**Memo**

To: Professor Pisano, Professor Kotiuga, Professor Osama, Professor Hirsch

From: Hal Levin, Moises Bensadon, Stanley Nguyen

Team: 21 - Efficient hybrid solar panels for hot water.

Date: 11/20/22

Subject: First Prototype Test Report

**Equipment**

**Set-Up**

The set-up of our test was consistent with the set-up section from our test plan which can be seen below.

The plastic tank is filled with water. There is a pump inside the tank that is connected to one end of plastic tubing, which exits the tank through a hole in the lid. The plastic tubing was chosen so we could focus on the ECE components for the first prototype, yet in the near future, we will use a harder material to work with such as copper for the tubing that would transfer heat much better. This tubing is then adhered to the back of a photovoltaic cell, coiled in a flat spiral against the back. There is an insulative backing holding the flat spiral securely against the panel, which minimizes the environment's impact on the temperature of the solar panel. The solar panel with the piping and backing on it is supported by a wood frame. This wood frame holds the panel horizontally (facing the sky) and the water tank fits underneath the frame. The frame rests on a corner of the wood, allowing for future modifications that may include using stepper motors to adjust the angle of the solar panel wood structure to aim the solar panel towards the sun throughout the day. When the pump turns on, water is pumped through the tube on the back of the panel, then it goes through the end of the piping into another hole in the lid of the water tank.

An Arduino is connected to a thermistor, a voltage divider, and to the power supply of the water pump. The Arduino reads the temperature of the surface of the solar panel using the thermistor. When it measures above a chosen temperature at the time of testing, the Arduino sends power to the pump, which allows it to pump ice water underneath the panel, cooling it. Once the temperature is sensed by the thermistor/Arduino to be below this temperature threshold, the Arduino stops supplying power to the pump, thereby stopping the flow of ice water to cool the solar panel. The Arduino is also connected to a voltage divider which is connected to the 12V battery that the solar panel supplies power to. This allows us to monitor the voltage of the battery over time, to see how much power the solar panel is supplying.

**Testing**

Once the prototype was powered and we could read the output of the Arduino, we chose the threshold temperature to be 20 degrees C based on the room temperature of the lab. We started off by cooling the thermistor so as to ensure that our test began with the pump in the off state . We then placed the thermistor against the solar panel and allowed it to rise to room temperature, causing the pump to turn on, beginning the flow of ice water. Then after being cooled by the water, the thermistor reached a temperature below the threshold, turning the pump off. In effect, this simulated what would happen in warmer climates where the temperature is higher than the ideal operating temperature of the solar panel. We are able to save and model the data we received from the Arduino during this prototype testing. This data consisted of the temperature determined by the thermistor, the voltage of the battery, and the time it took for the testing. Using the temperature vs time data, we can determine which method of cooling is the quickest, and in the future, which method of cooling is the most efficient. These methods of cooling include different tubing materials, and different configurations of the tubing on the back of the solar panel. We can use the voltage vs time data along with temperature data to eventually determine an ideal operating temperature for our specific solar panel. We also plan on adding current measuring capabilities in the near future for further data collection as well as possibly adding additional temperature sensors to account for discrepancies in the distribution of the tubing.