



BASS
CONNECTIONS

PVT Final Presentation

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Motivation

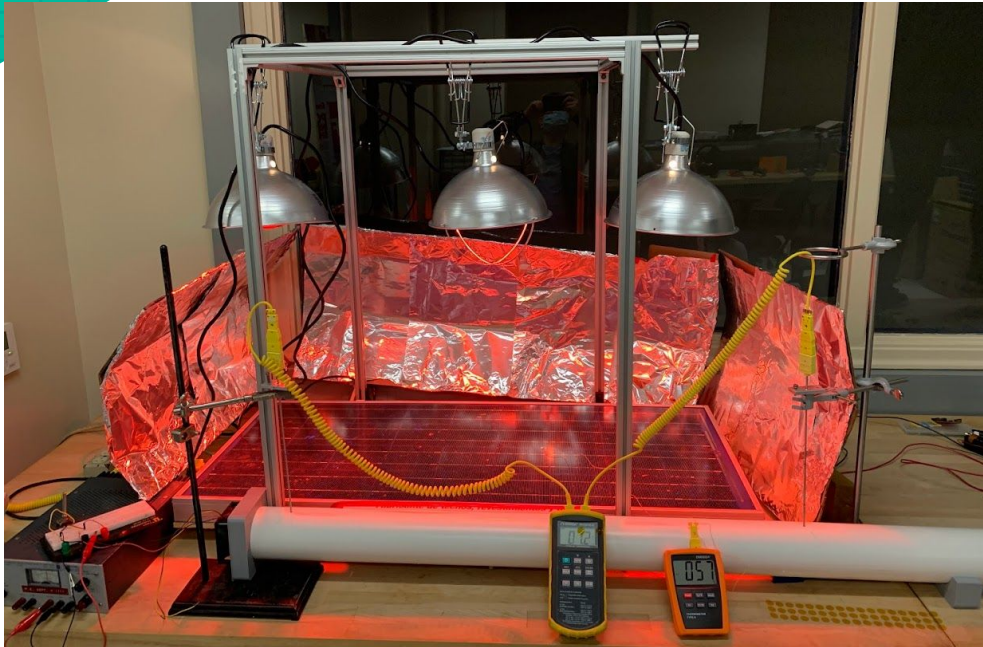
Capture thermal
energy

1. Test efficacy of Heat Pipes
2. Test different Heat Pipe configurations

Past Experiment Takeaways

- Smaller effective length = increase in heat pipe temperature
- More insulation along heat pipe = smaller temperature difference between ends of heat pipe
- Little difference in heat transfer between 0° and 45° orientation
- Smaller mass flow rate = larger temperature increase

Experiment #4: Integrated PVT Model



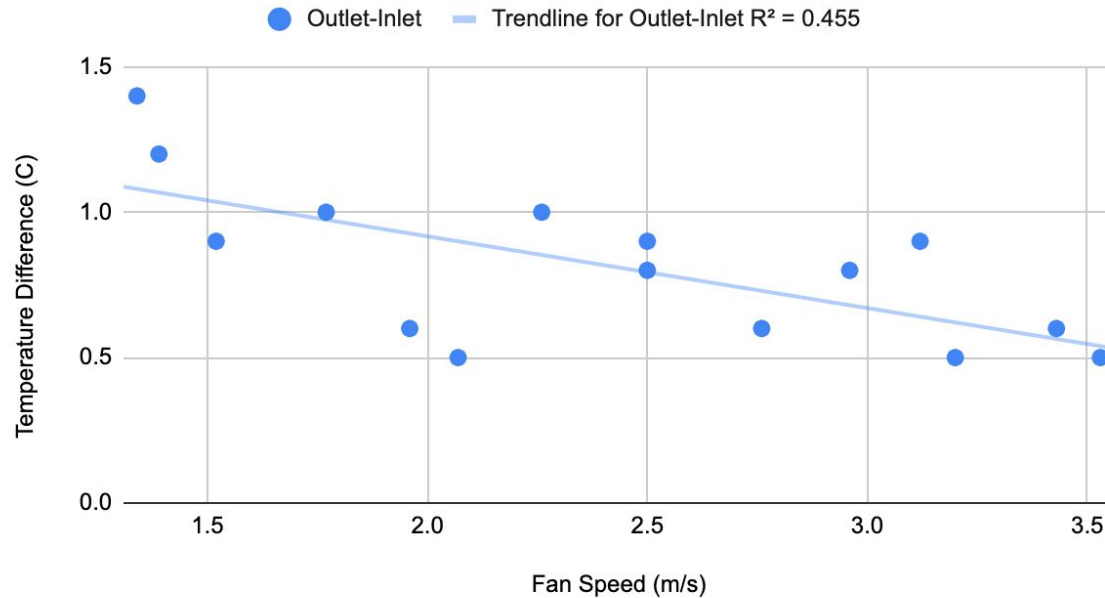
What: Heat solar cell with heat lamps. Measure temperature of heat pipe at both ends

Why: See how effectively the heat pipe operates while integrated with solar cell

Lessons Learned: Heat pipe got to 34 °C. Room for improvement.

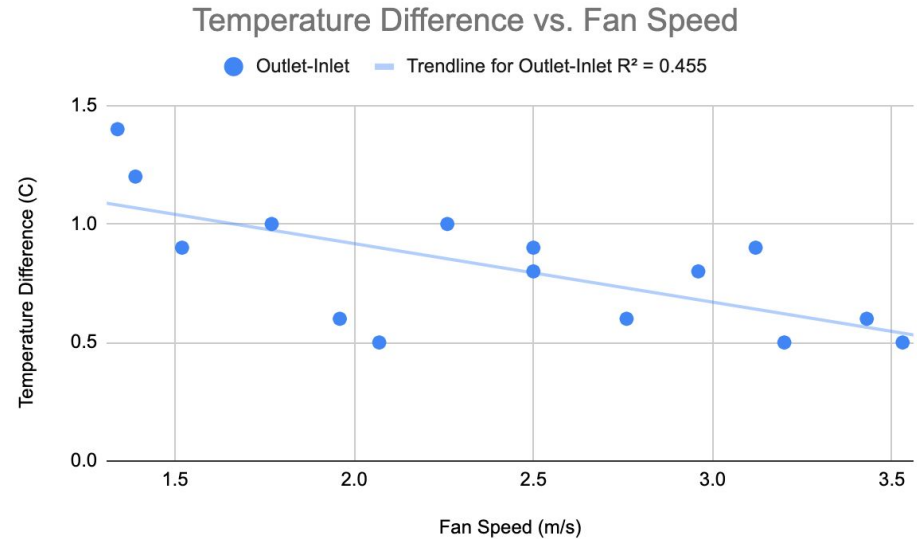
Experiment #4: Results

Temperature Difference vs. Fan Speed



Experiment #4: Conclusions

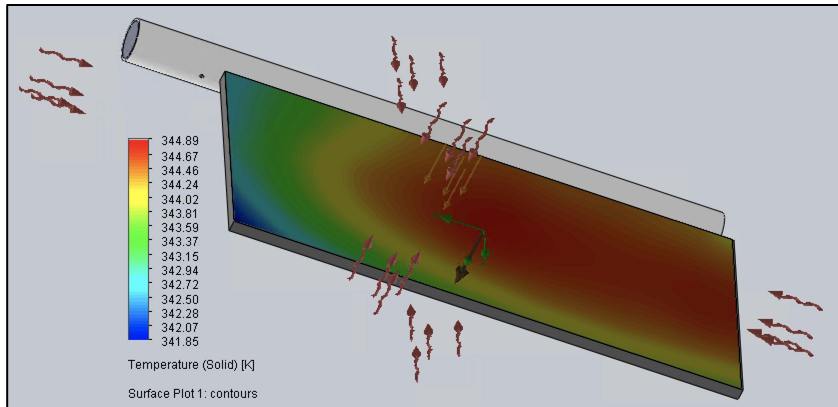
- Data was consistent with expectation of temperature increase
- Statistically inconclusive given potential error in thermal readings



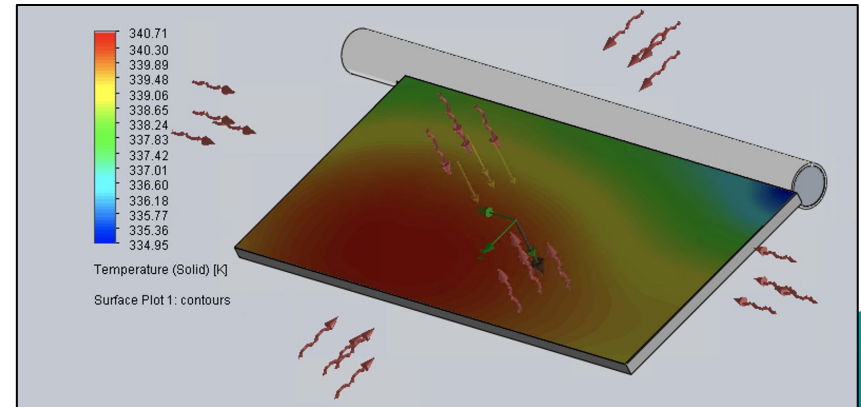
SolidWorks Simulation

Panel with Heat Pipes Extending to PVC

System with Natural Convection



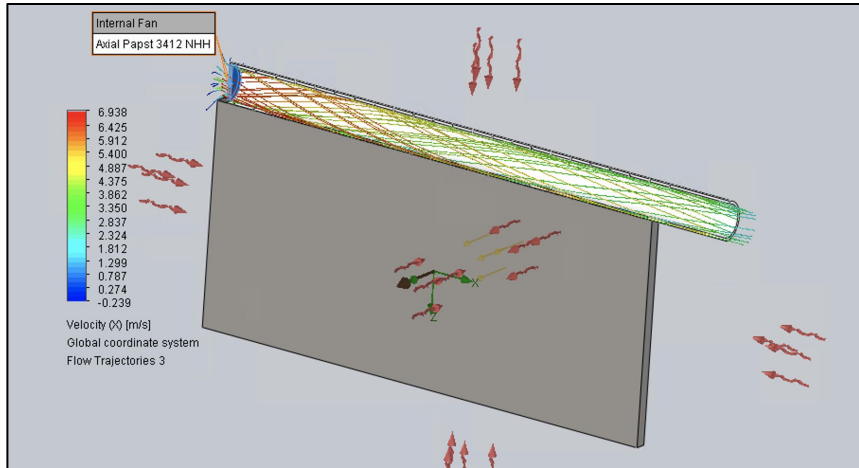
System with Fan Forced Convection



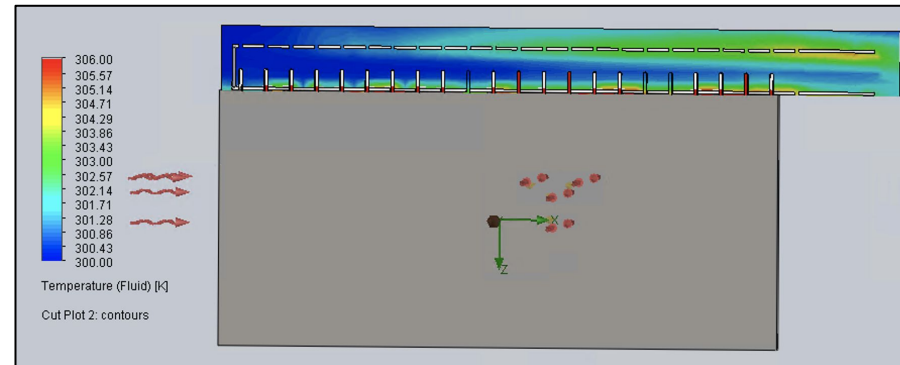
SolidWorks Simulation

Panel with Heat Pipes Extending to PVC

Fan Velocity of 7 m/s

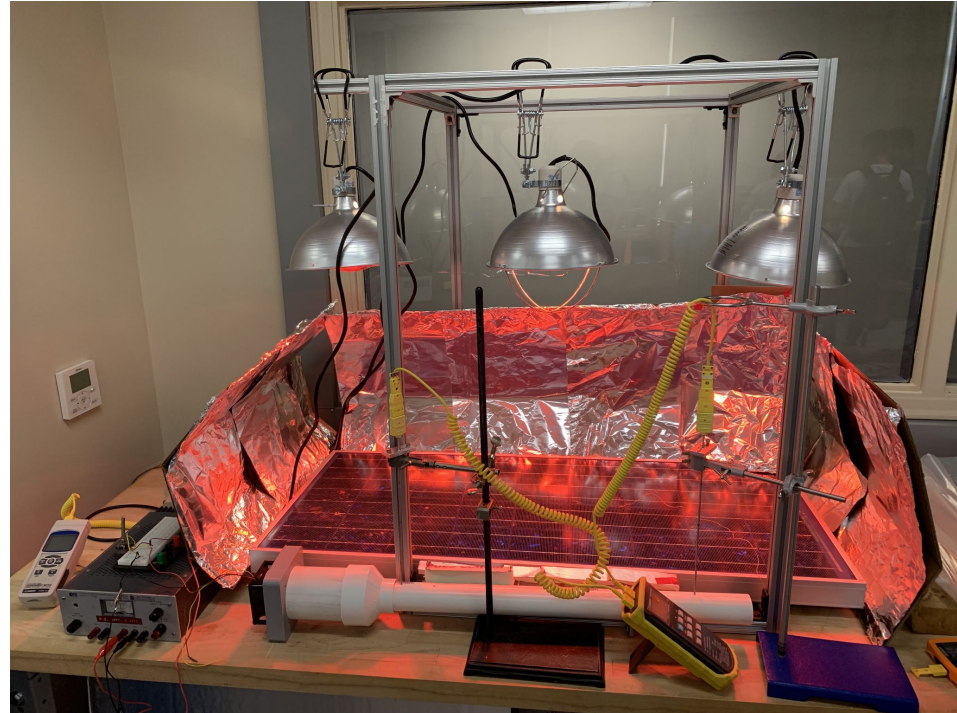


Air Heated 2-3°C



Final Design with Reduced PVC Pipe

- Minor improvements with air flow reduction, ~2 degree C
- Continued to suggest temperature increase trend



Bill of Materials

Item	Quantity	Price
500 mm long, 7 mm diameter Round Copper Heat Pipe	6	\$15.11
Fan	1	\$10.00
1.5" diameter, 3 ft long PVC Pipe	1	\$2.00
Foam board insulation	1	\$20.00
Total	--	\$47.11

NREL Case Study



PV vs. PV-T (NREL Study)

- PV-T can provide up to 10-26% of hot water capacity
- PV-T is 85% more expensive than a PV array
- PV-T has a payback period (in the US) between 19-98 years
- Cell efficiency increased by 15%, when compared to a normal PV array
- Total system costs of \$43,000
- Use Case:
 - Federal buildings must use solar thermal for 30% of hot water heating in new buildings and major renovations
 - High levels of insolation and a hot climate
 - High energy costs
 - Limited roof space (increases need for combined PV and solar thermal)

Environmental Analysis

Areas to Investigate for Final Report:

- Quantifying energy savings
 - Energy in the form of heat
- Analyzing Supply-chain Considerations & Negative Impact
 - Manufacturing of heat pipes
 - Mining of copper
 - Recyclability of components

Next Steps & Future Work

- **Next Steps for Team:**
 - **Finish report**
- **Potential Improvements:**
 - **Multiple panels**
 - **Increase # of heatpipes**
 - **Conductive backing**
 - **Flow restrictor**
 - **Water as working fluid**

The background of the slide is a teal-colored field filled with a repeating pattern of white circuit board traces and circular pads. The pattern is dense and covers the entire area. A white triangular shape is located in the top-left corner, and another white triangular shape is in the bottom-right corner, meeting at a diagonal line that runs from the top-left towards the bottom-right.

Thank you!
Questions?

Heat Pump vs. Water

Heat Pump

- Cheaper installation
 - Hot air
- Can be deployed in smaller modules
- Non-reversible heat pumps only
- Most effective when heat is not needed (e.g. summertime)
- Best for prototyping

Water

- Expensive installation
 - Piping
 - Sealant
- Can pre-heat water all year round
- Only cost effective in large numbers with central water tank
- High level of research and literature surrounding use