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Final Project Proposal: IoT Electricity Use Monitor

Motivation:

The goal of this project is to build an IoT device that will track electricity usage. The motivation for this build is our growing need for energy and our lack of immediate visibility of our daily energy use. This project will focus on electricity. We have the ability to utilize off the shelf parts and some ingenuity to monitor and temper our electricity use. Most households take note of their electricity use when it's time to pay the bill. The device that may offer a glimpse into your real time electricity use, the electric meter, is inconveniently placed on the outside of the home in most situations. Smart meters are being rolled out however their abilities are lacking, and the energy companies are not motivated to spend time and resources to provide more functionality to the end user. The meter's primary purpose is to report usage to the company for billing.

There are some products on the market that provide readings for instantaneous energy use however they do not store any usage data or provide any meaningful insights. Since a household's main energy use is interior environment (highest) and hot water heating (2nd highest), the original thought was to track a heat pump and/or hot water heater usage with this device. It would involve a direct connection with parts that can handle the higher amperage.

Instead, this project will be a proof of concept that will focus on ease of use for the end user while utilizing standard off the shelf parts to handle 15-20 amps at 120v. The design of this device, in theory, can be expanded to anything in the household using electricity. One of the goals of this build is ease of use so the device will incorporate pass through ability, meaning the device will have male plug on one end to be plugged in to the socket and female on the other end of the device for the load to plug in to.

Technical approach and details:

Power monitor will utilize a WCS1800 Hall Effect Current sensor with analog output to an ESP-32 board with Wi-Fi and Bluetooth capability. The WCS1800 is pre-mounted to a board that includes the necessary circuitry for safe operation as outlined on the data sheet. The amperage being used by the circuit will be measured, stored, and broadcast on the network that it is connected to.

A current sensor is toroidal in shape. The measurement is taken from the hot part of the circuit that passes through the center of the toroid. The output of the sensor is a much smaller dc voltage that ranges in proportion to the amperage being utilized in the circuit. Because of the

toroid shape, it may be challenging to simply insert the device into the circuit. Design of this device will prevent having to open the circuit to get a measurement.

The power monitor will have the ability to power itself from main power by an 120v – 5v inverter and provide visual output via an OLED screen.

A library is provided by the WCS1800 sensor manufacturer to conduct the calculations necessary. Output will be calibrated using known loads and another meter.

On first power up, the device will go into access point mode at which point the user can connect to it with their computer or phone and select their wireless access point and password. This will be saved by the device, reboot itself and then connect to the directed access point. Device will have the ability to beacon periodic information in JSON or CSV format. Separate software (app, client, etc) can be utilized to receive this beacon and store/display the info. The board should also act as a server and provide information on demand as a client connects to it.

Project Timeline for deliverables:

Milestone	Due Date
Submit Proposal	20-Feb-23
Obtain parts	25-Feb-23
Test individual parts/order replacements	4-Mar-23
Wire prototype	11-Mar-23
Measure/order enclosure	18-Mar-23
Write software	19-Mar-23
Test/Debug/refactor	25-Mar-23
Modify/set/mount to enclosure	1-Apr-23
Expand notes/findings into report	8-Apr-23
Produce Video	15-Apr-23
Submit Report and Video	1-May-23

Source and order parts:

Board - https://www.amazon.com/HiLetgo-ESP-WROOM-32-Bluetooth-Development-Display/dp/B072HBW53G/ref=sr_1_3?keywords=esp32+oled&qid=1675898874&sr=8-3

Female plug end bulkhead
https://www.amazon.com/gp/product/B092VQNKN7/ref=ppx_yo_dt_b_asin_title_o03_s00?ie=UTF8&th=1
WCS1800 Hall Effect Current Sensor

https://www.amazon.com/Comimark-WCS1800-Current-Detection-Overcurrent/dp/B07XY7NT6K/ref=sr_1_2?crid=3LT7NSIO12IF9&keywords=wcs1800&qid=1675898986&sprefix=wcs1800%2Caps%2C70&sr=8-2

Inverter – 120v AC to 5v DC 2 amp
https://www.amazon.com/Converter-Universal-Isolated-Switching-Version/dp/B07SGQ6XXR/ref=sr_1_3?crid=1U69WM7VOOL7Y&keywords=120v+to+5v&qid=1675899104&sprefix=120v+to+%2Caps%2C77&sr=8-3

Software:

ESP 32 board is programmable using the Arduino environment.
WCS1800 sensor has a library provided by the manufacturer.

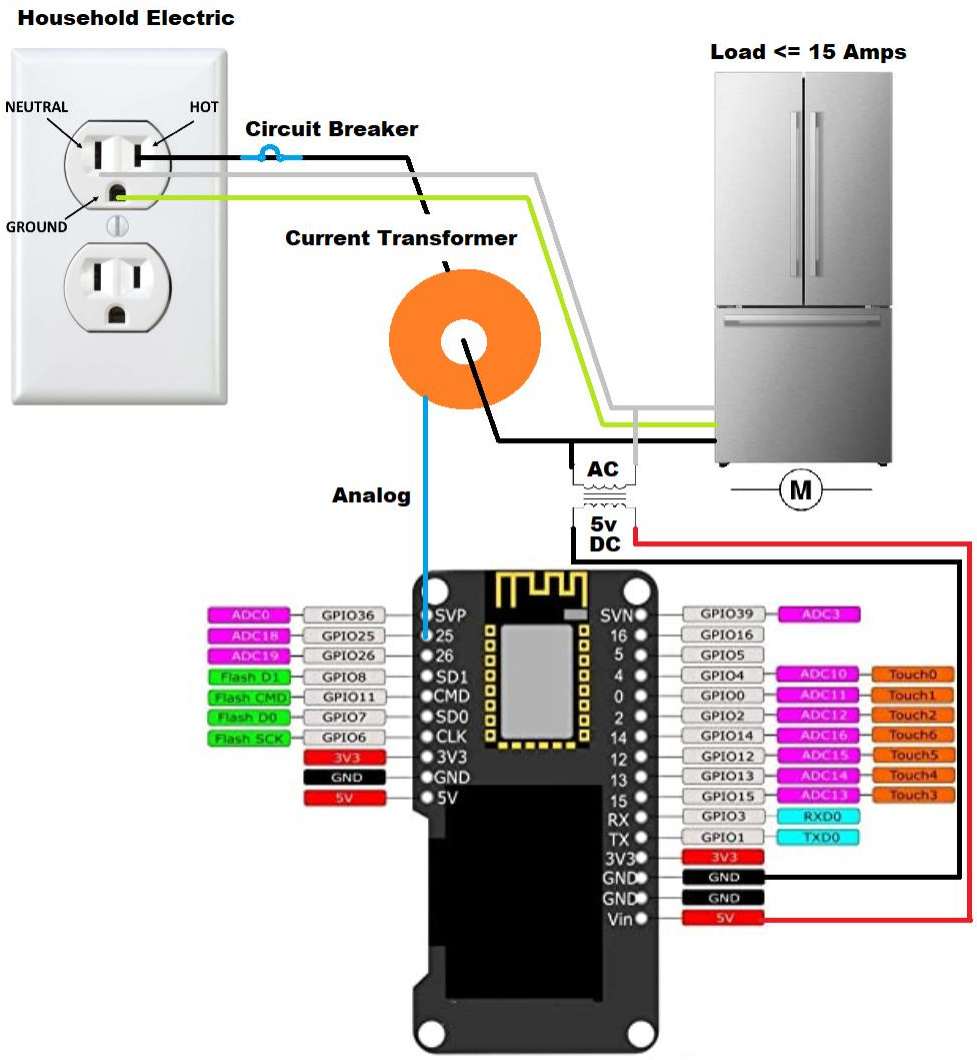
- Calibrate using known loads and inline ammeter.

Wireless AP connection setup.

- Find and offer user ability to select nearby access point to connect.

Track instantaneous and historic energy usage

- Instantaneous usage should be visible on screen.
    - Instantaneous usage metrics calculated by
    - If you are not looking at the device screen, report to app or otherwise through the network.
- Historic usage will depend on availability of onboard memory.
    - Longer term through storage in SQL or other database.



ESP32 with OLED Screen, WiFi and Bluetooth