The Butler Sun Solutions, Inc. Solar Six Pack™ water heating system is a state-of-the-art solar water heating system that augments your existing water heater. This system can save over 2,400 pounds of CO₂ production per year compared to a conventional water heater, making hot water from clean sunlight. It is like having an oil well on your roof producing 2.5 barrels of oil per year (but without the pollution from burning the oil!).

The Solar Six Pack™ system has been designed for easy installation by either a professional contractor or a do-it-yourselfer. This guide is designed to lead you through the installation of the system in a simplified manner. It includes a pictorial summary of the installation steps, followed by explanations of each step. For a complete description with detailed instructions, our System Installation Manual is available on our website. We hope you enjoy bathing and washing with hot water provided by the sun!

Dr. Barry Butler, CEO of Butler Sun Solutions, Inc.
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PICTORIAL SUMMARY OF INSTALLATION STEPS

1. FAMILIARIZE YOURSELF WITH THE SOLAR SIX PACK PARTS & PLAN YOUR SOLAR WATER HEATER INSTALLATION

2. SOLAR COLLECTOR MOUNTS WITH FLASHING FOR NO RAIN LEAKS

3. SPOC (PATENTED) POSITIVE OVER-TEMPERATURE PROTECTION UNIT INSTALLATION

4. STANDARD ROOF JACK PROPERLY FLASHED PENETRATION FOR UMBILICAL

NOTE:
1. Put the cladding in place without securing to check connections for leaks after filling.
2. Use screws provided to secure cladding.
3. Cladding may be painted to blend.

5. MOUNT PV PANEL & CONNECT 12V PLUG

6. COVER UMBILICAL INSULATION AND WIRES WITH ALUMINUM CLADDING
7. **INSTALL PATENTED SOLAR WAND IN TANK:**
   SEE MANUAL FOR BLOCKED TANK PORT OR FOR BRADFORD-WHITE TANKS

8. **MOUNT PUMP BOX ON WALL NEAR TOP OF HOT WATER TANK, WITH BRACKETS PROVIDED**

9. **ROUTE UMBILICAL FROM UNDERSIDE OF ROOF JACK AND CONNECT HOSES TO TOP OF PUMP BOX**

10. **CONNECT BOTTOM OF PUMP BOX TO WAND & MOUNT TANK TEMPERATURE SENSOR**

11. **FLUSH SYSTEM WITH WATER AND FILL WITH PEAK SIERRA PROPYLENE GLYCOL ANTIFREEZE**

12. **CLEAN UP ALL WORK AREAS, CONNECT POWER & VERIFY PUMP OPERATION**

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**STEPS**

1. Hook up garden hose to valve A and open valve A.
2. Connect drain hose to valve B, then open valve B.
3. Turn garden hose full on & flush system with city water.
4. Turn off garden hose and close valves A & B.
5. If overflow reservoir in SPOC is not empty, siphon it to almost empty.
6. Connect Glycol Filling pump to valve A.
7. Open valves A & B.
8. Pump until fluid in the drain hose turns to green.
9. Turn off valve B; now antifreeze is going into the overflow reservoir.
10. Pump about 1/2 gallon into the overflow reservoir, then close valve A, and turn off pump.
STEP 1. FAMILIARIZE AND PLAN

Step 1A: Open the boxes, lay out all of the parts, and be sure that you can identify them all. Look over the packing list to verify everything is included.

Subject to change without notice, check your packing list.

Step 1B: Check that the collector adaptor set (provided with the kit) is appropriate for the collectors and configuration you propose for your system. If in doubt, contact us.

STEP 2. SOLAR COLLECTOR ALIGNMENT AND MOUNTING

Step 2A: Determine where you are going to mount the solar collector to minimize the distance from the water tank to the collector and optimize the solar orientation of the system. The ideal orientation of the solar collector for maximum annual energy delivery is tilted at your latitude angle towards true South, with no shading of the collectors.

Step 2B: Determine how the collectors will be mounted, based on the type of roof you have: flat or pitched, composition shingle, wood shakes, concrete tile, or clay tile. For flat roofs you need a tilt kit for flat plate collectors or a rack for evacuated tubes. You should follow local codes for attaching the solar collectors to the roof. Our complete installation manual on our website shows the Housing and Urban Development Guidelines.

Step 2C: Mount the solar collectors sturdily to the roof, being sure that the highest point in the solar collector is fitted with the SPOC™ connection. Steam only goes uphill, so “Landscape”-oriented collectors must be tilted up by about 4” over 8 feet. This will ensure that steam can escape from the nearly horizontal tubes without pushing a lot of water in front of it. “Portrait” collectors must be tilted about 2° (1 full bubble, or 0.5 in/ft). Some collector adapters need to be soldered to the solar collectors. It is easiest to do this before the collector is brought to the roof,
or at least before you tie down the solar collector. Adapters that screw on should also be installed before the collector is tied down. The following pictures illustrate the collector adapters used with SunMaxx flat plate collectors.

**Figure 1. SunMaxx Flat Plate Adapter Kit Usage**

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**STEP 3. SPOC™ MOUNTING**

**Step 3A:** After the collector is mounted, with the adapters in place, it is time to put the SPOC™ in place. The SPOC™ is mounted parallel and even with the top of the collector by placing self-tapping screws through the flanges of the SPOC™ into the side of the collector. The radiator cap must be at the top, and the radiator section should slope slightly downward towards the collector connection.

**Step 3B:** Use the short length of black hose provided to connect the SPOC™ to the collector outlet fitting. Be sure to put the hose on the port that is labeled SPOC™ and not where the red collector outlet hose gets connected.

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**STEP 4. ROUTING THE UMBILICAL TO OR THROUGH THE ROOF**

**Step 4A:** Plan the route of the umbilical from the collectors to the water tank. This may mean going through an attic or crawl space. Typically, the umbilical penetrates through the roof below the bottom of the solar collector. In some cases it is possible to avoid a roof penetration by routing it around the eaves. Doing this properly will save time and money.

**Step 4B:** If you must make a roof penetration, use flashing found at your local building supply store, which will meet local roofing codes. Commercial “Roof Jack” flashing is designed to prevent rain water from entering the house and vermin from using the penetration as a pathway. Make sure that the flashing is fitted and sealed to the roof properly with roof tar or proper sealants that meet local code.

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**STEP 5. MAKING UMBILICAL CONNECTIONS ON THE ROOF**
Step 5A: First, make all of the fluid connections. Connect the red hose to the fluid outlet near the highest point on the solar collector. The red hose is 10 mm inside diameter and the fitting is 9.5 mm outside diameter, so make sure that the hose clamp is tight or the red hose fittings can leak. The black hose connects to the fluid inlet on the solar collector near the bottom. The black hose is 9 mm inside diameter and the fitting is 9.5 mm outside diameter, so it makes a tight fit. Make sure that all hose clamps are tight.

Step 5B: Now lay out the electrical connecting plug and see where you can conveniently mount the PV panel. Once you have a location that allows the PV panel to be plugged into the umbilical connector, mount the PV panel with the screws provided.

Step 6A: Fit up the cladding and elbows being sure that you have covered all exposed wires and umbilical on the roof. The cladding is made of thin aluminum and is not designed to support the umbilical, just protect it. If umbilical supports are needed you will need to add them.

Step 6B: Tighten all of the hose clamp connections on the collector fittings. You should leave them exposed so you can see them when you fill the system with fluid to verify that they do not leak.
Step 6C: After you have verified that the connections are not leaking, secure the cladding with the screws provided.

STEP 7. INSTALL SOLAR WAND™ INTO HOT WATER TANK

Step 7A: Check for obstructions in the hot water tank’s hot water outlet port. Some tanks have restrictions below the opening that will not allow the Solar Wand™ to be inserted without modification. To check the port, first turn the tank electric power or gas off, so it does not heat while you are working on it. Next, turn off the cold water valve which pressurizes the tank and open a hot water faucet to relieve the pressure. Then remove the nipple from the hot water inlet. If the nipple has a sacrificial anode attached to it, go to Step 7E. If it is just a simple threaded nipple, then look in and (if the water is cool enough) stick your finger in the opening to be sure that there are no obstructions under the fitting. If you do not find any obstructions, clean the threads with a wire brush or a ¾” National Pipe Thread Tap. Once cleaned out you may be ready to put the Solar Wand™ in place after you complete the next step.

Step 7B: Check the sacrificial anode in the tank. If the tank is only a few years old this may not be necessary. If the tank is more than five years old, it is a must. Replacing a bad anode will add another five to seven years to your tank’s life. A good LED flashlight will allow you to see the anode condition within the tank. If you have one, it is handy to use an inspection scope such as the one shown in the following figure. The pictures to the left in the picture below show anodes in various states of usage. The one on the far left is new, the one in the center is well used but still providing protection to the tank, and the one on the right is down to just the central wire. If the anode is showing the central wire, it should be replaced. If it is down to just the wire, you might consider replacing the tank since the anode has stopped providing any protection and the tank may be compromised.
Step 7C: If you do not have enough head room over the tank to insert the Solar Wand™, you have a couple of choices. One is to drain about half the water out of the tank, remove the earthquake straps and other connections and tilt the tank over to insert the Solar Wand™. If it is a gas tank you can sometimes slide the Solar Wand™ up the flue and then slide it down into the tank. Finally, if the umbilical is routed through the ceiling, you can slide the Solar Wand™ up through the hole it comes through.

Step 7D: If there is an obstruction below the hot water outlet fitting you may have to use a round file to remove some material from the bottom thread of the tank fitting. In a few water heaters there is a plate below the outlet opening that must be drilled out with a 15/16” drill or filed out with a round file or Dremel tool to accommodate the Solar Wand™. You can use a magnet to catch the filings, but if they fall to the bottom of the tank they will not hurt anything. When the Solar Wand™ fits through, screw it in and tighten it into place.

Step 7E: If a sacrificial anode was found attached to the hot water outlet, some additional plumbing may be called for. The anode is absolutely necessary to protect the steel in the glass lined tank from corroding. Therefore, first replace the hot water outlet nipple and anode (if it is still good) in the tank and cap it with a ¾” galvanized pipe cap. Now, if your tank has an extra ¾” NPT port on the top, use that for the Solar Wand™ and hot water outlet. If the tank has no extra port, then you must insert the Solar Wand™ into the cold water inlet port. It will have a plate below the fitting to hold the plastic dip tube that takes cold water to the bottom of the tank. Remove the dip tube. Follow the procedure in Step 7D to get the Solar Wand™ into the tank. Finally, plumb the cold water inlet into the bottom of the tank, using a T-fitting where the tank drain valve is installed, as shown in the following figure.
Step 7F: Mixing (also called “tempering”) valves are needed on solar hot water systems to limit the temperature of the hot water delivered from the system to the house. Water temperatures in solar storage tanks can reach 180°F (82°C) or more, but temperatures above 120°F (50°C) can cause scalding in sinks, showers or baths. The mixing valve senses the temperature of hot water being drawn from the tank and automatically mixes in cold water to reduce the temperature delivered to the house to a preset value below 120°F (50°C).

Be sure that the mixing valve you are using meets your local code requirements. You may not need mixing valves in new homes that have shower valves with built-in anti-scald control features. Be sure to plumb in a heat trap loop (a vertical loop that rises from the tank hot water outlet to a point several inches above the mixing valve). This loop prevents hot water rising by natural convection directly to the valve, then cooling and returning to the hot water tank. This action, if not prevented, will fill the valve with scale in a few years, dramatically decreasing the valve’s useful life.

The Butler Sun Solutions, Inc. (BSSI) mixing valve installation kit contains all the parts you need to install the mixing valve with its connections to the house and to your solar hot water tank. The kit is designed to simplify the installation and to minimize problems of heat losses, maintenance, and leakage from the mixing valve.

Mixing Valve Kit Inventory

The mixing valve installation kit consists of the following parts (see figure to right):

- Mixing valve assembly, with the mixing valve and pre-attached soldered fittings
- One male ¾” pipe adapter in case the cold water supply plumbing to the hot water tank does not have a male pipe fitting coming out of the wall
- Two brass street elbows, for connection at the Wand
and the hot water inlet to the mixing valve
- Three flex lines, two short and one long

**Mixing Valve Installation Instructions**

Refer to the figure below to see how the various parts fit together in both single-tank installations and two-tank installations. Note the isolation valves that are added in the two-tank installation that allow the solar tank to be bypassed if necessary without disconnecting any plumbing.

The mixing valve attaches to the cold and hot water lines leading to the house, and to the cold and hot water ports of the hot water tank. Step-by-step installation instructions follow:

1. Turn off the cold water supply to the hot water tank. If there is no valve at the tank for this purpose, you will need to turn off the house cold water supply, and this would be a good time to install a cold water valve if one is not already present. If the cold water supply does not have a ¾” male pipe fitting, solder the supplied fitting onto the end of the pipe.
2. Disconnect the existing hot water pipes between the tank and the wall.
3. Remove the open half of the ¾” copper union from the mixing valve, and solder it to the hot water pipe going to the house.
4. Attach the mixing valve assembly to the union and tighten by hand. Adjust the position so the mixing valve adjustment knob is easily reached and the dial can be seen.

5. Attach one of the short flex lines from the cold water supply fitting (step 1) to the bottom of the mixing valve assembly. Note that the flex lines have rubber seals and therefore do not use Teflon™ tape on their threads.

6. Attach the other short flex line from the other end of the bottom of the mixing valve assembly to the cold water inlet of the hot water tank.

7. Apply Teflon™ tape to the bottom threads and install the Solar Wand™ into the hot water outlet of the hot water tank, if it is not already in place.

8. Apply Teflon™ tape to the side threads of the Solar Wand™ and to the mixing valve hot water inlet and screw a street elbow onto each fitting. Tighten the elbows until they are both pointing upwards.

9. Attach the long flex line between the two elbows. This line must arch upwards from the tank to a point 4-6” above the mixing valve before coming back down to the mixing valve. This upward arch prevents hot water from the tank from rising up to the valve, cooling, and leaving deposits inside the mixing valve.

10. Make a final adjustment of the flex hoses to ensure they have smooth curves and are not pinched, and a final adjustment of the mixing valve to orient it for easy access, then tighten all fittings. Don’t forget to tighten the union on the back of the mixing valve!

11. Turn on the cold water and verify all the joints are leak-free. Tighten the flex lines and other joints as needed to eliminate any leaks.

12. When done with the rest of the system installation, verify again that all joints remain leak-free. Then, insulate the hot water line coming from the tank. In California, you are required to insulate the last 1.5 m (5 feet) of the cold water line to the tank to limit heat losses by conduction from that line as well.

13. Adjust the knob on top of the mixing valve to obtain the desired hot water temperature in the house. Note that the adjustment at the mixing valve will take precedence over the setpoint of the tank, so if you increase the tank setpoint temperature, the water going to the house may not get hotter unless you also increase the setting of the mixing valve.

**STEP 8. MOUNT THE PUMP BOX**

**Step 8A:** Find a location for the pump box on a wall near the top of the tank. Mounting near eye level makes reading the gauges and lights convenient. Use the screws provided to secure the pump box to the wall. If you can’t hit a stud, you may have to use dry wall anchor screws (not provided).

**STEP 9. CONNECT UMBILICAL TO TOP OF PUMP BOX**
**Step 9A:** Route the umbilical carefully to the top of the pump box. It should be supported to keep it from sagging along its length and not be subjected to sharp bends that could kink the rubber hoses.

**Step 9B:** Connect the red collector return line to the top of the pump box on the left side, and tighten the hose clamp securely. The red hose is 10 mm inside diameter and the fitting is 9.5 mm outside diameter, so make sure the hose clamp is tight or the red hose fittings may tend to leak. There may be short segments of tube already on the pump box tubes to indicate where the red and black hoses should go.

**Step 9C:** Connect the black collector feed line to the top of the pump box on the right side (where the pump is), and tighten the hose clamp securely.

**Step 9D:** Do **NOT** connect the electrical power connector to the top of the box at this time. Connecting this power lead will power up the pump, and if the rotor is not lubricated by the antifreeze fluid it can damage the pump. A damaged pump caused by running dry is not covered under warranty.

**STEP 10. CONNECT PUMP BOX TO SOLAR WAND™ & INSTALL TANK TOP OVER-TEMPERATURE SENSOR**

**Step 10A:** Connect the upper hose connector of the Solar Wand™ to the bottom of the pump box on the left side using red hose, and tighten the hose clamps on both ends securely.

**Step 10B:** Connect the lower hose connector of the Solar Wand™ to the bottom of the pump box on the right side (where the pump is) using black hose, and tighten the hose clamps on both ends securely.

**Step 10C:** Route the sensor wire from the bottom of the pump box to the hot water tank. The thermostatic switch should be placed on bare metal close to the top of the tank, but not on the Solar Wand™. The Temperature/Pressure relief valve is an easy place to put it, as shown in the following photo. It must be covered with insulation so the metal sensing surface does not get cooled by air passing over it. Other temperature sensors are thermistors or digital temperature sensors. They can be placed against the tank between the tank and insulation. A screwdriver can be used to create a space between the insulation and the tank wall in which to place the sensor, as shown below.
STEP 11. FILLING THE SYSTEM AND FLUSHING WITH ANTIFREEZE

Step 11A: Fill the system with tap water using the hose adapter fitting provided in the kit (see figure on the right). The hose attaches to the upper ¼” fill valve above the pump, and a drain line attaches to the lower valve. Open both valves and turn on the hose to fill the system and flush any dirt or debris out of it. There is a check valve in the pump that prevents “short-circuiting” between the valves, so water should enter the fill valve, go up through the collector, back down through the Solar Wand™, and exit from the drain valve. When the water is flowing clear with no bubbles or debris, briefly close the drain valve to verify that the radiator cap allows flow into the reservoir at about 15-20 psi, then turn off both valves, turn off the hose, and remove the hose adapter.

Step 11B: After the system is filled with water, verify that the pump operates by plugging in the umbilical power cord to the pump box and touching the open contact of the overtemperature switch to energize the pump. Verify the correct LED lights come on, and if it is sunny, watch the temperature gauge for increased temperature indicating that circulation is occurring (see Step 12 for more details). Check all system fittings for leaks and tighten hose clamps as needed. Finally, disconnect the lead on the overtemperature switch again to stop the pump while you flush the system.

Step 11C: The antifreeze recommended for Butler Sun Solutions, Inc. systems is Peak Sierra Pet Safe antifreeze. Most NAPA Auto Parts stores carry this antifreeze. It is a propylene glycol-based antifreeze that is phosphate-free, has nontoxic inhibitors, and can be safely disposed of in a sanitary sewer. Antifreeze that has ethylene glycol is toxic and its use will void your warranty. Before you substitute other propylene glycol antifreeze products, be sure that they have similar viscosities and are not loaded with buffers that can make them like molasses in cold climates. Recommended disposal is in a dry well, where it will break down into harmless sugars in 24 hours.

Step 11D: A manual or battery-powered charging pump is used to flush out the tap water and fill the system with antifreeze solution (see figure above to
If it is very sunny, it is a good idea to cover the solar collectors with a tarp or blanket to keep the system from boiling while you are flushing it. **There is no need to access or remove the radiator cap.** First, fill the pump reservoir half way with propylene glycol and then continue to fill it with water to dilute the antifreeze 50%/50% by volume. It is OK to mix it a little stronger (e.g., 60% glycol/40% water) because some water will remain in the system after flushing. A typical system will require between one and two gallons of antifreeze mix.

**Step 11D:** Pump up the reservoir of the charging pump to 40psi, or turn on the pump if it is battery powered. Then, connect the pump where the hose adapter was connected (at the fill valve on the upper part of the pump box).

**Step 11E:** Open the fill valve and the drain valve on the pump box. Direct the drain hose to a bucket.

**Step 11F:** Actuate the valve on the charging pump to begin pumping antifreeze into the system. The antifreeze should circulate up through the collector and back down through the Solar Wand™, pushing the water out ahead of it and out the drain valve. Watch the level of fluid in the pump reservoir and stop filling and refill the tank as needed to avoid pumping air into the system.

**Step 11G:** Watch the fluid coming out of the drain line, and stop when it changes from clear to green, indicating that the system is fully filled with antifreeze.

**Step 11H:** Note the level of fluid in the charging pump. Close the drain valve. Actuate the valve on the charging pump to pump fluid through the radiator cap into the overflow reservoir of the SPOC™ system on the roof. Continue to add fluid until about ½ gallon of fluid has been added to the reservoir.

**Step 11I:** Close the fill valve on the pump box and disconnect the charging pump. Remove the drain line and store it with the hose fitting for use if the system needs to be drained and refilled at some time in the future.

**STEP 12. CONNECT POWER TO PUMP BOX AND VERIFY OPERATION**

**Step 12A:** Connect both leads to the overtemperature switch at this time to enable the pump.

**Step 12B:** Check the gauges and lights on the pump box to be sure the system is operating normally. If the sun is out, the PV panel should produce power to operate the pump. First, verify that the green LED is lit, indicating power is available. Next, check the yellow LED that shows if the pump is enabled. If it is not on, it indicates that the overtemperature switch is not connected or has opened because the tank is too hot. If both the green and yellow LED’s are lit, the pump should be spinning. El-SID-10 pumps have LED’s in the body of the pump, and all four LED’s light up when the pump is running. El-SID-20 (Black Magic) and Laing pumps have no indicators, but you can feel a slight vibration of the pump when it is spinning. If it is sunny, after the pump has run a few minutes the temperature gauge should begin to rise, indicating that circulation is occurring.

The system will burp all of the air out of the piping over several days of operation, and it will be heating the water tank while burping. Because of this, it is a good idea to top off the fluid level in the SPOC™ reservoir after a week or so of operation. This can be done by attaching the
charging pump to the fill valve, opening the valve, and actuating the pump valve to pump more antifreeze into the system.

**APPENDIX 1. TOOLS OF THE TRADE**

The following tools will allow you to collect information on your system operation and will be real time savers if you are installing multiple systems. A digital multimeter (inexpensive ones are available from hardware stores) with a thermocouple readout to measure temperatures will allow you to check system voltages and currents to determine if the PV panel is providing the proper power. The tools on the right in the following photo are the only specialty tools one should need in addition to simple drills and carpentry tools.
SAFETY TOOLS: In addition to the above tools you should have the following safety items:

- Safety Glasses
- Leather work gloves
  - Prevent hand cuts
  - Prevent scalding by hot water
- A safety harness and climbing ropes if you are on a pitched roof
- Closed-toe shoes with slip-resistant soles
- Rated ladder for access to roofs. Ladders slipping and related falls are all too common, and can be avoided with proper safety procedures such as anchoring ladders to roof and ground

Of course, none of the above tools should be considered a replacement for Common Sense! These systems contain hot fluids at pressure that can cause damage, and working on roofs is inherently dangerous. So, pay attention, be careful, and trust your gut – If it feels dangerous, it probably is!