Arduino Based Home energy measurement

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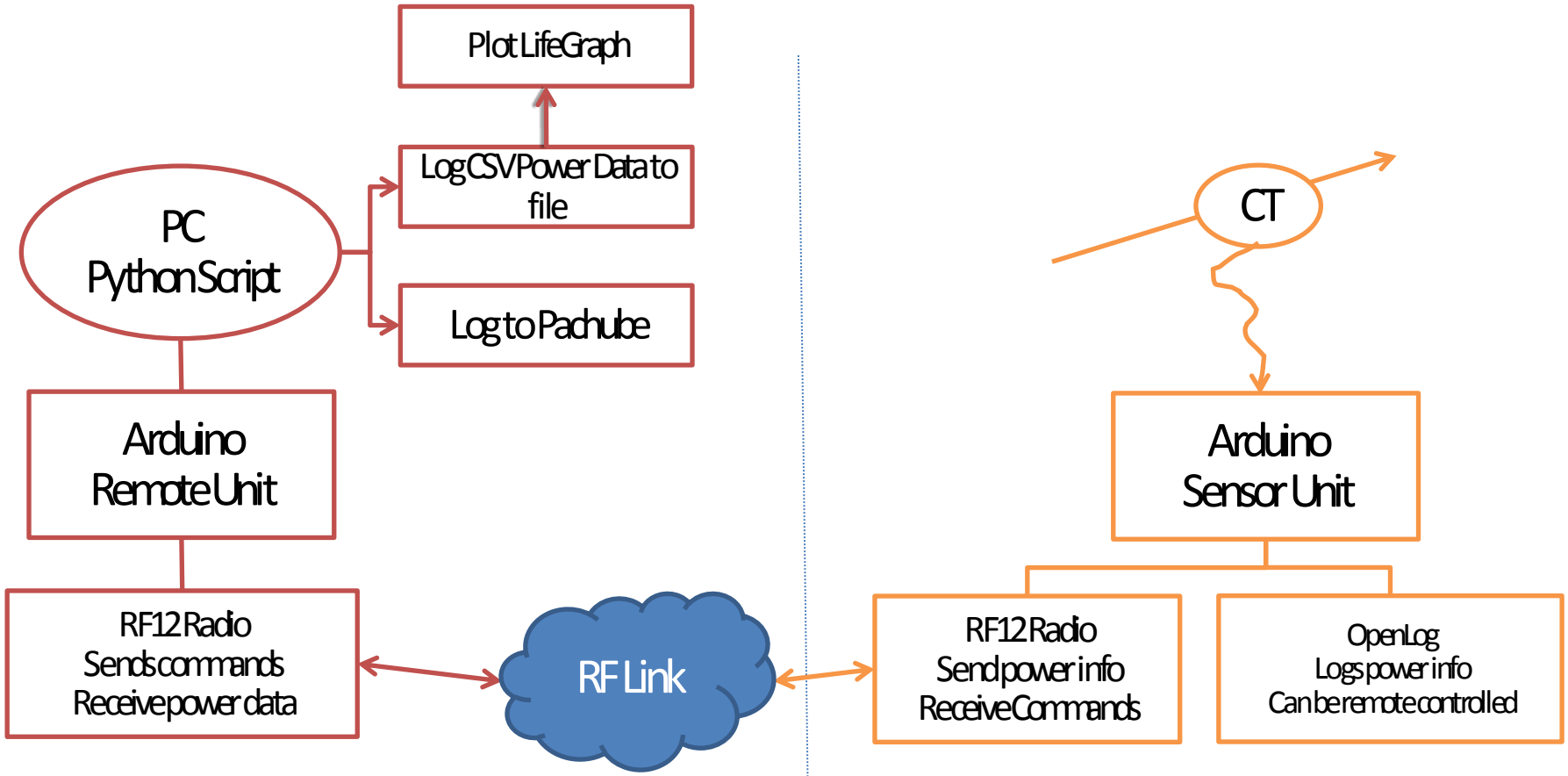
Background

- This is my attempt to build a small home based energy logger.
- It is not unique but has an RF12 on board so it can integrate with other systems, and it logs data to an OpenLog unit
- This makes changing SD cards and logging a breeze
- It is based on OpenEnergyMonitor
- Many of these projects have been done all around the world
- I think what makes this one unique is the fact that the sensor unit (the arduino with the CT) has a RF12 radio built in and also an Openlog unit from Sparkfun
- The OpenLog unit is connected to the UART of the sensor unit. Full control off the Openlog can be obtained via the remote unit connected via RF12 radio
- This means that the sensor unit can keep on logging to the Openlog. You can remotely initiate a session with the Openlog from the base station, and make changes to the settings, before putting it back in logging mode

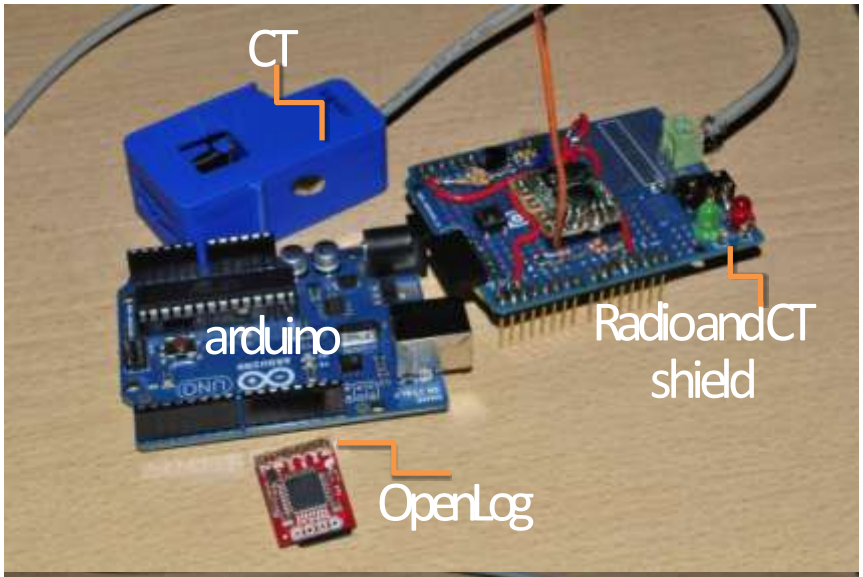
Some facts

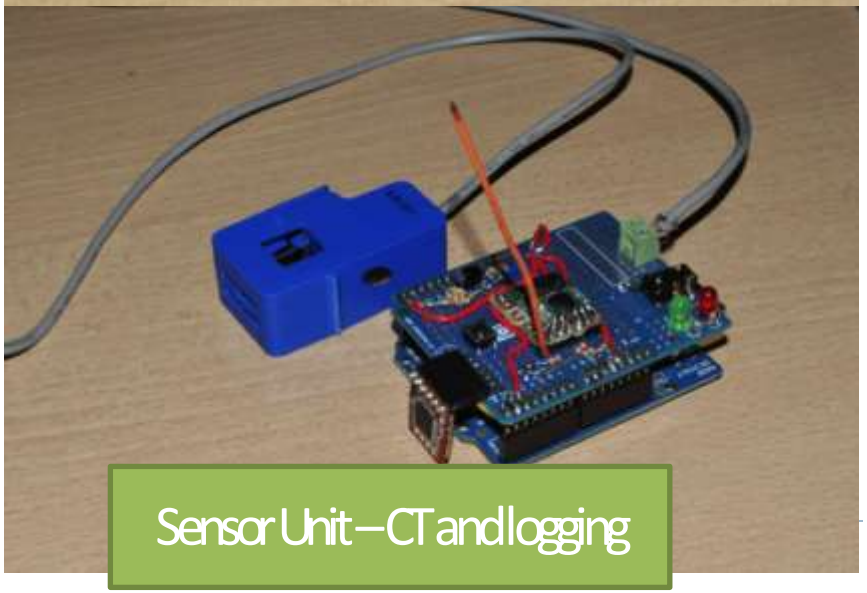
- Small home built energy logger
- Based on Atmel ATMega328 chip and arduino compatible
- Based on the OpenEnergyMonitor project
- Measure current only, Voltage assumed constant
- RF12 radio installed, this makes the system very expandable
- OpenLog from sparkfun installed
- Voltage assumed constant and only RMS current measured using Emon.cc library from the OpenEnergyLogger project

Device Setup

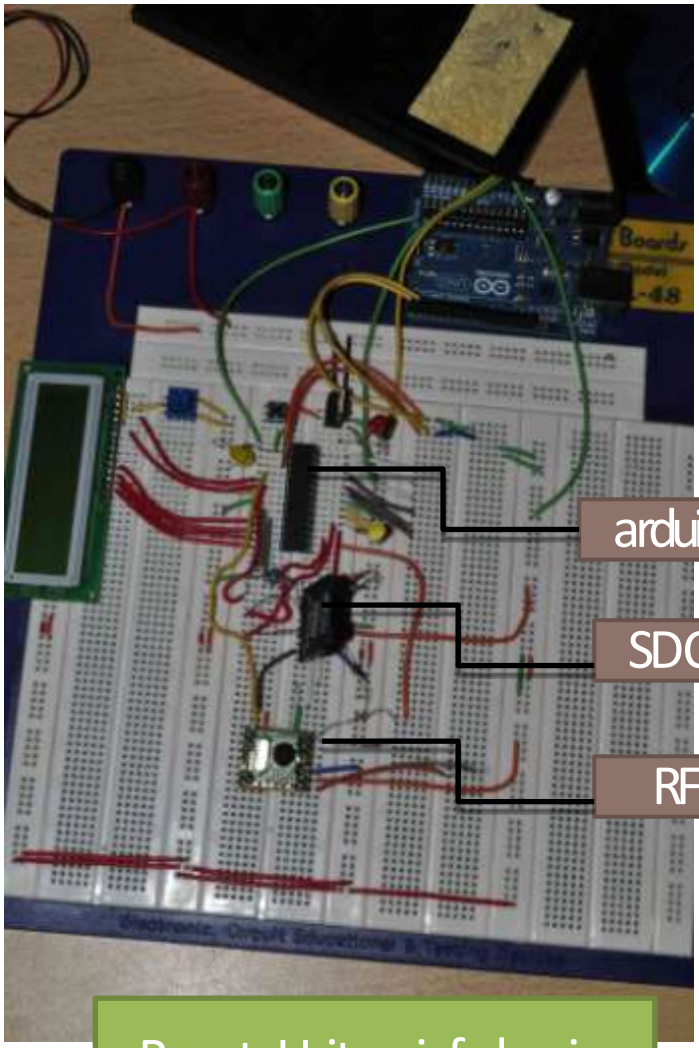


Some photos





Sensor Unit – CT and logging

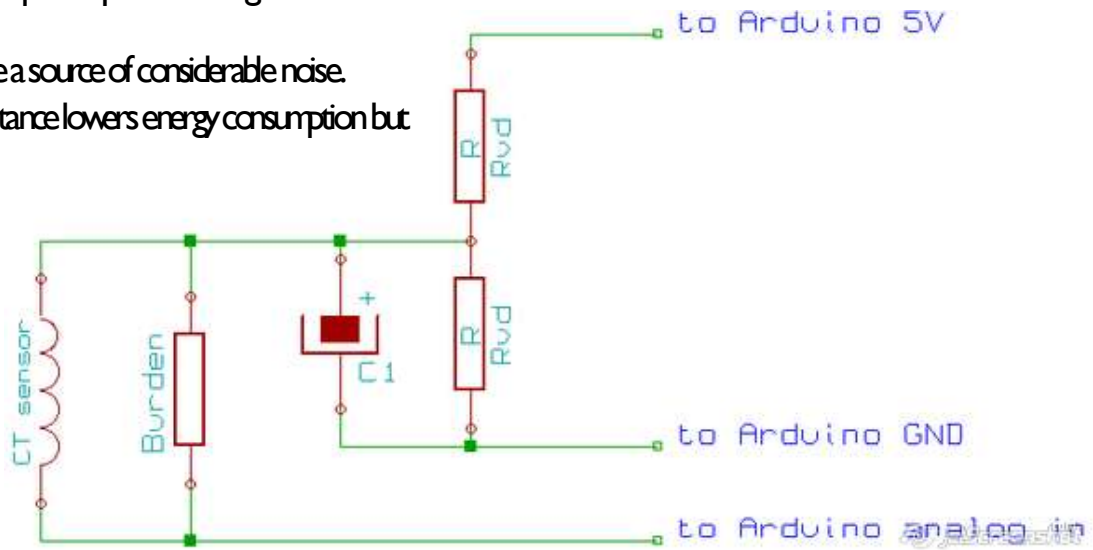


Remote Unit – rx info, logging

Connecting the CT

- Use bias resistors to bias CT voltage around 2.5V, since the controller cannot read the negative portion of the current wave
- We would have to filter out this DC voltage later on with a digital high pass filter – refer to code in emon.cc
- The CT sensor produces a current that is proportional to the instantaneous current flowing in the mains wire by:
  - *Isens = CTturnsRatio x Iinst*
- The resistor in parallel with the CT sensor is called a burden resistor and converts the current Isens into a voltage:
  - *Vsensl = Burden Resistance x Isens*
- The two Rvd resistors form a voltage divider that outputs a voltage at half the Arduino supply voltage of 5V. This voltage biases the AC voltage produced by the CT sensor and burden resistor by 2.5V, needed because the Arduino analog input channel requires a positive voltage.
  - *Voltage at analog input = Bias Voltage + Vsensl*
- The capacitor C1 stabilizes the DC bias as this can often be a source of considerable noise.
- Suitable sizes for resistors Rvd are 10 to 100k. Higher resistance lowers energy consumption but also increases noise.
  - A suitable value for C1 is 10uF.

- Source - http://openenergymonitor.org/emon/node/59



Measuring Power

variable deceleration and setup
void loop()
{

for n=0 to numberOfSamples
{
read in voltage and current sample

remove voltage and current sample offset with digital high pass filter

correct current phase displacement with linear interpolation caused by: ADC multiplexing,
inherent CT and power adapter phase displacements.

accumulate squares of voltage and current for rms calculation
accumulate product of voltage and current for real power calculation
}
calculate values for real power, apparent power, power factor, rms voltage, rms current from accumulators
apply voltage and current calibration coefficients.

print values to USB serial

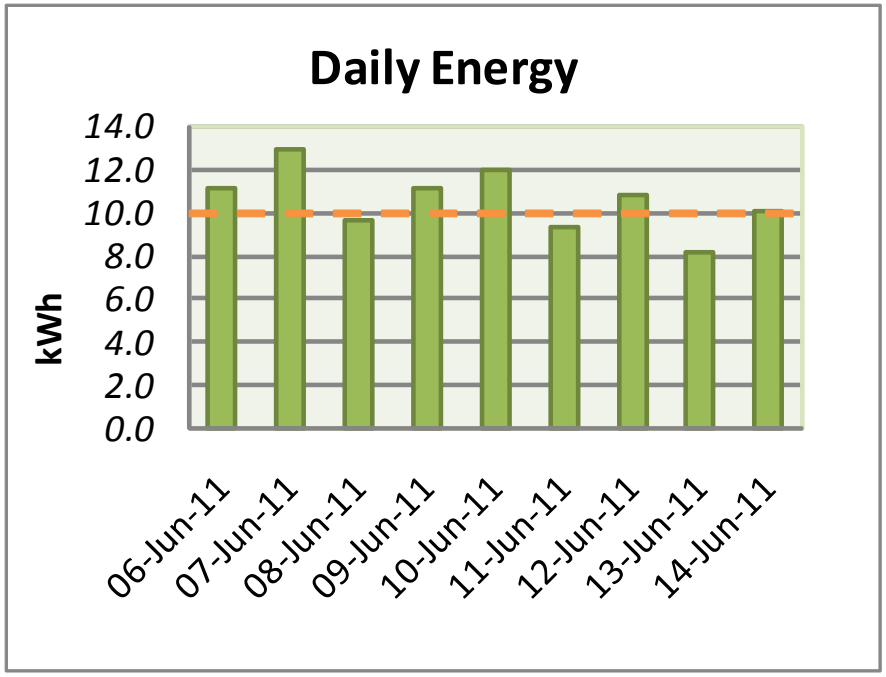
reset accumulators.

}

- http://openenergymonitor.org/emon/

Measurement of home hot water energy

Row Labels	Sum of Energy
06-Jun-11	11.1
07-Jun-11	12.9
08-Jun-11	9.6
09-Jun-11	11.2
10-Jun-11	12.0
11-Jun-11	9.4
12-Jun-11	10.8
13-Jun-11	8.2
14-Jun-11	10.0
Grand Total	**95.0**



Average(kWh)	***10.56***	*Average kWh for a day*
Approx Losses	***1.50***	*Lets remove losses, to see how much we used*
Q(joules)	***32614785.61***	*We used this many joules for water heating*
T1(degreesC)	***65.00***	*Geyser Setting*
T2(degreesC)	***10.00***	*Lets guess the input water temperature*
Mass of water use(litres)	***141.19***	*Approximate water use for the house (Q=mc delta T)*
Number of people (n)	***2.50***	*How many people in the house....baby = 0.5*
Litres of water used per person	***56.48***	*Average water use per person per day*

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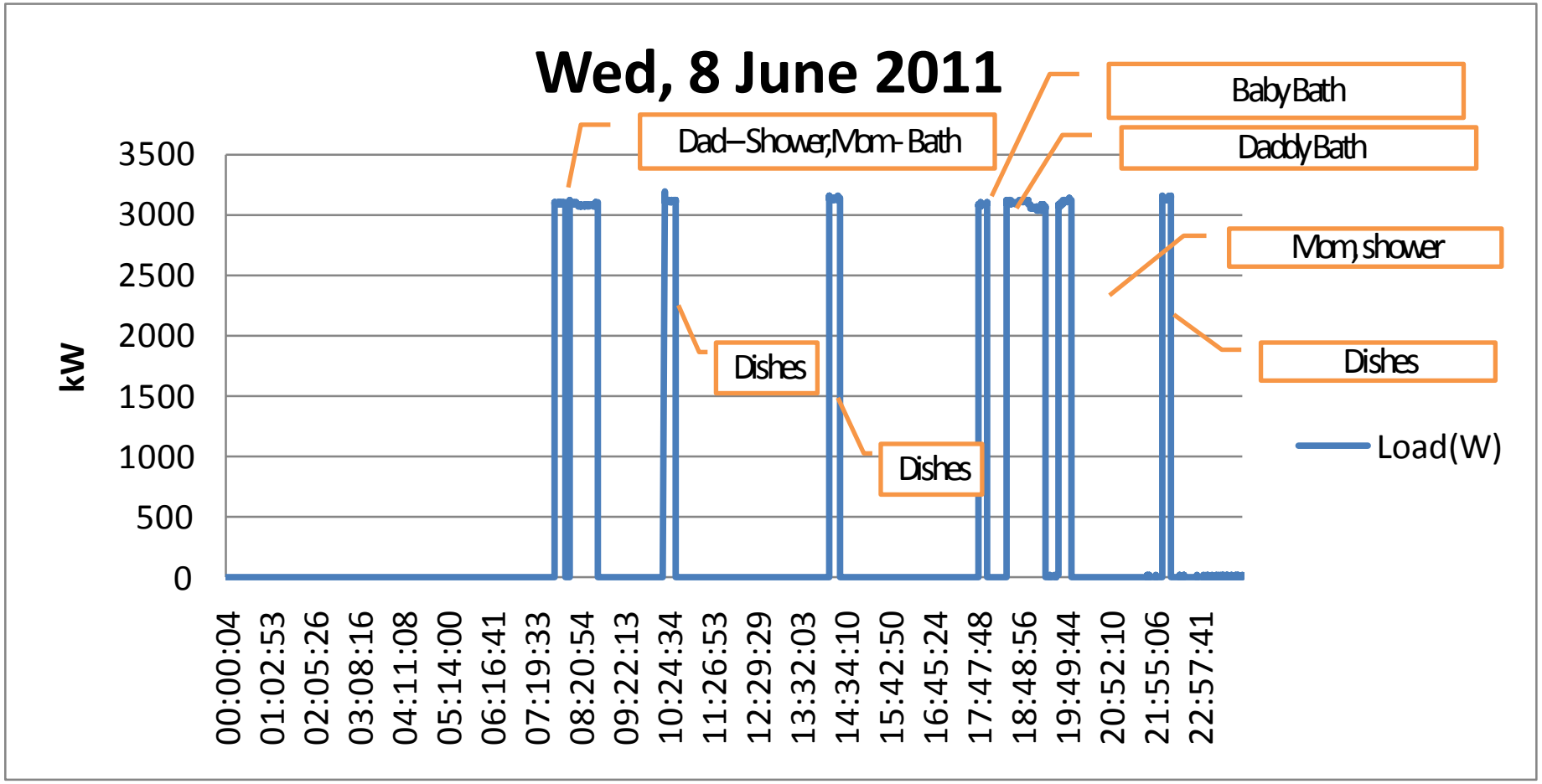
Specific Day measurement



Get some more logged data at https://github.com/Toblippe/Energy_Logger/tree/master/loggeddata

Logging data to Pachube with Python

- Log your realtime data to the clowd using Pachube and Python
- Download eeml - https://github.com/petervizi/python-eeml/tree/207ef35b9c0dd6485f249b83d91b5e0506c5ebbd
- CODE Example

```
import eeml
import serial

# parameters
API_KEY = 'YOUR PERSONAL API KEY'
API_URL = 'YOUR PERSONAL API URL, LIKE /api/1275.xml'

serial = serial.Serial('/dev/ttyUSB0', 9600)
readings = serial.readline().strip().split(' ') # the readings are separated by spaces
pac = eeml.Pachube(API_URL, API_KEY)
pac.update([eeml.Data(0, readings[0], unit=eeml.Celsius()), eeml.Data(1, readings[1],
unit=eeml.RH())])
pac.put()
```

Project Info

- GIT - https://github.com/Tooblippe/Energy_Logger
- GIT Wiki - https://github.com/Tooblippe/Energy_Logger#readme
- Sparkfun – www.sparkfun.com
- Arduino – www.arduino.cc
- OpenEnergyMonitor - http://openenergymonitor.org/emon/
- My RF12 data hub - https://github.com/Tooblippe/Energy_Logger/wiki/The-RF12-Radio
- RF12 Radio on its carrier - http://www.flickr.com/photos/tooblippe/5665521708/

More about me

- www.navitas.co.za/tobienortje

Project licence

- Free as in really free... give us a mention and we are happy, but you don't have to.

OpenEnergyMonitor info

- OpenEnergyMonitor is copyright © 2009,2010,2011 the OpenEnergyMonitor researchers (see developers), and other contributors.
- Principal author:
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