Solar Hot Water Heater Teacher Notes

Recommended year level: 9 – 10 (7 – 12 including options)

Time taken: 90 minutes

Subject: Physics, Environment

Intro:

- This project uses an array of sensors to monitor the water temperature inside a functioning solar hot-water heater.

Learning Outcomes:

- Students will understand how a solar hot water system works, and how such a system can be monitored for the existence of Legionella bacteria.
- These outcomes will be achieved through a remote experiment which monitors the temperature of the water inside a solar water heater located in Melbourne, Australia.

Experiment Summary:

- Students will remotely access temperature data from a solar water heater located in Melbourne, Australia.
- Students use an online plotting tool to visualise the temperature recorded at 18 points inside the storage tank. This temperature data will determine whether or not the water may contain dangerous levels of Legionella bacteria.

Expected Results:

- The water temperature reaches a maximum in the early afternoon and a minimum overnight.
- Water near the top of the storage tank is warmer than water near the bottom of the tank.
- For a given height within the tank, water on the left and right sides of the tank may be at different temperatures. The coldest part of the tank is usually near sensor T1 or sensor T13.
- During the summer the water temperature is usually high enough to kill the Legionella bacteria. During the winter, however, it is likely that Legionella bacteria will be able to survive inside the tank.

Detailed Explanation:

- Cold water is more dense than hot water. Therefore cold water is less buoyant and tends to sink to the bottom of the tank.
- The difference in density between cold water and hot water allows water to flow between the storage tank and the collector without the need for a mechanical pump. Cold water falls through the outlet at the bottom left of the storage tank and into the collector. At the other end of the collector, heated water rises upwards and re-enters the storage tank through the inlet located on the top right of the tank. This process is called *thermo-syphoning*.
- The solar water heater used in this experiment was designed specifically for use in the hot, dry climate of outback Australia. In such a climate it is expected that the temperature will be high enough to kill Legionella bacteria most of the time.

Technical notes on the experiment:

- The temperature data are recorded approximately every 5 seconds. Since this is a lot of data, the plot will only display a maximum of 1000 data points (the time resolution is adjusted automatically). Downloaded data are at full time resolution.
- Sometimes the temperature sensors fail. This may lead to gaps in the data, or nonsensical temperature values. The temperature sensors do not perform well at temperatures below about 30°C.
- The minimum exposure periods to inhibit the growth of the Legionella bacterium are defined in Australian Standard AS 3498, *Authorization requirements for plumbing products---Water heaters and hot-water storage tanks*. There are several other conditions in the standard related to the temperature, which have not been explored in this experiment. Only one of the conditions needs to be satisfied for the water to be considered safe.