

Research **AND** Development of a Polycarbonate Solar Water Heater

University of Wisconsin
Eau Claire

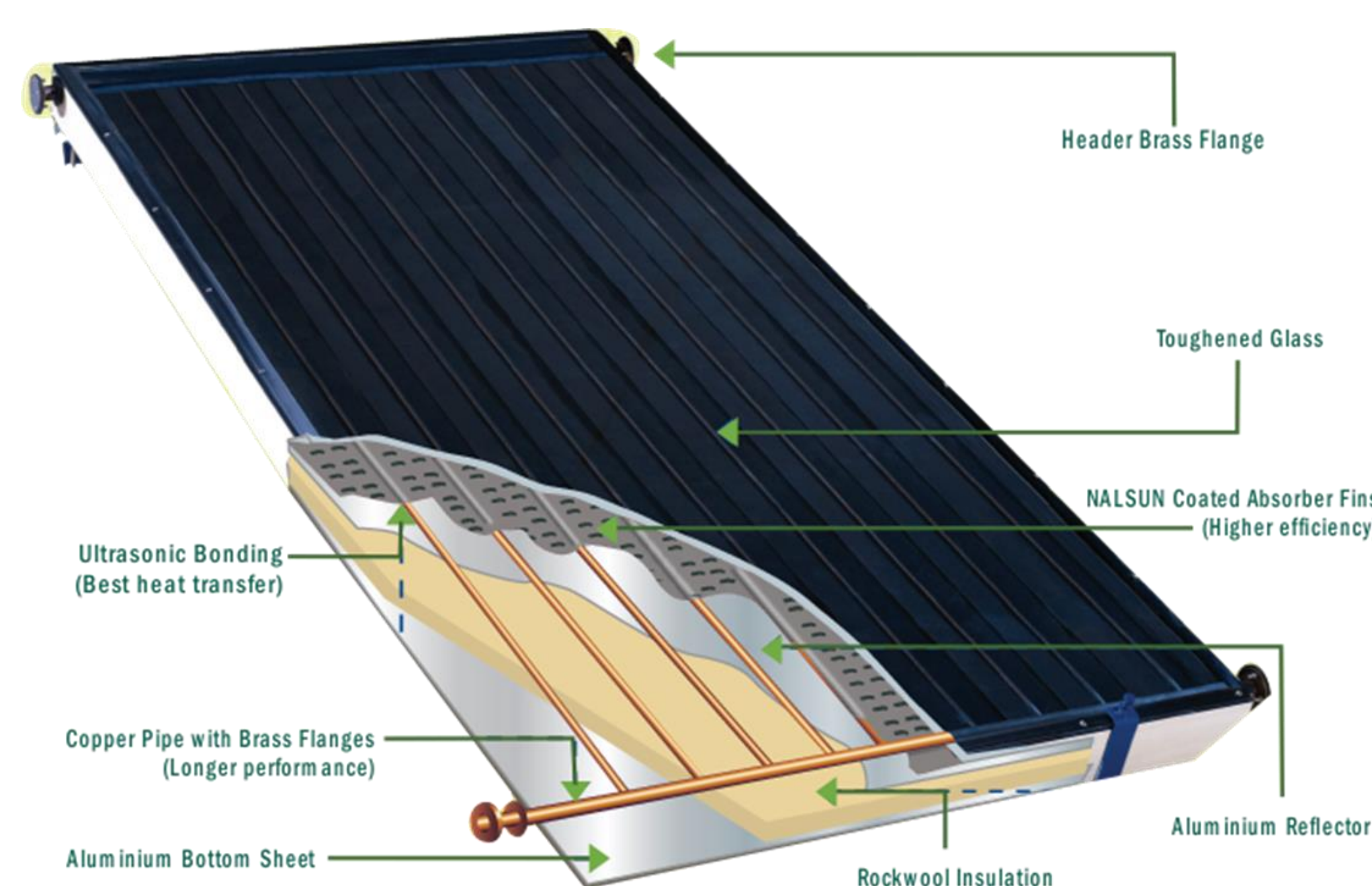
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Purpose

Solar power is growing rapidly as a global source of renewable energy. However, commercial solar panels are still quite expensive. The goal of this project was to design an efficient, inexpensive, and durable solar panel. These panels would reduce the installation costs for homeowners due to low-cost materials, leading to more systems being installed. By making renewable energies more economically viable to the average consumer, reliance on non-renewable energy sources will be reduced.

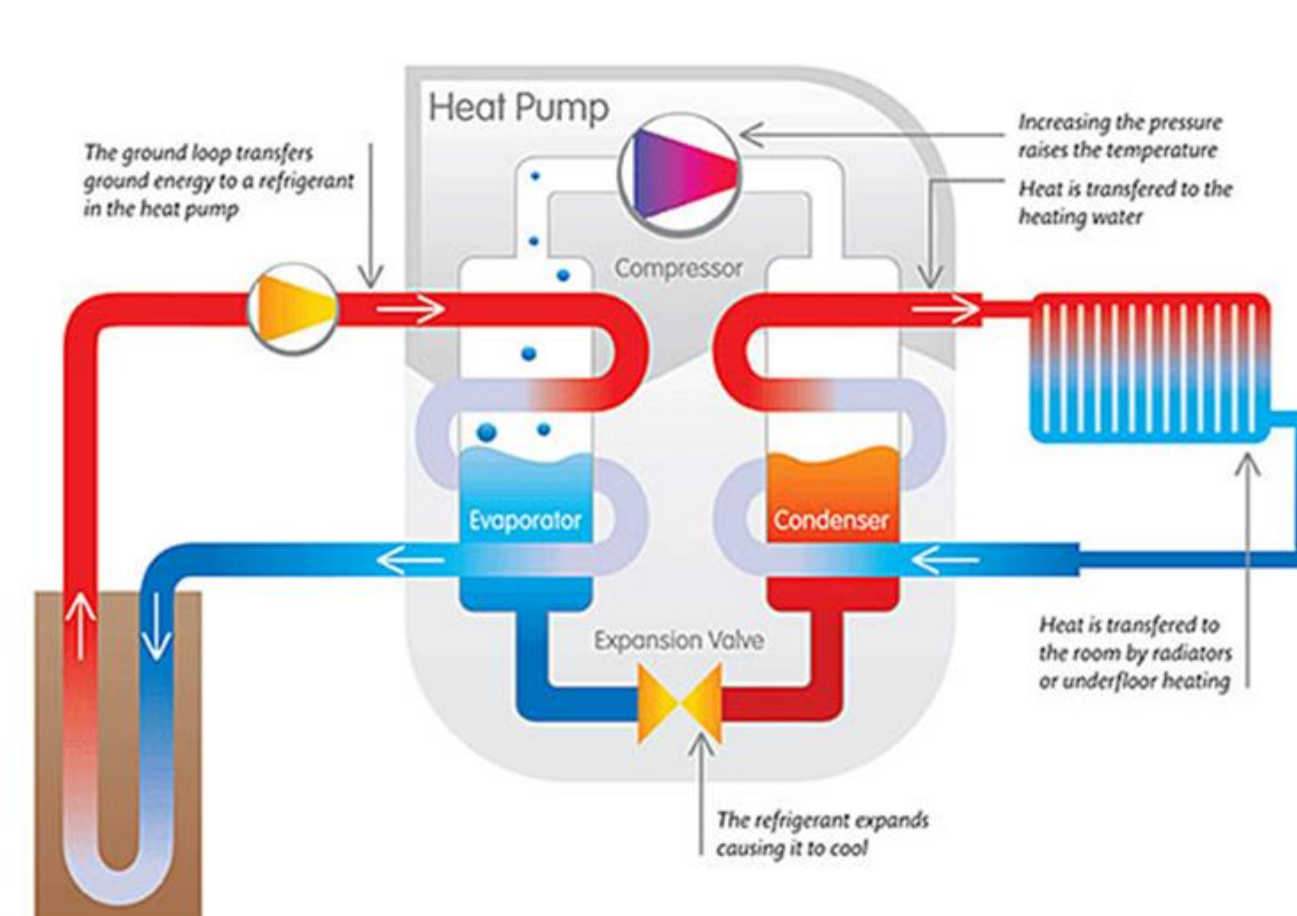
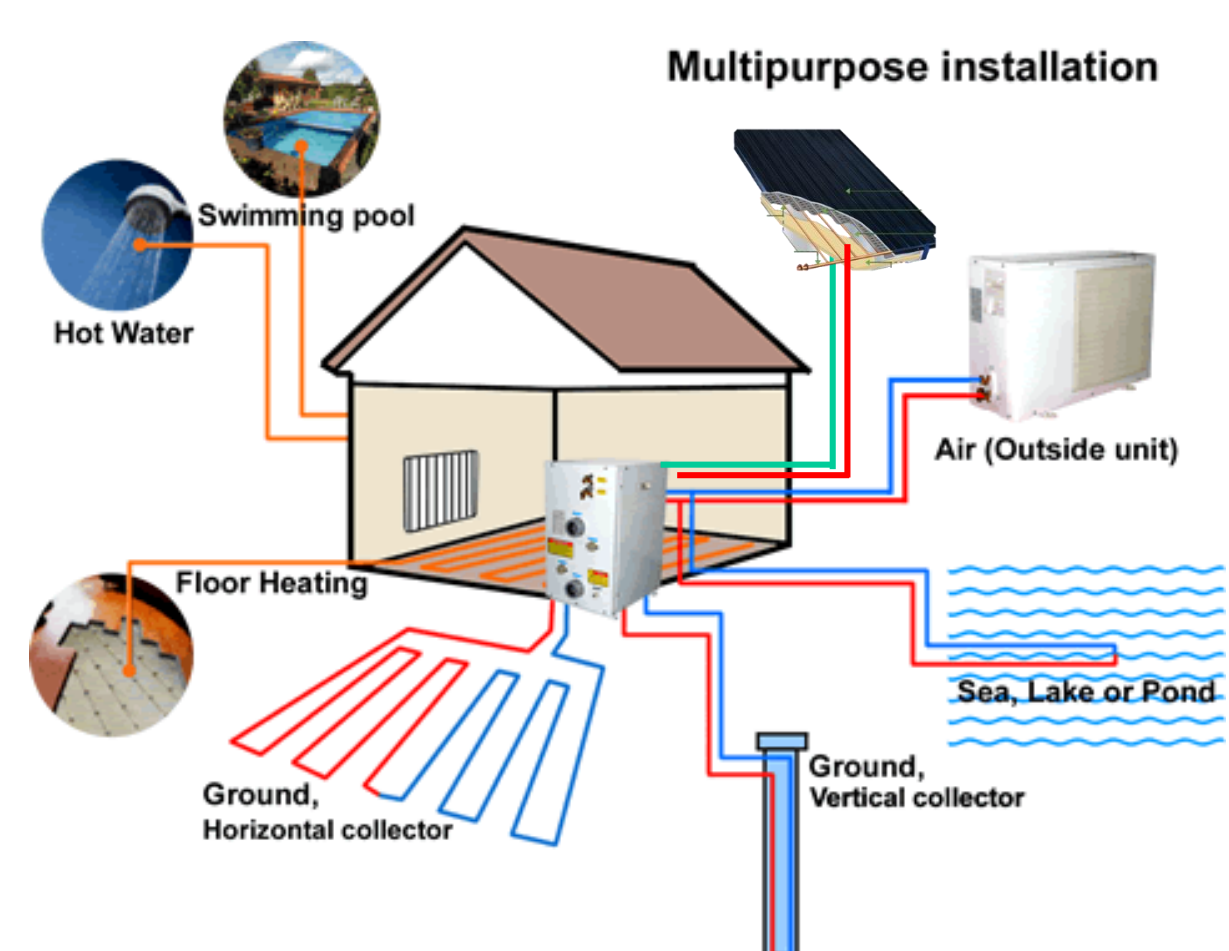
Solar Water Heater Systems

Current commercial designs use copper fins to absorb and transfer heat energy to water within the panel. The heat energy travels along the fin to a pipe which contains water which gets heated. The polycarbonate design utilizes a polycarbonate honeycomb panel. Sunlight hits this panel and transfers energy to the panel which then transfers energy to the water that is flowing through the panel.



Coupling with Heat Pump

The following figures show how a polycarbonate solar water heater could be incorporated into a heat pump system. Heat pump systems gather thermal energy (heat) from the air or by pumping cold water into the ground to absorb heat. Instead for our system, cold water flows out of the heat pump and into the solar water heater. The water moves through the panel and absorbs the Sun's energy and warms up. Our system was specifically designed to produce a large volume of warm water that is sent back into the heat pump and turned into a smaller volume of hot water. This hot water is then used directly or used with a radiant heating system to heat homes. The water is then sent back to the solar water heater to repeat the process.



Testing the Solar Water Heater



Motivation & Efficiency Calculations

The motivation for this project came from the theoretical efficiency calculations comparing current commercial copper fin solar water heaters to polycarbonate solar water heaters. The theoretical calculations show that the polycarbonate solar water heater design is over three times more efficient than the copper fin design being used today. Despite having a much lower thermal conductivity, the shorter distance that the heat has to transfer causes the polycarbonate design to be more efficient. This led us to design and construct a prototype that we could test.

Copper Fin

$$K_{copper} = 400 \frac{W}{m \cdot C} \quad L_{copper} = 0.038m \quad A = 0.01951m^2$$

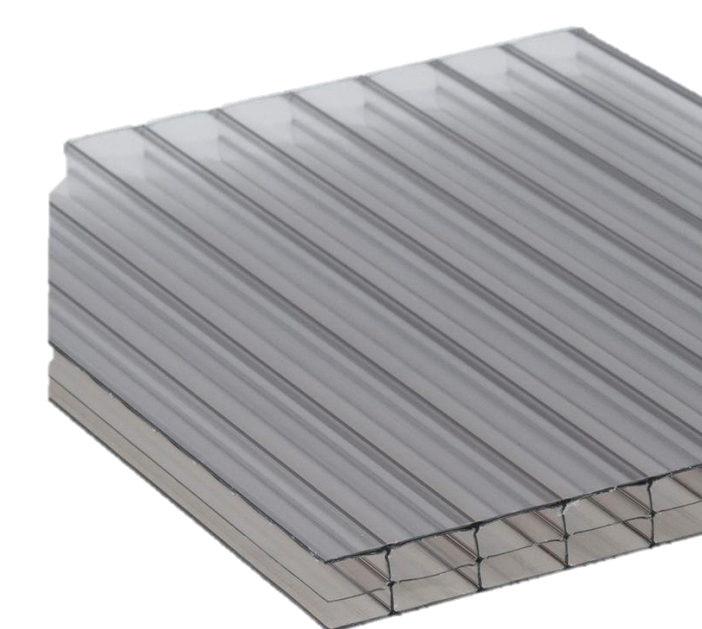
$$\frac{Q}{\Delta T} = \frac{KA}{L} = \frac{(400 \frac{W}{m \cdot C})(0.01951m^2)}{(0.038m)} = 205 W/^{\circ}C$$



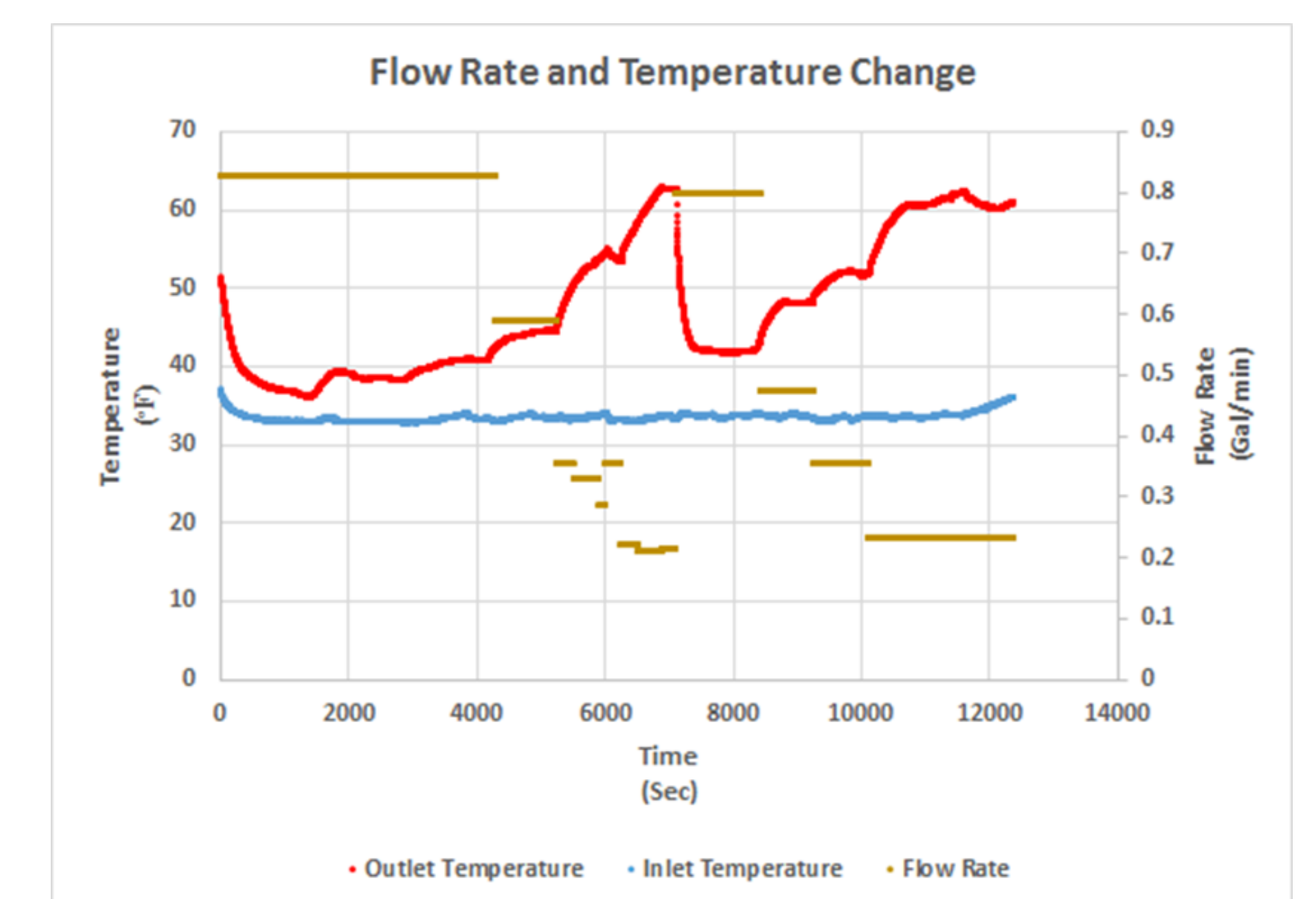
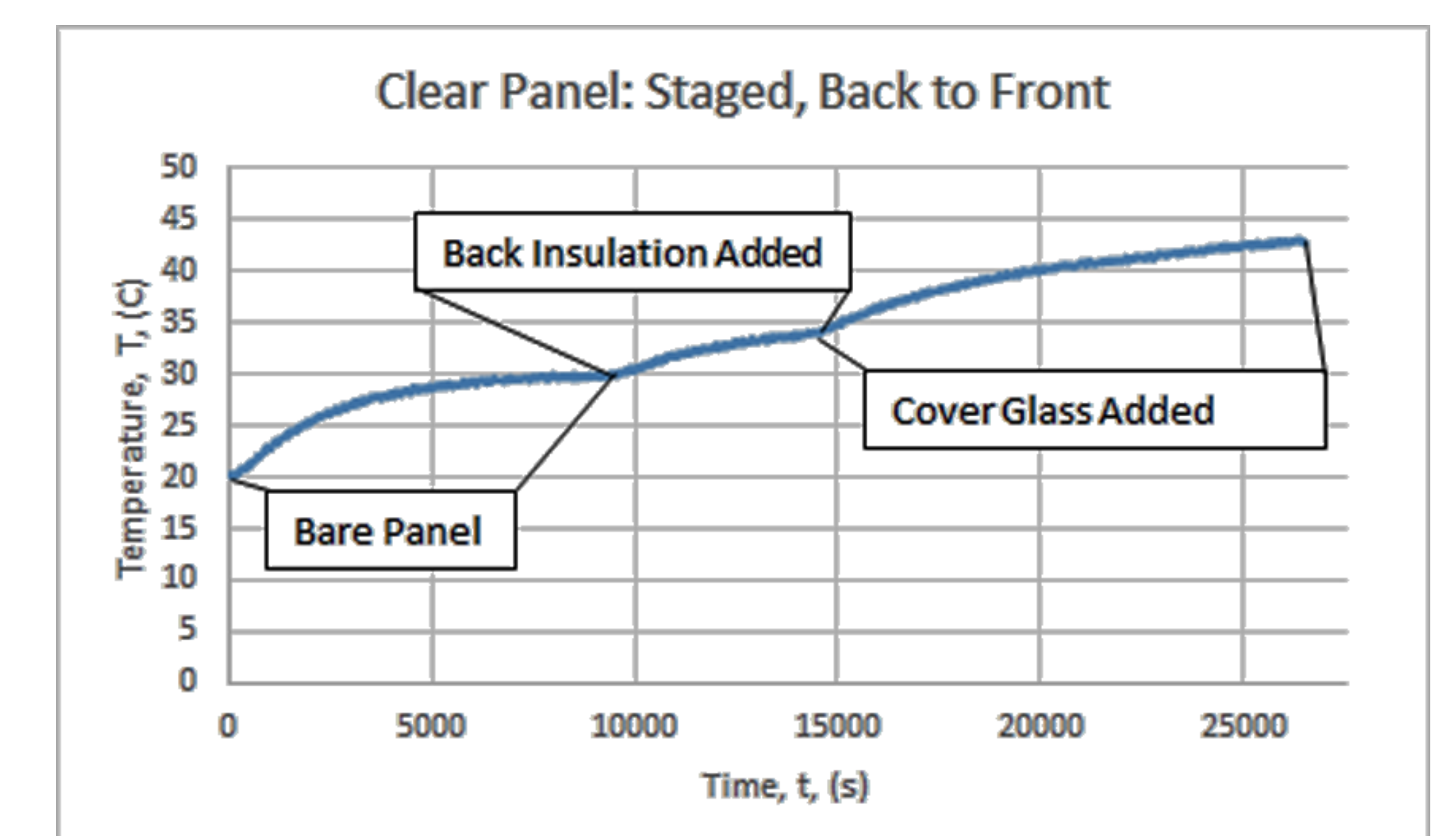
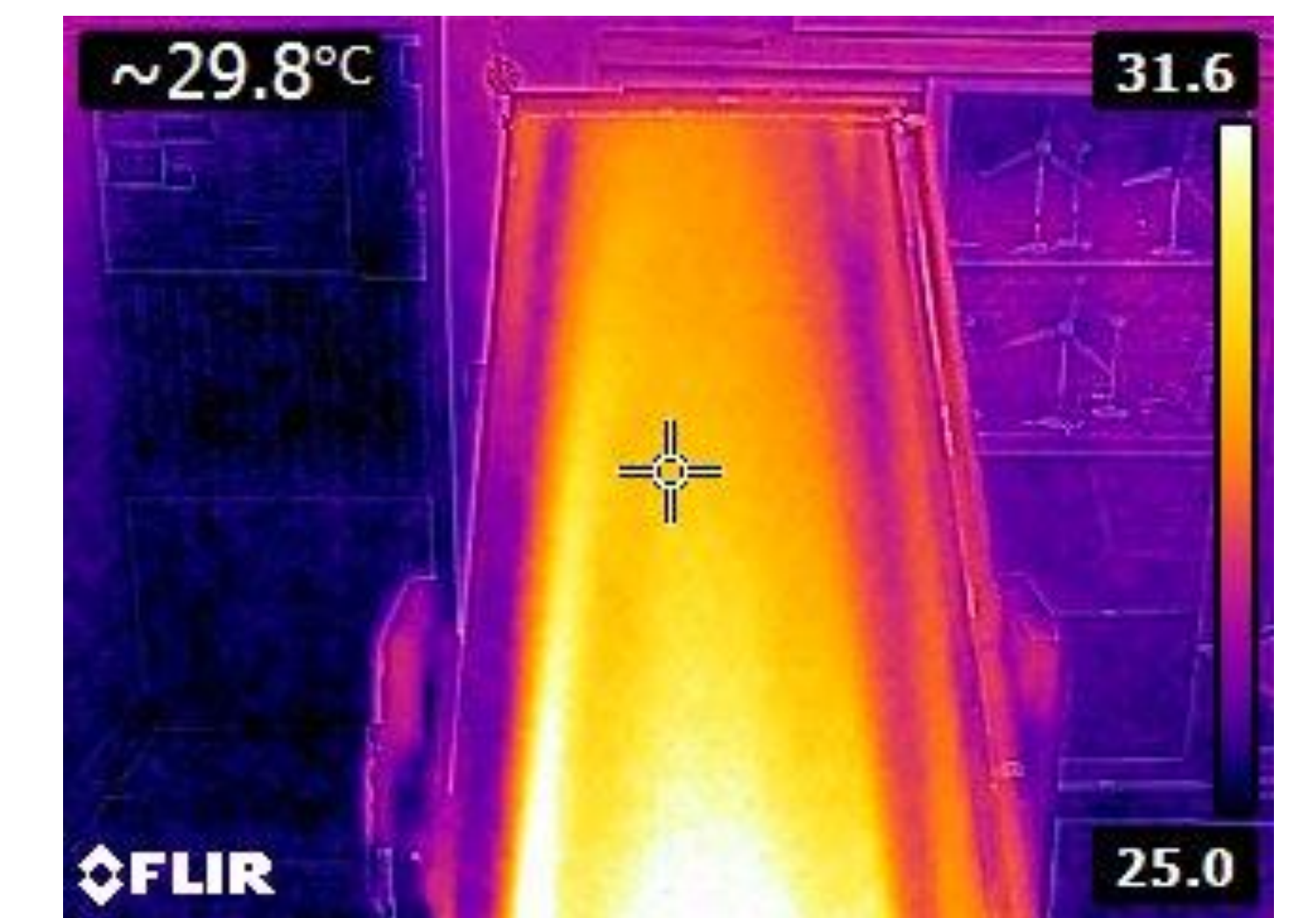
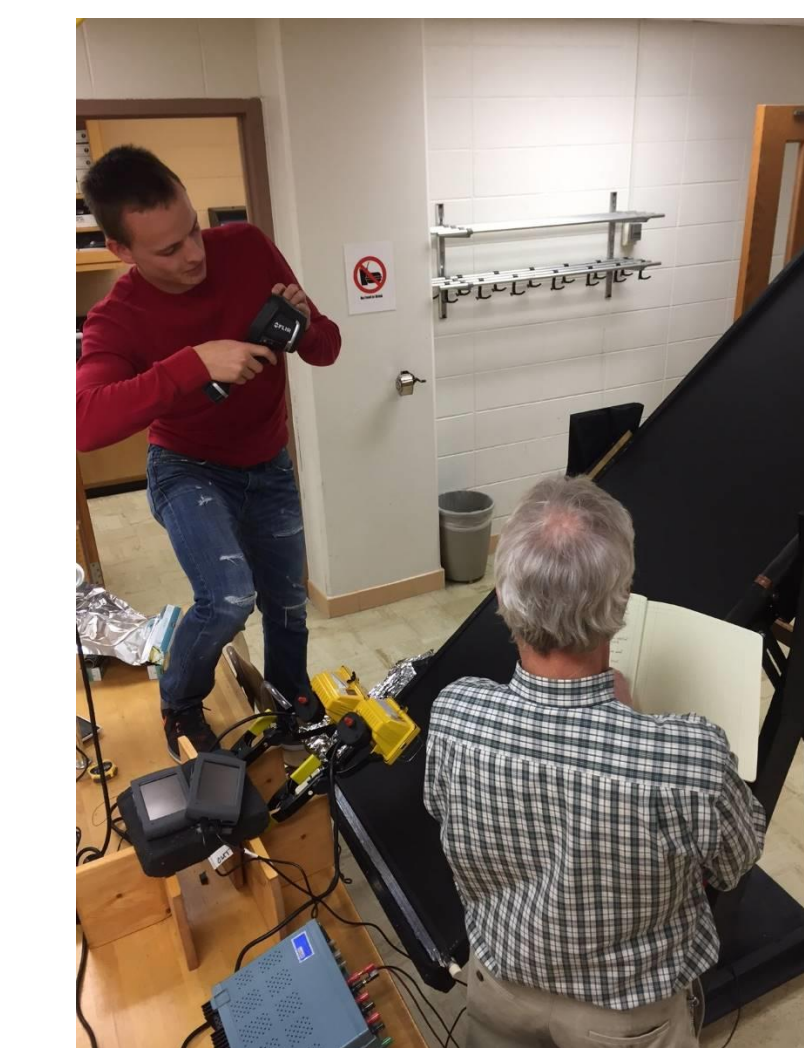
Polycarbonate Sheet

$$K_{poly} = 0.22 \frac{W}{m \cdot C} \quad L_{poly} = 0.0005m \quad A = 1.49m^2$$

$$\frac{Q}{\Delta T} = \frac{KA}{L} = \frac{(0.22 \frac{W}{m \cdot C})(1.49m^2)}{(0.0005m)} = 656 W/^{\circ}C$$



Results



Continuation of Research

The next step for this research is to make a computer simulation of the model to determine what theoretical effects different design changes may have on the efficiency of the system. This will serve as a scientific and a financial model to determine what changes will increase the efficiency the most with respect to keeping the cost low. Next, we will seek funding to develop a new prototype. These enhancements will then be made and tested experimentally to determine their actual efficiencies which will lead to new designs and further testing. The ultimate goal of this research project is to produce a low-cost, yet efficient renewable energy heating system available to consumers.