Solar Water Heater – Case Study in India

The Big Picture

A number of factors have contributed to the large-scale use of solar water heating in India, especially in low temperature applications in the commercial sector. Hot water is a major requirement for hotels, restaurants and other food processing establishments in India. The continuing increases in the sector's electricity tariffs as well as problems associated with the electricity supply such as outages and voltage fluctuations have aided the market for solar hot water systems. Most parts of India receive high amount of solar radiation, which makes solar water heating an attractive and viable option. India's Ministry of Non-Conventional Energy Sources (MNES), operating through the Indian Renewable Energy Development Agency (IREDA) and other public sector organizations, provides soft loans to domestic and institutional solar hot water systems, which makes the investment more attractive. All these factors have contributed to the installation of over half a million square meters of collector area in the country.

There are two main technologies for solar water heating: Flatbed Plate Connector (FPC) and Evacuated Tube Connector (ETC). Trillenium believes ETC to be the better and more efficient technology, albeit ETC is relatively new to the market. FPC is an older technology however well recognized and also demonstrates the potential of solar water heating. Please refer to the case study provided for an illustration.

Case Study Assignment

A client in Tamil Nadu, India asked a vendor to assess the feasibility of installing a solar water heating (SWH) system for a new hotel. The hotel planned to have 60 rooms, 10 suites and a conference room.

Site Information

The hotel is being constructed in the city of Chennai, Tamil Nadu (Latitude 13°N, Longitude 80°E). The nearest weather station is at Madras/Minambakkam. The hotel will require 3,000 L of hot water per day at a temperature of 70ºC. The 8-storey building is expected to be in use 24 hours a day, 7 days a week, with an estimated occupancy rate of about 90%.

Based on previous project experience, the vendor proposed a locally manufactured thermo siphon SWH system with a rooftop-mounted water storage tank. Auxiliary water heating was provided via electric resistance elements in the rooftop tank. In the absence of a SWH system, the hotel would likely install conventional electric water heaters in the individual guestrooms.

The glazed SWH collectors used were manufactured by Tata BP Solar India (type TBPT 24M1) and have a "tau alpha" coefficient of 0.69 and a "Fr UL" coefficient of 4.20 (W/m²)/ºC. The collectors have an area of 2.31 m² each. 38 mm pipe diameter has been specified for the balance of system.

For the greenhouse gas analysis, the conventional generation fuel mix that the SWH project would displace was approximately as follows: 50% coal and 50% large hydro.

Major Assumptions

- This analysis only considers the hot water requirements of the guest rooms. The hotel's other water heating requirements (for restaurants, laundry, housekeeping, etc.) have been excluded to simplify the case study.
- The ratio of storage capacity to collector area was set to 93 L/m² so as to correspond to a storage capacity of approximately 3,000 L.
- An interest rate subsidy of 8% is available to the hotel. This reduces the effective interest rate to 5%, which is the rate used in this analysis.

- The depreciation tax basis is assumed to be the entire initial cost of the project less the cost of the feasibility study.
- It is estimated that the annual O&M cost of the central solar water heating (SWH) system is lower than the cost of maintaining individual electric water heaters in 70 guest rooms.
- It is estimated that for the base case, the individual electric water heaters would need to be replaced at a rate of 8 water heaters (at INR2,500) every 10 years. This constitutes a periodic credit of INR20,000 for the SWH system.

Financial information

The glazed SWH collectors cost INR5,400/m². The inflation rate is projected to be 2.5% over the 20-year life of the project. The discount rate can be taken as 12%. Concessional debt is available to cover up to 85% of the cost of the system at an interest rate of 5% for a period of 5 years. The current electricity tariff is INR4.10/kWh and is expected to increase by 3% annually. The cost of the SWH system can be depreciated in the first year in accordance with the tax laws favoring the use of renewable energy equipment. The corporate tax rate payable by the hotel is 35%.

Results

The Hotel Golden Tower in Chennai, Tamil Nadu, India, was completed in early 2002. It is located in the heart of the city close to the railway and bus terminuses and expects a high level of occupancy. The hotel has 70 guest rooms and requires hot water 24 hours a day, 7 days a week. A solar water heating (SWH) system was installed at the hotel and has enabled it to drastically reduce its potential electricity consumption.

The solar resource in Chennai is particularly strong. Average daily solar radiation on a collector surface tilted at an angle of 25° to the horizontal is 5 kWh/m² per day, equivalent to 1,800 kWh/m² per year. The system proved to be very satisfactory from environmental, aesthetic and technical points of view.

System description

The thermo siphon SWH system consists of 14 glazed flat plate solar collectors with a total area of 32.3 m². The collectors are installed on a flat roof and connected to a hot water tank with 3,000 L capacity. Auxiliary water heating is

provided via electric resistance heaters. Since the utility water supply is not continuous, a cold-water tank is located above the hot water storage tank.

Lessons learned

- Solar water heating can be very attractive financially when compared to electric resistance water heaters in areas where the cost of electricity is high.
- In areas with frequent electric outages, a SWH system can enhance the reliability of the overall water heating system. This is particularly relevant in an application such as a hotel, where the availability of hot water is highly valued.
- The piping design is critical in thermo siphon systems to avoid reverse-siphoning, air locks, slow circulation and corrosion problems.
- Where SWH systems replace or augment electric water heaters, they can serve as a good demand side management and load shaving option for electric utilities.