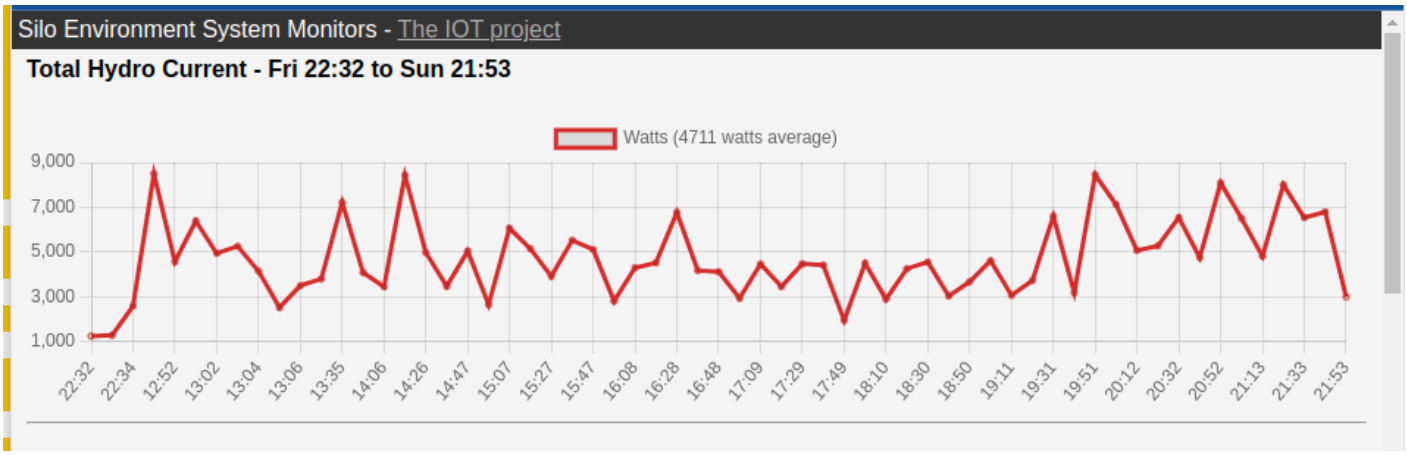
Home Power Consumption Monitoring

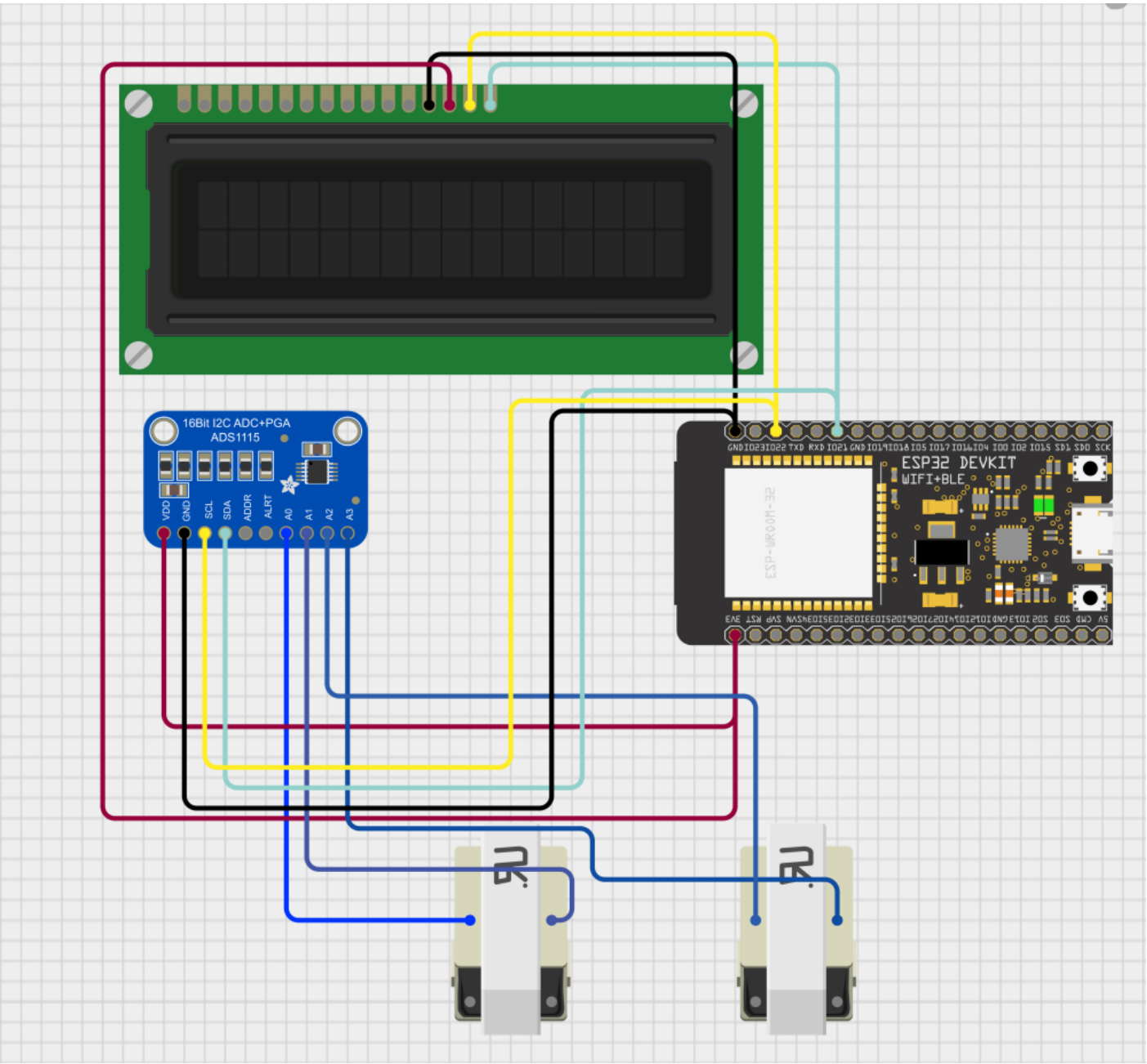
For this project the goal is to know exactly how much current is being used for the entire property. To collect this data I placed 2 SCT013 non-invasive split core current transformers around the phase 1 and 2 wires in the main electrical panel. Using some simple math this can convert the small voltage in the transformers into an accurate current reading.



Components (total cost $20 CAD):

- ESP32 WROOM ($5 CAD) - https://www.aliexpress.com/item/4000471022528.html
- 2 x SCT013 split core transducers ($8 CAD) - https://www.aliexpress.com/item/1005006318596840.html
- 16 Bit I2C ADS1115 Module ($3 CAD) - https://www.aliexpress.com/item/32817162654.html
- OLED SSD1306 ($1.50 CAD) - https://www.aliexpress.com/item/32643950109.html
- 3d printer filament ($1 CAD)

Wiring Diagram:



A clamp meter was used to confirm the calculated values were valid for a wide range of current (1 amp up to 60)

Relay unit mounted on the wall:

And the code to make it all happen:

```
#include <SPI.h>
#include <WiFi.h>
#include <HTTPClient.h>
#include <Wire.h>
```

```
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>
#include <Adafruit_ADS1X15.h>
#include <EEPROM.h>
#include "splashscreenbitmap.h" // just make it look fun on bootup

int activeConnection = 1;

// network 1
const String ssid1 = "xxx";
const String password1 = "xxxxxxx";

// network 2
const String ssid2 = "xxx";
const String password2 = "xxxxx";

const String heartbeatUrl = "https://xxx.xxx.com/silopower/heartbeat.php";
const String currentUrl = "https://xxx.xxx.com/silopower/set_hydro_current.php?data=";

#define EEPROM_SIZE 4
int eepromPingsAddress = 0;
float totalServerPings = 0;
int eepromFailedPingsAddress = 1;
float totalServerPingFails = 0;
int eepromActiveConnection = 1;

#define SCREEN_WIDTH 128 // OLED display width, in pixels
#define SCREEN_HEIGHT 64 // OLED display height, in pixels
#define LOGO_HEIGHT 128
#define LOGO_WIDTH 64

// Declaration for an SSD1306 display connected to I2C (SDA, SCL pins)
#define OLED_RESET - 1 // Reset pin # (or -1 if sharing Arduino reset pin)
Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT, & Wire, OLED_RESET);

Adafruit_ADS1115 ads;

long secondsOfHour = 0;

const int pulseRate = 1000; // loop runs once per second
```

```
const int serverSendInterval = 10; // 10 minutes between sending a pressure update to the server
const int samplesPerReading = 12 * serverSendInterval; // reading current takes 5 seconds so 60 / 5 = 12

int loopCount = 0;

String payload = "";
int httpCode = 0;
bool wifiConnected = false;
bool wifiPaused = false;
int wifiPausedTick = 0;
bool wifiSleeping = false;
bool debug = false; // when true server does not update
bool serverFailed = false;
int wifiConnectionAttempts = 0;

float basePressureVoltage = 0.46;
float totalledAveragePressure = 0;
float averagePressure = 0;

const float FACTOR = 9;

const int secondsPerHour = 3600; // set to 60 for debugging

HTTPClient http;

void setup() {

  Serial.begin(115200);


  if (!display.begin(SSD1306_SWITCHCAPVCC, 0x3C)) {
    Serial.println(F("SSD1306 allocation failed"));
    for (;;); // Don't proceed, loop forever
  }

  if (!ads.begin()) {
    Serial.println("Failed to initialize ADS.");
    while (1);
  }
```

```
// ads.setGain(GAIN_FOUR);

 display.clearDisplay();
 display.drawBitmap(0, 0, epd_bitmap_annie, 128, 64, 1);
 display.display();
 delay(3000);

 EEPROM.begin(EEPROM_SIZE);

 activeConnection = EEPROM.read(eepromActiveConnection);

 Serial.print("eepromActiveConnection :");
 Serial.println(activeConnection);

 if (isnan(activeConnection)) {
   activeConnection = 1;
 }

 if (activeConnection == 0) {
   activeConnection = 1;
 }

  if (activeConnection > 2) {
   activeConnection = 2;
 }

 Serial.print("activeConnection: ");
 Serial.println(activeConnection);

 float pingData = EEPROM.readFloat(eepromPingsAddress);
 if (isnan(pingData)) {
   pingData = 0;
 }
 totalServerPings = pingData;
 EEPROM.end();
 EEPROM.begin(EEPROM_SIZE);
 float pingFailData = EEPROM.readFloat(eepromFailedPingsAddress);
 if (isnan(pingFailData)) {
   pingFailData = 0;
```

```
  }
  totalServerPingFails = pingFailData;
  EEPROM.end();

  if (!connectToWiFi()) {
    delay(2000);
    WiFi.disconnect();
    delay(1000);
    if (activeConnection == 1) {
      activeConnection = 2;
    } else {
      activeConnection = 1;
    }
    connectToWiFi();
  }

  delay(2000); // Pause for 2 seconds

}

void loop() {

  secondsOfHour++;

  // after 24 hours reset this integer
  if (secondsOfHour > 86400) {
    secondsOfHour = 1;
    ESP.restart();
  }

  float amps = getAmps();
  float watts = amps * 120;

  display.clearDisplay();
  display.setTextSize(2);
  display.setTextColor(WHITE);
  display.setCursor(0, 0);
  display.print("W:");
  display.println(watts, 0);
  display.print("A:");
```

```
display.println(amps, 0);
display.setTextSize(1);
display.println("internet:");
display.println(wl_status_to_string(WiFi.status()));
display.display();

//////////////////////
// SERVER RELAY

if (!debug && (loopCount >= samplesPerReading) || serverFailed) {

  loopCount = 0;
  totalledAveragePressure = 0;

  setWifiSleepMode(false);

  delay(2000);

  // do a heartbeat check to see if we are online...
  http.begin(heartbeatUrl);
  httpCode = http.GET();
  if (!httpCode > 0) {
    // wifi may not be alive yet so wait 3 seconds
    delay(3000);
  }

  String recordedWatts = String(watts, 1);

  recordedWatts.trim();

  loopCount = 0;

  http.begin(currentUrl + recordedWatts);
  httpCode = http.GET();
  if (httpCode > 0) {
    payload = http.getString();
    Serial.println("HTTP Response: " + payload);
    recordPingSucces();
  } else {
    recordPingFailure();
```

```
    }
    http.end();

    setWifiSleepMode(true);
  }

  loopCount++;

}

bool connectToWiFi() {

  String activeSsid = "";
  String activePassword = "";

  if (activeConnection == 1) {
    activeSsid = ssid1;
    activePassword = password1;
  } else if (activeConnection == 2) {
    activeSsid = ssid2;
    activePassword = password2;
  }

  Serial.print("Connecting to WiFi: ");
  Serial.println(activeSsid);

  WiFi.begin(activeSsid, activePassword);

  while (WiFi.status() != WL_CONNECTED && wifiConnectionAttempts < 20) {
    delay(500);
    Serial.print(".");
    wifiConnectionAttempts++;
  }

  wifiConnectionAttempts = 0;

  if (WiFi.status() == WL_CONNECTED) {
    Serial.println("\nConnected to WiFi");
    Serial.print("IP Address: ");
    Serial.println(WiFi.localIP());
```

```
    wifiConnected = true;

    EEPROM.begin(EEPROM_SIZE);
    EEPROM.write(eepromActiveConnection, activeConnection);
    EEPROM.commit();
    EEPROM.end();

    Serial.print("set activeConnection to : ");
    Serial.println(activeConnection);

    return true;

  } else {
    Serial.print("Connection to ");
    Serial.print(activeSsid);
    Serial.println(" failed. Trying alternative");
    return false;
  }
}

/**
 * set wifi sleep mode between data relays to conserve energy
 * @param sleepMode - if true set wifi card to sleep to conserve energy
 */
void setWifiSleepMode(bool sleepMode) {

  wifiSleeping = sleepMode;

  if (sleepMode) {
    WiFi.disconnect();
    WiFi.setSleep(true);
    delay(1000);
    Serial.print("sleep wifi status: ");
    Serial.println(wl_status_to_string(WiFi.status()));
  } else {
    WiFi.setSleep(false);
    WiFi.reconnect();
    delay(1000);
    Serial.print("awaken wifi status: ");
    Serial.println(wl_status_to_string(WiFi.status()));
```

```
    // Check if the connection is still active. if not trigger wait for it to come back online
    if (WiFi.status() != WL_CONNECTED && !wifiPaused) {
      Serial.println("Connection lost. Attempting to reconnect in 1 minute ...");
      WiFi.disconnect();
      wifiPaused = true;
      wifiConnected = false;
      connectToWiFi();
    }
  }
}

/**
 * record server ping success in long term memory
 */
void recordPingSucces() {
  totalServerPings++;
  EEPROM.begin(EEPROM_SIZE);
  EEPROM.writeFloat(eepromPingsAddress, totalServerPings);
  EEPROM.commit();
  EEPROM.end();
  wifiConnected = true;
  serverFailed = false;
}

/**
 * record server ping fails in long term memory
 */
void recordPingFailure() {
  totalServerPingFails++;
  EEPROM.begin(EEPROM_SIZE);
  EEPROM.writeFloat(eepromFailedPingsAddress, totalServerPingFails);
  EEPROM.commit();
  EEPROM.end();
  wifiConnected = false;
  serverFailed = true;
}

/**
 * ESP32 wifi card statuses
 * @param status
```

```
 * @return string
 */
String wl_status_to_string(wl_status_t status) {

  String response = "";

  switch (status) {
  case WL_NO_SHIELD:
    response = "WL_NO_SHIELD";
    break;
  case WL_IDLE_STATUS:
    response = "WL_IDLE_STATUS";
    break;
  case WL_NO_SSID_AVAIL:
    response = "WL_NO_SSID_AVAIL";
    break;
  case WL_SCAN_COMPLETED:
    response = "WL_SCAN_COMPLETED";
    break;
  case WL_CONNECTED:
    response = "WL_CONNECTED";
    break;
  case WL_CONNECT_FAILED:
    response = "WL_CONNECT_FAILED";
    break;
  case WL_CONNECTION_LOST:
    response = "WL_CONNECTION_LOST";
    break;
  case WL_DISCONNECTED:
    response = "WL_DISCONNECTED";
    break;
  }

  return response;
}



/**
 * Get the current in amps coming from the hall sensor
 * @return float
```

```
 */
float getAmps() {

  float sensor1Reading;
  float sensor2Reading;
  float amps1 = 0;
  float amps2 = 0;

  float combinedReading;
  float sum = 0;
  long time_check = millis();
  int counter = 0;

  while (millis() - time_check < 5000) {

    sensor1Reading = ads.readADC_Differential_0_1();
    sensor2Reading = ads.readADC_Differential_2_3();

    // ac current flows in 2 directions so grab the flow in each direction
    if(sensor1Reading < 0) {
      sensor1Reading = sensor1Reading * -1;
    }

    if(sensor2Reading < 0) {
      sensor2Reading = sensor2Reading * -1;
    }

    if(sensor1Reading < 2) {
      sensor1Reading = 0;
    }

    if(sensor2Reading < 2) {
      sensor2Reading = 0;
    }

    amps1 += sensor1Reading;
    amps2 += sensor2Reading;

    combinedReading = amps1 + amps2;
```

```
  counter = counter + 1;
 }

 float reading = (combinedReading / counter);

 float averageAmps1 = (amps1 / counter);
 float averageAmps2 = (amps2 / counter);

 // some adjustments for variations in readings
 float divider = .155;
 averageAmps1 = averageAmps1 * divider + (averageAmps1 * 0.015);
 averageAmps2 = averageAmps2 * divider + (averageAmps2 * 0.015);

 return averageAmps1 + averageAmps2;

}
```

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