# Smart Campus Energy Lab
# WIP: Environmental Sensor Network Nodes

**Students:** Emily Lum (EE496), Emily Kane (EE496), Clyde Felix (ENGR396)
**Project Advisor:** Dr. Anthony Kuh
**Smart Campus Energy Lab - Renewable Energy and Island Sustainability**

## Introduction & Motivation

- In 2012, the University of Hawaii at Manoa (UHM) paid $35 million for their electricity bill. Despite the implementation of energy efficient measures, UHM paid $34.3 million for their electricity bill in 2014. This is due to the fact that the price of electricity per kilowatt hour has increased greatly.
- SCEL is in the process of creating a wireless environmental sensor network to collect data used to forecast solar irradiation patterns and determine optimal places to install renewable energy sources on the UHM campus.

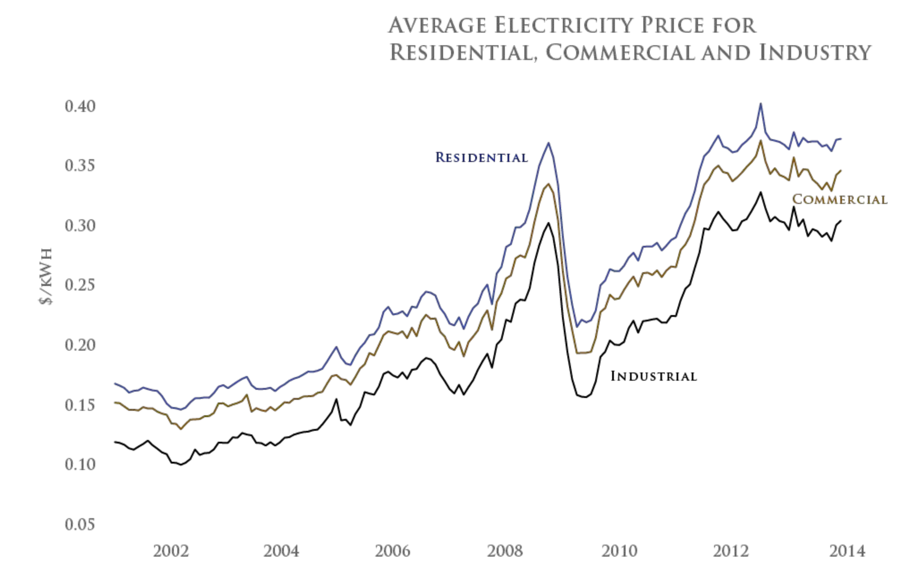


**Figure 1:** Electricity prices in Hawaii
**Source:** University of Hawaii Economic Research Organization

## Project Description

**Objective:** Design and build a low cost, low power consumption sensor module that collects data on various weather characteristics, such as solar irradiation, temperature, humidity, and pressure.

- Improve the hardware of the third generation weatherbox modules by increasing functionality, data reliability, and ease of use
- Modify sensor modules to include GPS and Real Time Clock
- Design weatherproof housing for sensor node
- Deploy the sensor modules on rooftops of buildings around the UHM campus
- Collect and store data in real time in a database on a local server and use it to predict solar irradiance patterns around campus

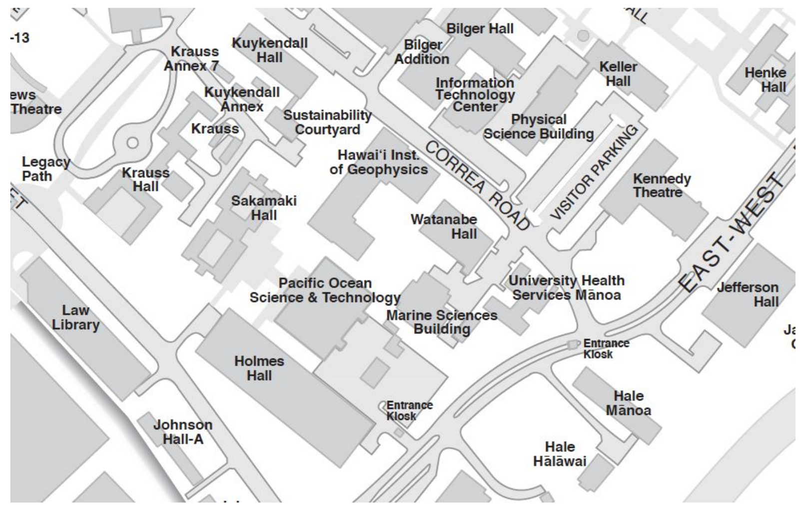

**Figure 2:** Planned sensor module deployments on the upper UHM campus buildings: Holmes, Sakamaki, MSB, HIG, and Kuykendall

## Design

### Hardware Methods

**Power Management**
- Incorporate solar panel and rechargeable battery
- Utilize solar charging chip for self-sufficiency

**Low Cost**
- Design own sensor circuit using Eagle
- Print 3D Housing made by Housing Team

**Increased Functionality**
- Utilize GPS for future data tracking purposes
- Include Real Time Clock separate from GPS to timestamp data and provide lower power consumption

**Communication**
- Transmit sensor and diagnostic data using an XBee Pro S2B, which has a maximum range of 1 mile
- Use smaller relay nodes to extend the range of the sensor network

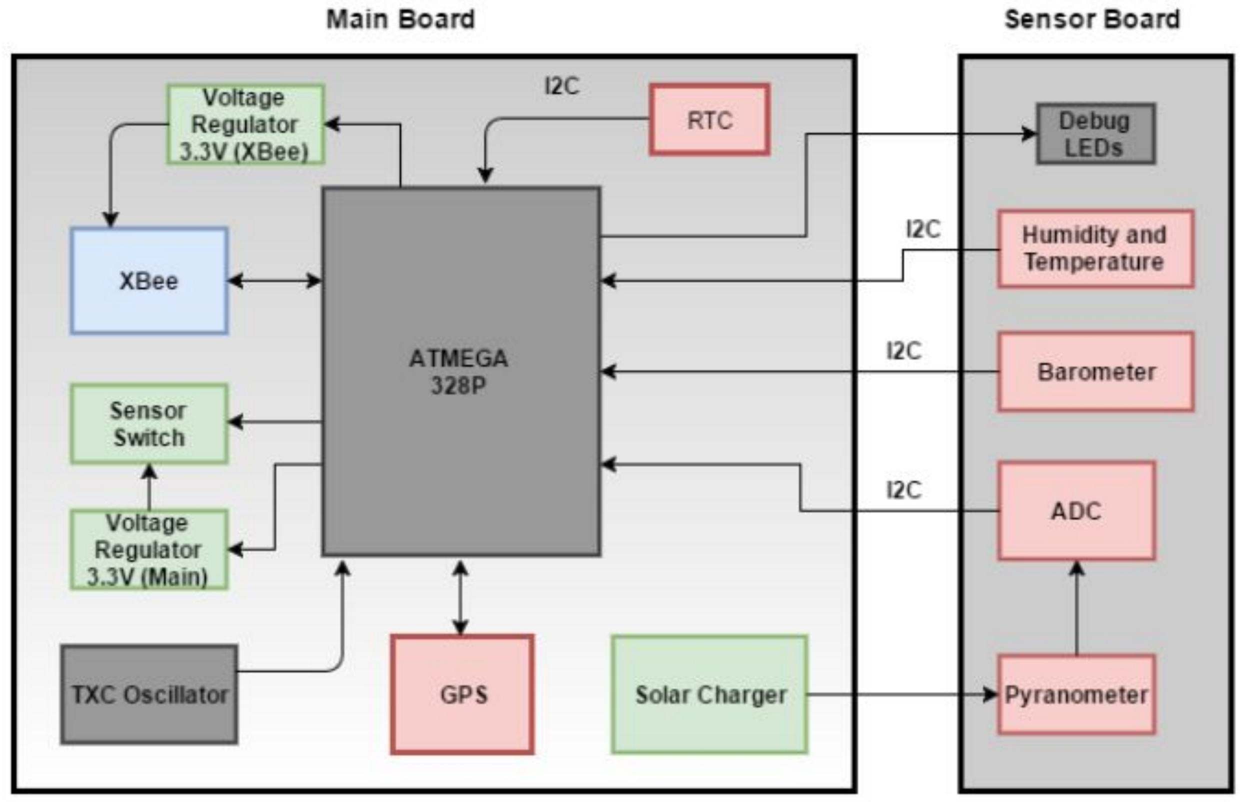


**Figure 3**: Hardware block diagram

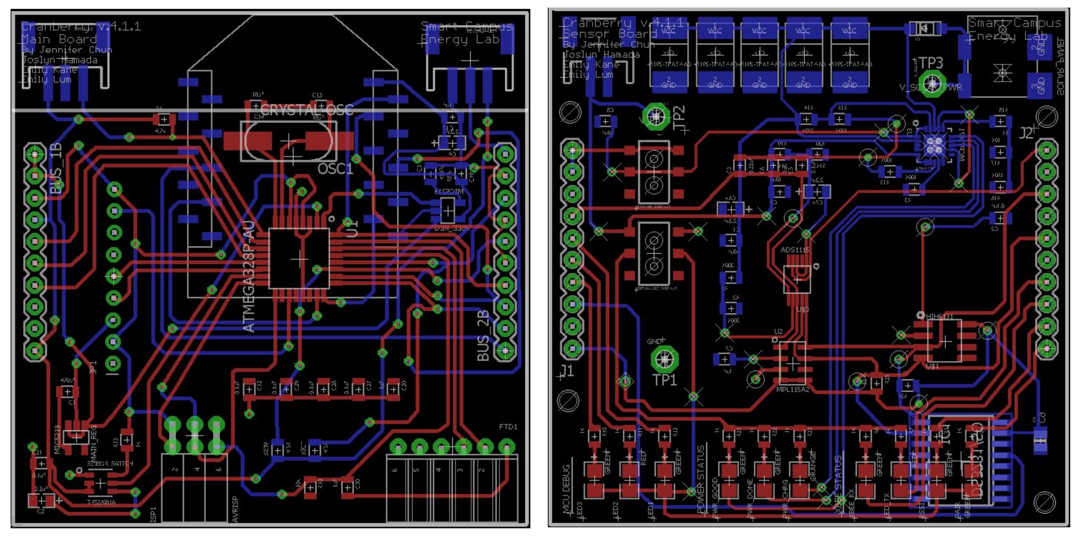

**Figure 5:** Cranberry v4.1 PCB (2.375'' by 2.375'')

### Firmware Methods

**Data Encoding**
- Heartbeat packet contains diagnostic data
- Data packet contains sensor data

**Data Collection**
- Gather diagnostic data and sensor data
- Different sampling rates for different data packets

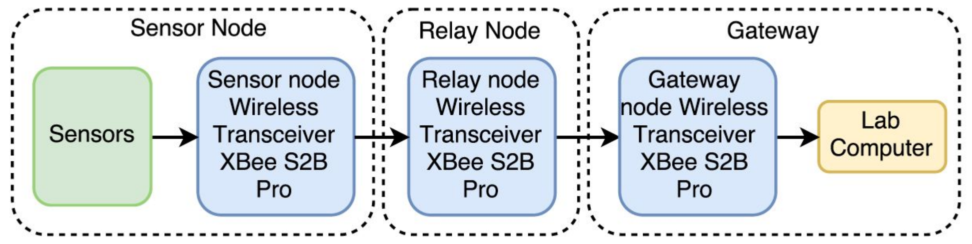


**Figure 4:** Relay node block diagram

## Results

- Populated two Cranberry v4.1 boards and began debugging
- Deployed one Cranberry v4.1 board to the top of Holmes Hall
- Analyzed deployment results and debugged issues
- Began designing new version v4.2

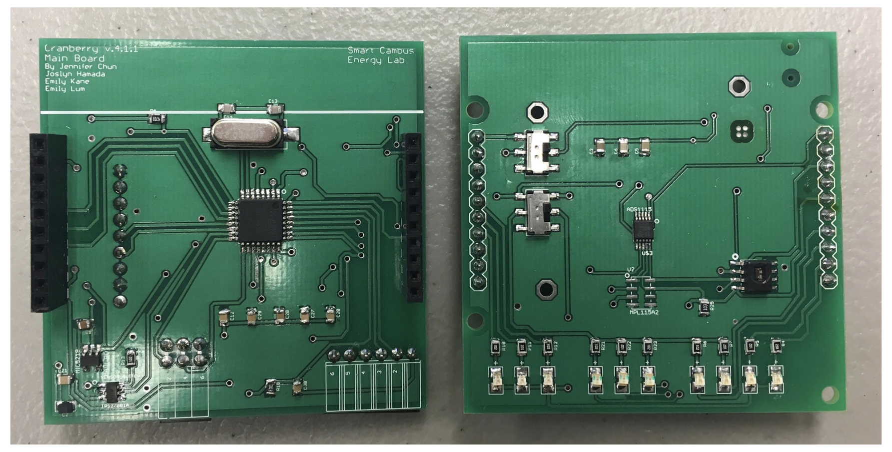

**Figure 6:** Populated Cranberry v4.1

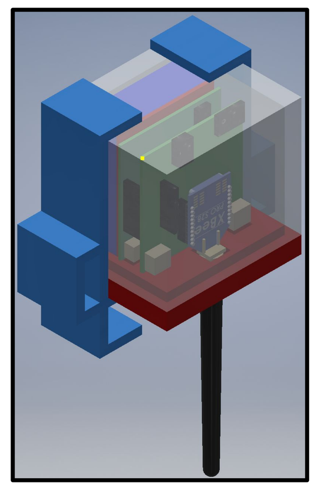

**Figure 7:** 3D Housing Design

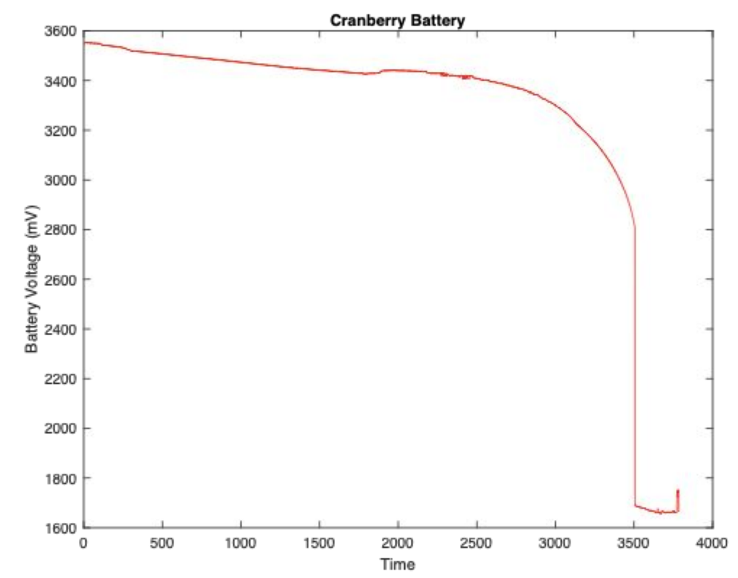


**Figure 8:** Battery voltage data for the 4th generation sensor module

## Conclusion

**Key Work**
- Completed soldering two Cranberry v4.1 boards
- Deployed one Cranberry v4.1 board

**Future Work**
- Design new Cranberry generation (v4.2) with further improvements
  - Shrinking Cranberry back to original 2" by 2"
  - Fixing potential issues found with Cranberry v4.1
  - Mass deployment across campus

**Figure 9:** Deployed Cranberry v4.1

## Acknowledgments

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