POWERVISION:
Energy Monitoring

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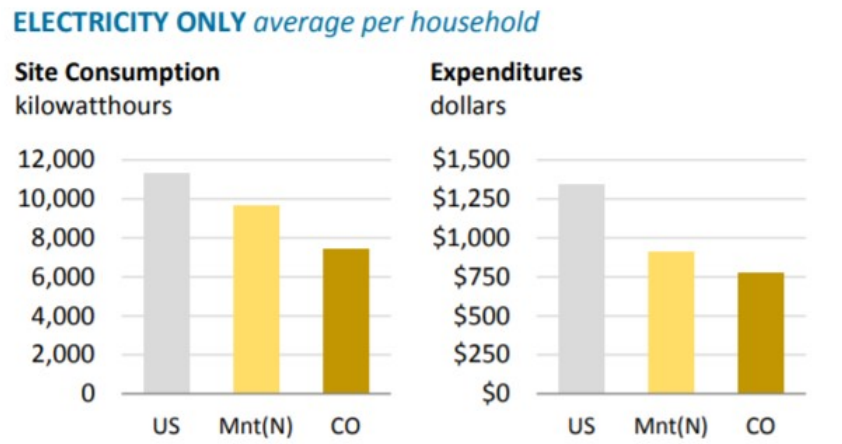
Introduction

PowerVision empowers homeowners to save energy, by providing them with tangible energy usage data shown on a counter top device. Inspired by the team members' personal experiences of wasted energy within their homes and it was designed based on extensive customer development. It's targeted towards the average single family home and people who are looking to reduce their environmental footprint. The product uses circuit transformers to read in electricity usage data at the panel and sends it to the user interface using radio frequency signals. It also uses open-source electronic prototyping electronics to collect and display this data. This device will minimize costs for the consumer and differentiate PowerVision from its competitors.

Figure 1: Team Members and Roles (from Left to Right): Jeremy Donhowe: Test Engineer, Austin Urban: CAD/Manufacturing Engineer, Clara Wilson: Project Manager, Katlyn Stockslager: Logistics Manager, Matthew Roberts: Financial Manager

Definition

Consumers of electricity generally have some idea of which devices in their home consume more energy than others. Most people are aware that a clothes dryer uses far more electricity than charging a cellphone. However, those same people don't have a good quantifiable way to track their energy consumption outside of their power meter or their electric bill. Often people don't go look at their electric meter, and they don't feel motivated to make changes after seeing their electric bill. Residential energy use accounts for 21.8% of the nation's consumption (U.S. Dept of Energy). The team set out to design a product that would address these problems and have the potential to reduce residential greenhouse gas emissions.



https://www.eia.gov/consumption/residential/reports/2009/state_briefs/pdf/CO.pdf

Figure 2: Electricity Consumption in Colorado

PowerVision a small device that would sit in a prominent location in the home that users would pass by or notice on a daily basis. This device displays energy use information in real time to give users instant, actionable feedback. Feedback from potential customers informed design priorities such as simplicity, easy installation, and saving the user money.

Solution

The final design consists of a two-part device: the panel reader and the user interface. The panel end of the product is built inside a commercial electrical housing which can fit easily into residential electrical panels and read usage data.

Feature	Justification
Purchased Housing	Meets Residential Code
Magnets	Easy Installation
Circuit Transformers	Safe Installation in Panel
Battery Power	Limit Consumer Time in Electrical Panel

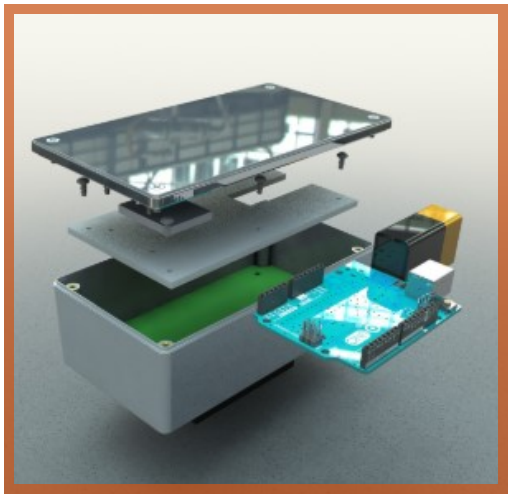


Figure 3: Panel End Render

The user-interface strikes a fine balance between sleek industrial design and manufacturability.

Figure 4: User Interface Render

Feature	Justification
1/4" Acrylic, Solvent Bonded	Sturdiness in High Traffic Areas
Simple Design	Consumer Appeal
Light Bar and LCD Screen	Quick Information Uptake
Arduino	Intuitive Coding
RF Transceivers	Extended Transmission Range
Slots in the Shell	Heat Dissipation

Creation

Give-A-Watt completed the product's physical manufacturing over the course of a month and a half by following their defined schedule.

Band Saw Acrylic

Mill Basic Pieces

CNC Milling of Complex Pieces

Sand and Deburr

Solvent Bond

Ready for Electronics Integration

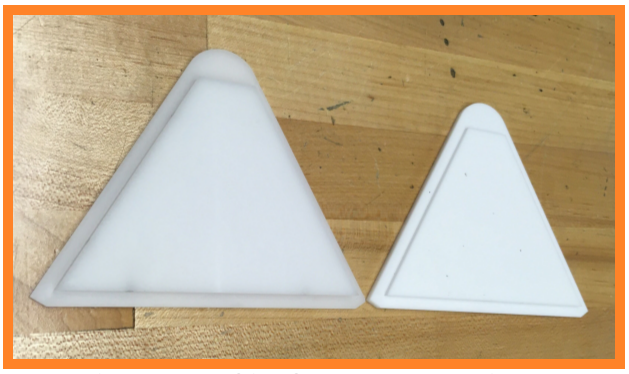


Figure 5: Machined User Interface Pieces

Figure 6: Milling Operations

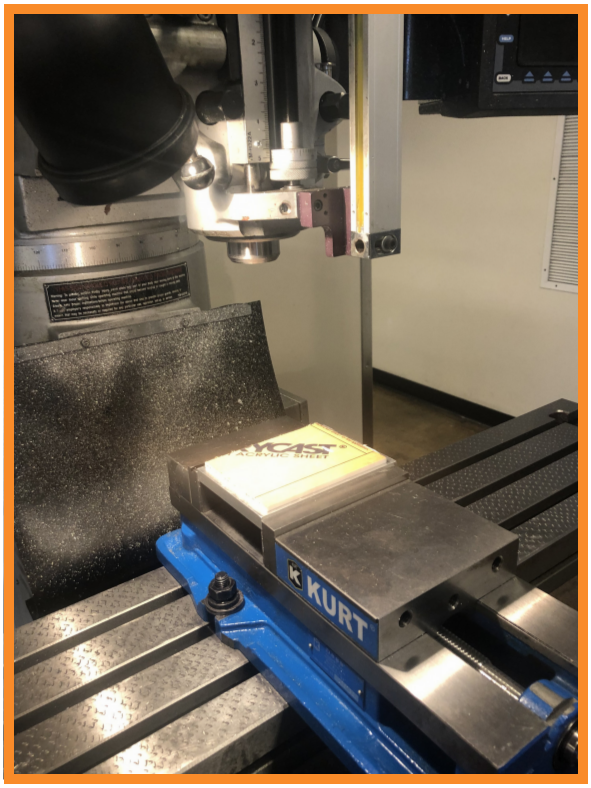


Figure 7: Milling Operations II

Creation

After the physical form was complete, Give-A-Watt transitioned into integrating all the electrical components together, and ensuring they functioned as one system.

Sub-System	Details
LCD Screen	**Coded to display energy use** in easy-to-understand metrics
LED Strip	Coded to display **rate of energy use** Uses color scale (Red to Green) to indicate high and low power draw
Current Transformers (CT's)	Connected to an Arduino Data **converted with known conversion scalar to energy usage (kWh) and then to dollar amounts**
Transceivers	Coded to send data every 5 seconds Long range antennas added to ensure **data can be sent throughout any house**
SD Card Storage	Internal SD Card **stores all energy use data** for interested consumers

Figure 8: LCD Screen Possible User Interface

Disruption

Due to COVID-19, manufacturing and testing of PowerVision was disrupted. This decision was reached through consultation with all stakeholders and consensus within the team based on the limited manufacturing and testing resources available. The next steps in the creation of the product included integrating all of the electronic segments that had been individually tested and completing the assembly of the user facing device. After this phase is complete, the team will begin accuracy and distance testing with the RF modules in both devices as well as testing on home breaker panels. This will be immediately followed by another round of iteration and completion of the design.

Figures 9 & 10: Progress on User Interface

Conclusion

Although manufacturing of PowerVision has been delayed, the team is still incredibly proud of the product design. The user end shell was assembled completely, as was the panel end. The electronics function as expected, all that remained is the integration of the electronics, code, and shells. If PowerVision was going to market, the team would refine the investment pitch and look for investors. More customer development would be conducted to fully understand the consumer base, as well as redesign to optimize for mass production. Regardless of the hurdles, the team considers PowerVision to be a success. PowerVision represents the powerful blending of engineering and entrepreneurship, and the team is happy with the results given the circumstances.

Figure 11: The Team