Hawaii Solar Energy Association
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White Paper
Providing Hot Water Heating Load for a Residential Dwelling &
Comparison between Solar Hot Water and Photovoltaic Cost for Same Dwelling
Hawaii Solar Energy Association
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Summary

The following analysis compares the average cost to produce hot water suitable for use in a residence between solar hot water (SHW) and a photovoltaic system (PV). The data used to compare the two technologies has several limitations, and any conclusions should be taken in the context of a changing and nuanced marketplace. For instance, although the utility has collected data for SHW over the past three decades, data for PV is much less comprehensive and tested, and only reflects limited studies over the past decade. Data for SHW is based on statewide numbers, which may or may not be applicable in certain sun zones found in the islands. In addition, rising PV costs in an unstable market could dramatically impact a PV v. SHW comparison, as well as other factors such as PV degradation rates and other efficiency and maintenance concerns. Also, local conditions can easily sway a cost impact analysis, and may depend upon site conditions, local weather, household water use, and so on.

The following analysis compares the average cost to produce hot water suitable for use in a residence between solar hot water and a photovoltaic system. Using data from the KEMA Energy and Peak Demand Impact Evaluation Report of the 2005-2007 Demand Side Management Programs prepared for HECO, MECO, & HELCO, the cost comparison results between PV and SHW depend upon family size and installed PV system cost. PV is generally more cost effective than SHW to heat water for a family of one or two. SHW is more cost effective once the family size is three or greater, with an average net-installed cost for a family of four of $1,962 for SWH and $2,789 for PV. As the family size increases, the cost efficiency of installing SHW increases, with the installation of a PV system for a family of six costing approximately $1,959 more than the cost to install an appropriately sized SHW system for the same sized family. Cost comparisons include deductions for rebates and current tax incentives, and are calculated using a metric of $5.50/watt to install PV. This comparison assumes consistent water use, and would not apply in vacation homes or other situations where water use was intermittent.

Analysis

In order to compare the cost efficiency of SHW to PV when heating water for residential use, the following analysis first determined the amount of energy saved when SHW replaced an electric water heater. A PV system was then sized to generate the same amount of electricity, and the relative costs were compared. Please find the data for the following analysis in the attached excel documents.

1. Average Electric Use for Electric Water Heater and Savings with SHW

This analysis begins with the solar sample base case which quantifies the annual electric use for an electric water heater for an average number of occupants. It then looks at the average savings with installed SHW. The difference between these two is the average savings per year or the average amount of energy saved per person, which was found to be 1.53 kWh/person/day. This data includes an average efficiency loss for various types of systems.

2. How many PV panels would be needed to save the same amount of electricity?

To determine the cost of installed PV to offset the same amount of electricity when heating water with SHW, the daily savings of 1.53 kWh/day/person needs to be translated from AC to DC as solar panels are rated at DC. Loss of converting electricity from DC to AC runs at about 19%. Thus, the kWh needed would be 19% higher in a PV system, which takes the needed generation from 1.53 kWh/day/person to 1.88 kWh/day/person. Next, this analysis assumes 5.2 sun hours per day as a statewide average solar resource. This number may be more or less, depending upon the location. At 5.2 sun hours/day, the required PV array DC to generate the same amount of electricity as the SHW would be sized at 362 watts/person. At $5.50 watt installed, the system cost would be approximately $1,992/person.

3. How do the costs of the two systems compare?

In order to determine how the costs compare between the two systems, both the installed cost of the system and any tax credits or rebates must be considered. For a SHW system, the average installed cost for an 80 gallon system is $6,357 and for a 120 gallon system is $7,106, minus the HEP rebate, and the state and federal tax credits currently in place in 2012. The combined weighted average system cost is $6,625. The cost for a PV array increases with family size, minus current state and federal tax credits. For a household of one to two persons, the cost of a PV system to heat water is less than the average cost of SHW of an 80 gallon system. For households of three persons, or more, SHW is more cost effective than PV for heating water.

Other Considerations and Assumptions

1. Assumptions

The KEMA hot water averages were determined using data from monitored systems located in a wide range of sunshine zones. The results will change for installations in zones that are different from the average. In addition, when PV is used to heat water, the heat loss due to the efficiency of the water heater has not been considered here. This heat loss would decrease PV's overall cost efficiency when compared to SHW.

2. Economies of scale

The fiscal advantage of SHW over PV diminishes with reduced water use. For instance, using the analysis shown above, the overall net cost difference between SHW and PV is $1,959 for a family of six, while the overall cost difference of SHW over PV to heat water for a family of four is $827. Keep in mind that these figures are averages, and will vary depending upon system efficiency and water use.

3. Efficiency depends upon consistent use

The cost efficiency of SHW depends upon how the water is used. For instance, in the preceding example for a family of six, the assumption is that the family has roughly the same water use every day. In the case of a vacation rental, however, SHW would not have the same advantage if the water is only heated a few times a month, or if the system had to be sized to accommodate a large group for a short period of time.

4. SHW does not impact circuit penetration levels

SHW systems do not produce electricity, and are therefore not connected to the residence's electrical system. Thus, a SHW system would never add to local circuit penetration levels. On the other hand, a PV system engineered to provide electricity to heat hot water may impact circuit penetration levels. Whether the PV impacted circuit penetration levels would depend upon the size, engineering of the system, and the total capacity of all distributed generation technologies on the circuit.

5. SHW heats water that can be used later during peak load hours

SHW heats and stores water effectively so that it may be used during the evening utility peak load which occurs after sundown in Hawaii. To date about 30MW of generating capacity required by HECO to meet peak demand has been deferred by SHW systems installed on Oahu alone. PV systems do not provide electricity to heat water after sundown unless the system has battery backup. Water heated by PV and stored in the water heater may have peak load use, depending upon the size and efficiency of the water heater and the household water use.

6. Maintenance costs

Maintenance costs for PV are somewhat lower than maintenance costs for SHW. However, should a home owner need to re-roof or perform roof repairs, removal and reinstallation costs for PV are much higher than they are for SHW.

7. Roofspace

Available roof space can also be an important consideration when deciding between PV and SHW. In a lot of cases, the south facing roof area is at a premium and can be best utilized using SHW first, and then PV. In addition, hot water collectors can be side tilted on west or east facing roof, leaving more prime south roof space for flush mounting PV panels.

8. Product Warranties

Product warranties for PV and SHW are roughly the same. Warranties for PV modules range from 10-25 years (inverters from 10-25 years) where warranties for SHW solar tanks range from 6-12 years and 10-12 years for solar collectors.