 0.0377 = 197 kWh

Calculation provides only a rough estimate of solar energy captured. It is not an accurate indication of displaced electric or fossil fuel energy. Losses inherent to electric or fossil fuel hot water tanks are not considered. Estimate of energy production should in no way be used to assess energy displacement for billing purposes.

Program (PRGM) Mode:

To enter program (PRGM) mode, push and hold all three buttons. By pushing *Item* button, Controller cycles through program settings, including operating mode and default temperature units (°F or °C).



Modification of PRGM operating mode, from Automatic (*Au*) to On (*On*) or Off (*oFF*) is only permitted to purge air from pump during charging procedure or to test system during periods of low insolation. Modification of PRGM mode is also permitted to change default temperature units between degrees Fahrenheit and degrees Celsius.



ALTERING, MODIFYING OR CHANGING ANY OTHER PRGM SETTINGS THAN THOSE DESCRIBED ABOVE IS NOT PERMITTED [except modification of *Maximum Storage setpoint temperature* for Space-Saver™ (single-tank) Appliance].

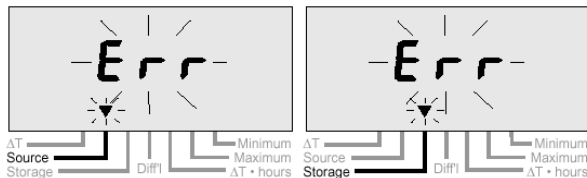


Changing PRGM settings other than operating mode or temperature units may lead to equipment malfunction or damage, to poor performance, and to health and safety risks. Altering any default PRGM setting other than the operating mode or temperature units will void the warranty.

PRGM Item	Description	Default
(operating mode)	Automatic ("Au"), On ("On"), or Off ("oFF"), - On reverts to Automatic after 15 minutes, - Off remains off until operating mode is changed	Au
ΔT	Setpoint temperature difference between Source and Storage temperatures	DO NOT MODIFY Default 18°F (10°C)
ΔT Diff'l	Differential for setpoint ΔT	DO NOT MODIFY Default 9°F (5°C)
Minimum Source	Minimum Source setpoint temperature	DO NOT MODIFY Default 41°F (5°C)
Minimum Source Diff'l	Differential for Minimum Source setpoint temperature	DO NOT MODIFY Default 9°F (5°C)
Maximum Storage	Maximum Storage setpoint temperature	Modification permitted only for Space-Saver™ Appliance Default 185°F (85°C) to 122°F (50°C)
Maximum Storage Diff'l	Differential for Maximum Storage setpoint temperature	DO NOT MODIFY Default 9°F (5°C)
°F or °C (blinking)	Temperature units	°C

Error Messages:

A multi-meter or ohm-meter should be used to test the resistance of the thermistors (temperature sensors) at the Source (solar panel) and Storage (solar storage tank) before they are wired to the controller. A table of temperature and resistance is included below (*Table 9*) and in the troubleshooting guide of the installation manual. If there is a problem with a sensor or with a connection, one of the following Error messages will be displayed. If an error message is displayed, check associated sensor and connections.



Error	Description
Source Err	Source (solar panel) sensor error open/short circuit
Storage Err	Storage (tank) sensor error open/short circuit

Deg C	Deg F	Ohms	Deg C	Deg F	Ohms
-40	-40	336,450.0	60	140	2,488.0
-35	-31	242,660.0	65	149	2,083.0
-30	-22	176,960.0	70	158	1,752.0
-25	-13	130,410.0	75	167	1,479.0
-20	-4	97,072.0	80	176	1,255.0
-15	5	72,951.0	85	185	1,070.0
-10	14	55,326.0	90	194	915.4
-5	23	42,326.0	95	203	786.6
0	32	32,650.0	100	212	678.6
5	41	25,391.0	105	221	510.6
10	50	19,899.0	110	230	587.6
15	59	15,711.0	115	239	445.2
20	68	12,492.0	120	248	389.6
25	77	10,000.0	125	257	341.9
30	86	8,057.0	130	266	301.0
35	95	6,531.0	135	275	265.8
40	104	5,326.0	140	284	235.4
45	113	4,368.0	145	293	209.0
50	122	3,602.0	150	302	186.1
55	131	2,986.0			

Table 9. Thermistor resistance vs. Temperature

Product & Installation Registration Form

Maintenance Log

Residential Site Survey

Tool and Supply Checklist



MAINTENANCE LOG

Date	Issue	Maintenance Performed	Comments	Maintenance-Provider Contact Details



PRODUCT & INSTALLATION REGISTRATION FORM

Date of Installation:		Water Hardness:		Energy Station Serial Number:	
		<input type="checkbox"/> GPG <input type="checkbox"/> ppm <input type="checkbox"/> mg/L		<input type="text"/>	
Customer Name:		Installer Name:		Solar Collector Serial Number: 1	
Installation Address:		Company Address:		Solar Collector Serial Number: 2	
Postal/Zip Code		Postal/Zip Code		Solar Collector Serial Number: 3	
Customer Telephone 1:		Installer Telephone 1:		Solar Collector Serial Number: 4	
Customer Telephone 2:		Installer Telephone 2:			
Customer e-mail:		Installer e-mail:		Thermistor stickers	

- Please put me on your mailing list to receive press releases and product information
- Do not add me to your mailing list

LAA063 - 070711

EnerWorks Inc.
 969 Juliana Drive • Woodstock ON N4V 1C1 • Canada
 Tel: 519-268-6500 • Fax: 519-268-6292
 Email: info@enerworks.com • Web Site: www.enerworks.com

Energy Kinetics Inc.
 51 Molasses Hill Rd • Lebanon, NJ 08833
 Tel: 800-323-2066 • Fax: 908-735-2068
 Website: www.energykinetics.com



RESIDENTIAL SITE SURVEY

PREPARED BY	Name _____ Phone 1 _____	
	Company _____ Phone 2 _____	
	Address _____ Fax _____	
	City _____ e-mail _____	
	State/Prov _____ Post Code _____ www. _____	
CUSTOMER	Name _____ Phone 1 _____	
	Address _____ Phone 2 _____	
	City _____ Fax _____	
	State/Prov _____ e-mail _____	
	Post Code _____	
SITE	Same as above <input type="checkbox"/> Coordinates _____ ° _____ ' _____ N	
	Name _____ ° _____ ' _____ W	
	Address _____ Phone 1 _____	
	Phone 2 _____	
	City _____ Fax _____	
	State/Prov _____	
	Post Code _____ e-mail _____	
WATER	Municipal mains <input type="checkbox"/> Hardness _____ GPG ppm mg/L	
	Community well <input type="checkbox"/> (if >29 GPG or >500ppm, water softener must be in place)	
	Private well <input type="checkbox"/> Turbidity _____ GPG ppm mg/L	
	Lake/River <input type="checkbox"/> Metals _____	
	Rain <input type="checkbox"/> Water analysis _____	
Chlorine shock <input type="checkbox"/> (Energy Station must be bypassed if water is shocked with chlorine or carbon filter must be in place)		
WATER & ENERGY USE	Adults _____	Total water use _____ US gal Imp gal L daily <input type="checkbox"/>
	Teenagers _____	(if not known, approx. 16 US gal, 13 Imp gal, or 60 L per person per day) weekly <input type="checkbox"/>
	Children _____	Hot water use _____ US gal Imp gal L monthly <input type="checkbox"/>
	Total _____	(if not known, approximately 1/3 of total hot water use) annually <input type="checkbox"/>
	Existing water-heater _____ Electric <input type="checkbox"/>	
	Brand / Model _____ Natural gas <input type="checkbox"/> Storage tank <input type="checkbox"/>	
	Size _____ US gal Imp gal L Oil <input type="checkbox"/> On-demand <input type="checkbox"/>	
Age _____ yrs Propane <input type="checkbox"/>		
Energy use _____ kWh BTU therm ft ³ m ³ Cost of Energy \$ _____		
monthly <input type="checkbox"/> annually <input type="checkbox"/> monthly <input type="checkbox"/> annually <input type="checkbox"/>		
Anticipated # of collectors _____ Solar storage tank size _____ US gal Imp gal L		
BUILDING	Age _____ yrs # of stories _____	Roof cladding _____ Asphalt shingle <input type="checkbox"/>
	Line-set route _____ roof-penetration, exterior wall <input type="checkbox"/>	_____ Metal with raised seams <input type="checkbox"/>
	_____ roof-penetration, interior <input type="checkbox"/>	_____ Tile <input type="checkbox"/>
	_____ around eave, exterior <input type="checkbox"/>	Other _____
	_____ in ground <input type="checkbox"/>	Roof/collector direction _____ azimuth _____ °
	Access to basement _____	_____ magnetic _____ °
	Sill height above ground _____	_____ declination _____ °
Basement construction <input type="checkbox"/>	_____ true _____ °	
Space for solar storage tank <input type="checkbox"/> x _____	Roof/collector pitch _____ : 12 or _____ °	
120 VAC available <input type="checkbox"/>	Roof condition _____	
Plumbing material _____ Size _____	Roof access _____	
copper <input type="checkbox"/> 1/2" <input type="checkbox"/>		
PEX <input type="checkbox"/> 3/4" <input type="checkbox"/>		
other _____ other _____		
Safety, Notes & Comments		

TOOL AND SUPPLY CHECKLIST

☑	Tools and Supplies	Note
For Line-Set & Collector Installation	fall-prevention/fall-arrest equipment	observe all local requirements
	ladders or scaffolding	
	rope and carabiners	for hoisting collectors/supplies
	sturdy bag or basket	for hoisting tools/supplies
	work lamps	for attic
	drill with charger and extra battery or extension cord	
	¼" drill bit (long, min. 6" or 12" bit required)	to pre-drill rafters for lag-bolts
	Open-ended wrench, ratcheting box-end wrench, ratchet with extension, and or nut driver (1/2" and 9/16")	for securing C-channel and collectors
	¼" driver bit	for roofing, thermistor cap screws
	5/16" driver bit	for flashing screws
	caulking gun	for roof sealant
	extra roof sealant (polyurethane/silicone)	
	level	
	measuring tape	
	hole saw to make 2 x 1 ¼" or one 2.5" hole	
	hammer / small pry bar	
	chalk or tape with marker	
	slip-joint pliers	for thermistor wire IDCs (insulation displacement connectors)
	spray bottle with dish soap solution	for leak testing
	Multimeter	to test thermistors, see pg X for temp. vs. resistance table
	insulation tape	for taping insulation seams
	pipe-cutter	
	de-burr (ream) tool	to de-burr copper tupe
	3/8" tube-bender	for tight bends (necessary for 3 & 4-collector Appliances)
copper clips/pipe straps	for securing line-set	
UV protection/wrap for exposed insulation	to protect line-set	
false downspout/electrical conduit/pvc/abs	exterior conduit for line-set	
extra spacers, lag-bolts, washers, roofing screws, etc.		
For Solar Storage Tank Installation	hose	to drain existing tank
	standard top or bottom-feed electric hot water tank (pre-heat) 50 US gal / 40 Imp gal / 175 L 80 US gal / 60 Imp gal / 275 L 120 US gal / 100 Imp gal / 455 L	size depends on number of collectors: 1-collector appliance 2-collector appliance 3, 4-collector appliances
	thermostatic anti-scald device (recommended or required)	to prevent scalding, observe local code requirements
	temperature and pressure safety relief valve	to prevent boiling/exploding observe local code requirements
	drip tube	for T&P relief valve, observe local code requirements
	drip pan	main-floor storage tanks, observe local code requirements
	tank blanket	minimize thermal losses, optional
	three ball-valves (pre-heat); one ball-valve (Space-Saver)	solar storage tank bypass/shut-off, match with existing pipes
	tie-wrap, zip-tie	bypass valve info card, control wires, etc.
	two sweat tees, 1/2" or 3/4"	for bypass, match with existing pipes
	90° elbow sweat fittings, 1/2" or 3/4"	as required, match with existing pipes
	1/2" or 3/4" copper pipe, or	as required, match with existing pipes
	pipe-cutter	
	de-burr (ream) tool	
	soldering torch	
	tool to clean copper fittings and pipe	
	lead-free solder	
	thread sealant/teflon tape	seal NPT-fittings, NOT flare-fittings
	adjustable crescent wrenches	
	pipe wrenches	
	combination wrenches	
level		
measuring tape		

TOOL AND SUPPLY CHECKLIST

For Energy Pack Installation	drill with charger and extra battery or extension cord	for Energy Pack mounting screws
	¼" driver bit with 6" magnetic extension	for Energy Pack mounting screws
	adjustable crescent wrenches	for flare-fittings, use two wrenches and counter-torque
	combination wrenches	for flare-fittings, use two wrenches and counter-torque
	level	for Energy Pack, pipe runs
	Phillips #2 screwdriver	for Energy Pack cover screws, tank thermostat
	precision slot/flathead screwdrivers (2.0mm, 2.4mm, 3.0mm)	for controller connections
	4' two-conductor cable suitable for 240VAC service	Space-Saver™ only , connect heating element to Controller
	air compressor/bicycle floor pump	to pressurize and leak-test, to pressurize expansion tank
	tire pressure gauge (Schrader)	as accurate as possible (<±1 psi)
	pipe-cutter	
	de-burr (ream) tool	to de-burr copper tube
	3/8" flare tool	for line-set connections to Energy Pack
	measuring tape	
	charge kit	to remove air from and to pressurize heat-transfer fluid loop
	gal (3.78L) distilled, deionized, demineralized water	to mix with propylene glycol to make heat-transfer fluid
	clean bucket, container or reservoir	for heat-transfer fluid
	clamps	to secure charge-kit fluid lines
power bar with extension cord	for operating charge pump	
work lamps		
Safety	fire extinguisher	observe all local requirements
	safety glasses	observe all local requirements
	steel-toed boots	observe all local requirements
	work gloves	observe all local requirements
	fall-prevention/fall-arrest equipment	observe all local requirements