Electrical Engineering Capstone Project

TROPIC: Dual-Mode Water Heating / Cooling

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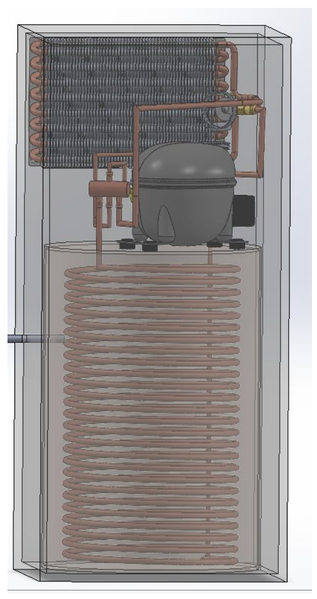
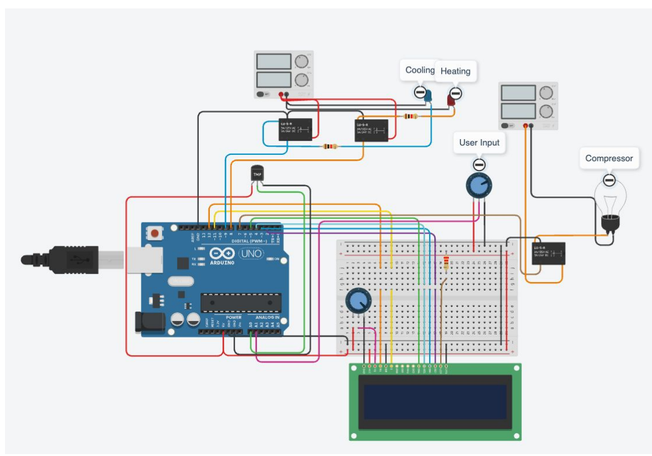
Problem Statement

Countries that are a part of the Gulf Cooperation Council (GCC) are geographically isolated from freshwater sources and thus must utilize desalination systems to supply over 60% of their municipal water. Pressure reductions occur due to increased demand during summer months, which prompts the use of rooftop storage tanks on residential buildings. The problem with this storage solution is that the water tanks are exposed to direct sunlight, causing water temperatures for the building to exceed 125 ℉. These temperatures are a problem for residents, who must either resort to storing water in buckets or delay hygiene routines in favor of having slightly cooler temperatures. While water heaters and chillers exist, building owners aren't incentivized to provide these extremely expensive systems to their homes.

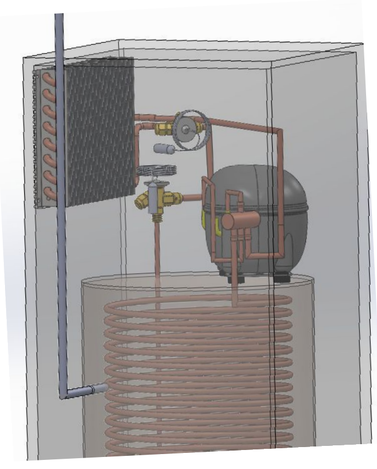
Modeling



Initial CAD Model

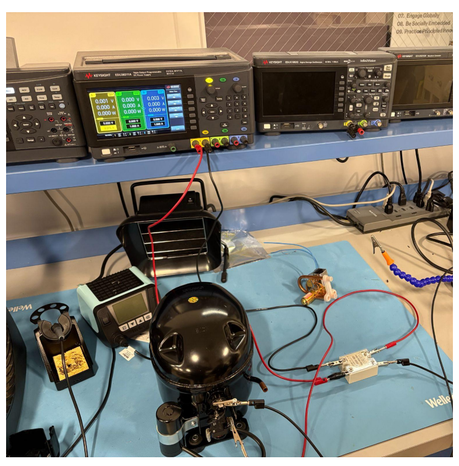


Circuit Simulation Diagram

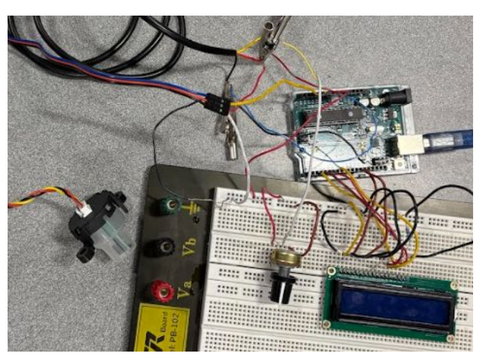


Initial CAD Model

Component Testing



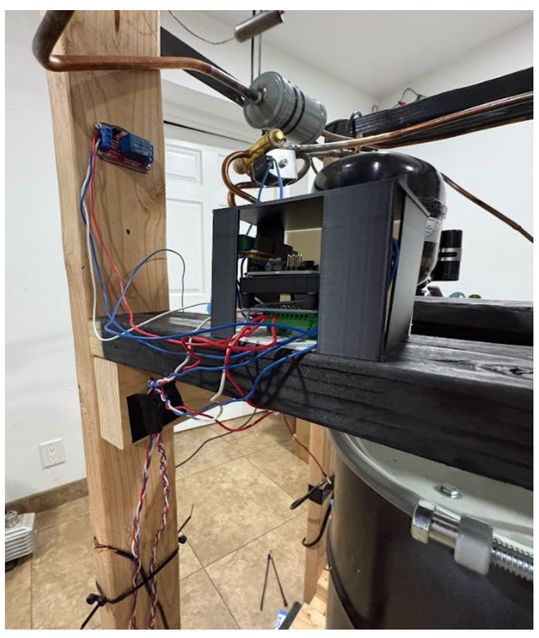
Operating compressor with manual relay triggers



Using a microcontroller to verify sensor functionality

Vacuum testing to ensure system has no leaks

Assembly



A combined effort between the EE team and ME team to assemble and test the system took 2 months to ensure correct system functionality.

Final Design

The user interface

The completed system

Conclusion and Future Work

In closing, the goal of this project was to construct a dual-mode thermodynamic system that can heat or cool water in a single household space depending on user input in order to provide apartment residents with comfortable water temperatures at any point of the day. The interdisciplinary team members all relied on firsthand experiences and concepts taught in and out of the classroom to complete this project. After 2 semesters of careful planning and execution, the team was able to successfully complete the project with minimal alterations from the initial design. The interdisciplinary nature of the project created new challenges but also allowed for each team to solely focus on their part, making the system better overall. Coordinating between teams provided a more realistic representation of industry work and better prepared everyone involved.

Now that the thermodynamic and electric systems have been prototyped, optomizing the system for size, and manufacturability have the most lucrative potential for the capstone sponsor. Since this initial prototype has shown the possibilities of this idea, further work into a custom PCB/microcontroller would reduce costs and increase manufacturability. Similarly, creating a custom housing would also allow for a more streamlined and professional look.