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How Are Solar Water Heaters Used In New Zealand?

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The use of Solar Water Heating (SWH) in New Zealand has been limited. There is little information on how well residential SWH systems are performing in actual households in New Zealand. This paper reviews why this information is important and then examines some current data sources available.

Keywords: solar water heating, residential energy use, renewable energy

1. INTRODUCTION

The SWH industry in New Zealand has been small but has recently been undergoing a strong growth phase. Historically there hasn't been much in the way of data recorded on the number of SWH units installed (for early data see; Isaacs, et al. 1981). The 1996 census contained a question asking about the methods used to heat water in the dwelling, which indicated that in 1996, 10,300 dwellings used solar energy as a source for their water heating (Pollard 2003). Work undertaken for EECA (EECA 2001) estimated that based on sales in 2001 and expected lifetimes, that there were approximately 16,000 SWH units in operation in 2001.

The Solar Industries Association (SIA) now collects good statistics on the number of SWH units installed by its member organisations and it has been reported (East Harbour Management Services, 2005) that 2,400 new systems were installed in New Zealand in 2004. This has taken the total number of assessed systems installed to 25,200. There are also a number of unknown units not recorded in the SIA statistics, which were manufactured or distributed by companies that are not members of SIA (including one-off constructed units).

It is encouraging that the Energy Data File (MED 2005) now quantifies the contribution that solar energy makes to New Zealand's renewable energy production, indicating that provisionally 0.2 PJ of energy was sourced directly from the sun in 2004. This figure includes other solar contributions such as photovoltaic systems.

2. BARRIERS TO THE UPTAKE OF SOLAR WATER HEATING

It is constructive to briefly review the barriers to SWH to identify where additional information can be helpful.

While much has changed over the last 24 years, the barriers identified by Isaacs, et. al (1981) largely remain today. The report *Solar Energy Use and Potential in New Zealand* (EECA 2001) highlighted a number of issues confronting the SWH industry in New Zealand, in particular cost, technical and market organisational issues. The report goes on further to state that the technology has matured and the technical barriers for SWH have largely been resolved.

The nature of the cost barrier is that the lower long-term running costs of SWH systems are offset by an increased purchase price for the system. While the marginal running cost savings are sizeable, the increased cost of an SWH system over a simple water heater is also significantly higher. This means that the energy savings have to be realised over a number of years before they account for the difference in purchase price between an SWH system and a simple water heater. It is possible to undertake a number of financing arrangements to reduce this ‘upfront cost’ barrier. Currently EECA is running the EECA Financial Assistance Programme which provides funding ($300) for the purchase of an approved system from an SIA accredited member, however economic analysis of the costs associated with SWH is limited by the lack of accurate information on the real world running costs of SWH.

There are a number of players who influence the water heating market ranging from the general public, the construction industry (architects, designers, builders, plumbers, manufacturers), the energy industry and even to the real estate industry (does having SWH installed at a property increase its market value?).

The low uptake rate of SWH in the water heating market limits the acceptance of SWH amongst many of the market participants. Greater acceptance of SWH would occur if the positive benefits of SWH were more widely known within this broad market. It is increasingly recognised that many of these positive benefits relate to non-energy (or non-financial) benefits (Zhao 2005).

There is also an educational role to be undertaken to reduce the barriers associated with SWH systems. SIA and EECA (2004) have put together a code of practice for the manufacture and installation of SWH systems. SIA has been working towards greater education for installers (see for example SIA 2005) including the support of the development of a training course at the Waikato Institute of Technology (WINTEC).

Ultimately an SWH system will be judged by homeowners’ experiences with the systems. Robinson (2005) states that there is a lot of overselling of the merits of particular SWH systems, and that some of these could not achieve this level of performance in the real world.

3. INFORMATION ON SOLAR WATER HEATING

Currently there is very little information on how well SWH systems perform in actual applications in New Zealand. Overcoming the barriers to a greater uptake of SWH, highlighted in the previous section, would be assisted by increasing the amount of information available about SWH. This section will review some of the information sources on how well SWH systems work in New Zealand.

The performance of a particular SWH system, like any hot water system, can be regarded as being determined by two underlying processes; one is the physics/engineering of the system to deliver the required hot water demand, and the other is examining the hot water demand via sociological/anthropological factors (Pollard, et al. 2001).

The availability of solar radiation into a SWH system is not consistent and is subject to climatic variation. Approximately 1400–1500 kWh/m^2 (EECA 2001) is available annually on a horizontal surface for a number of major sites around New Zealand. In addition to the possible measurement of solar radiation at the site of interest, there is also a network of metrological stations for which solar radiation information is recorded which may provide a location that is suitably comparable (Penney 2003). In addition to the localised climate issues are more site-specific issues such as shading.

Standardised testing of SWH can provide information on the physical properties of particular models of SWH systems. Together with specific installation information – what tilt angle the collectors are installed at, what direction the collectors face, the degree of the insulation on the pipework etc – this can provide enough information to model the performance of the hot water system given the amount of solar radiation and the hot water demand (draw-off patterns).

The standardised test methods for SWH (for example AS/NZS 2535.1:1999) use only basic draw-off patterns which do not match how hot water is really used in New Zealand houses. Measurement programmes such as the Household Energy End-use Project (HEEP) (Isaacs et al 2005) provide invaluable information on these patterns.

In 1996, BRANZ commenced measurements in households as part of the HEEP project. The objectives of HEEP are to understand the nature of energy consumption in the residential sector. Within the home, energy is consumed via a variety of energy sources (electricity, gas, solid fuel, solar etc), using a number of specific appliances (heaters, water cylinders etc) to deliver the energy services (warm homes, litres of hot water etc) desired.

Within the 397 randomly selected houses that form the primary HEEP sampling frame, only six households used solar energy as a means of heating their hot water. These systems varied from 25-year-old homemade units to brand new units.

As HEEP had to undertake measurements in a large number of houses at any one time, the experimental set-up for monitoring SWH systems was fairly basic. In addition to the energy monitoring of the supplemental heating for the hot water cylinder, thermocouples were attached to the water pipes leading into and out of the cylinder. This experimental set-up allowed for estimates to be made of the heat gain of the hot water within the cylinder which were due to solar radiation, supplemental heating or sometimes a wetback connection.

Figure 1 shows an average daily profile of the supplemental heating for one of the SWH systems.

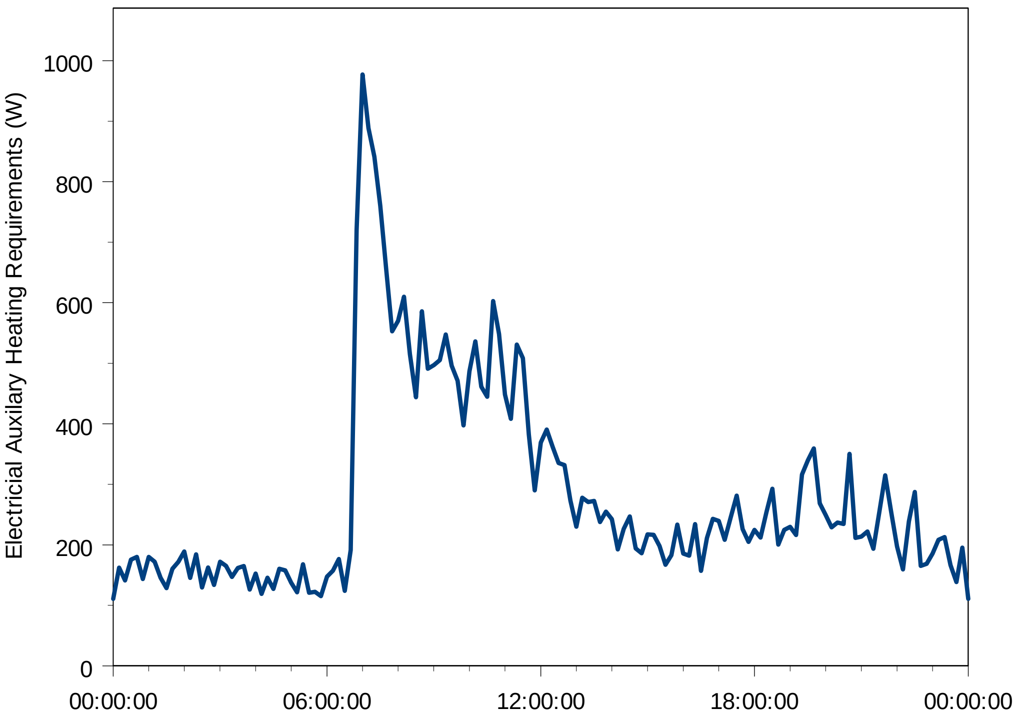

Figure 1. The daily electrical supplemental heating from one of the SWH monitored houses.

This profile reveals some interesting characteristics about the use of hot water in this household. The fairly flat profile (~125 W) from 3 am to 7 am is indicative of a cylinder maintaining a set-point temperature using occasional boosts of supplemental heating. As the auxiliary electric heating appears to be maintaining the cylinder temperature, no surplus heat from the previous day's solar radiation is available. The peak beginning at 7 am, and continuing until noon, indicates that there is regular morning usage of hot water and that supplementary heating is used to a high degree to reheat this water.

This raises some interesting points: given that the occupants' usage of hot water may not match when it can best be supplied by solar, how can the supplementary heating be controlled to maximise the fraction of the hot water energy that is supplied by solar? In the above example, should the supplementary heating be turned off in the morning so that the solar has an opportunity to heat the cooler water? Alternatively would the occupants be willing to modify their hot water usage patterns to better match the solar gains? Presently occupants receive little feedback about how well their hot water system is performing. More general advice on how to most efficiently use hot water systems is frequently anecdotal (Pollard 2005).

HEEP has a wealth of information (a nationally representative dataset) on how people use hot water (Isaacs, et al. 2005). It is feasible to process the hot water energy time series measurements to determine the demand for hot water (in terms of litres of water) as distinct from the energy used by the system such as the standing heat losses. This demand information could be used to model the impacts of a variety of technologies, including solar, on water heating use.

4. CONCLUSIONS

Currently there is little data on how people use SWH systems in New Zealand. The case highlighted in this paper expressed concern that the effectiveness of the SWH systems may be dependent on the demand for hot water within the household. Fortunately HEEP has collected extensive information on hot water energy use which will be of assistance.

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