

Linuxcon 2011

Power Monitoring with Linux

<http://marc.merlins.org/linux/talks/PowerMonitoring/>

Marc MERLIN

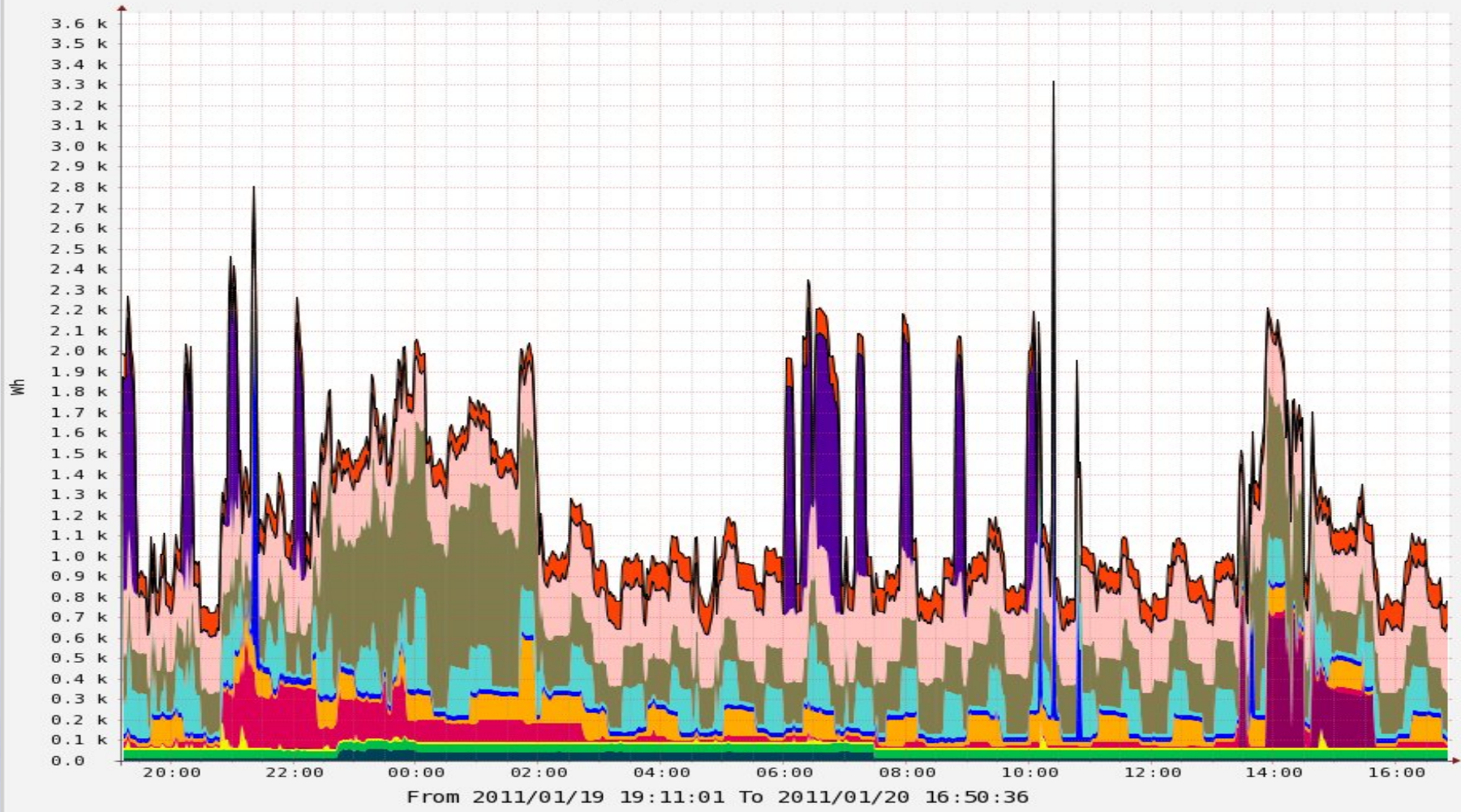
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Quick Outline

- How to Monitor Power
- Power Monitoring options
- Xbee Radios for wireless serial data
- How to monitor with a Brultech ECM1240
- Ecmread.py and parseecmpower
- Cacti Basics
- Graphing power with cacti
- Questions

Aggregate House Use (ECM)



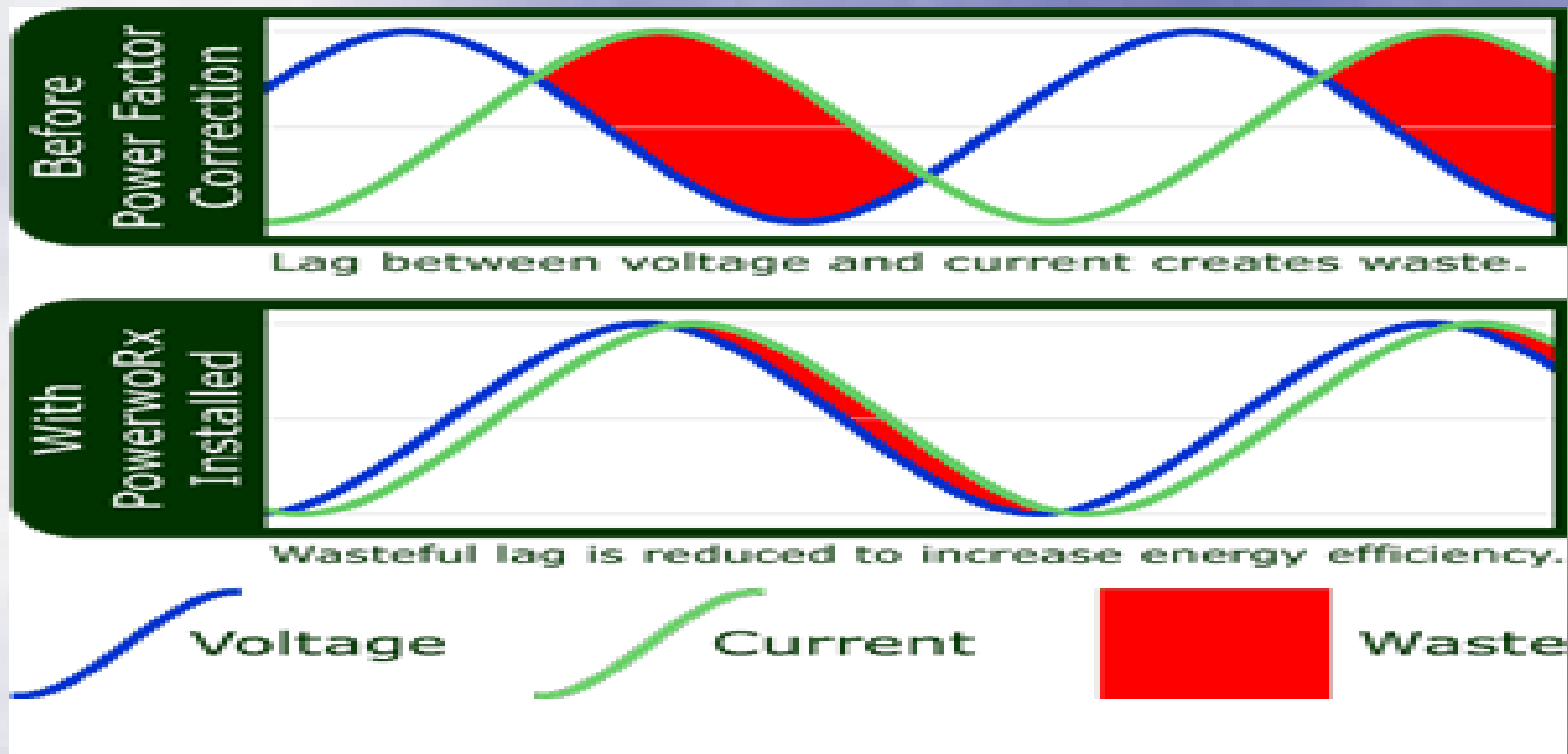
■ LVR Plugs/Kitchen Vent	Current:	12.9 Wh	Average:	25.2 Wh	Min:	10.4 Wh	Max:	59.1 Wh
■ Computer Office/BR4	Current:	39.0 Wh	Average:	39.5 Wh	Min:	38.0 Wh	Max:	63.3 Wh
■ Garage Plugs1	Current:	11.0 Wh	Average:	13.3 Wh	Min:	10.7 Wh	Max:	134.9 Wh
■ Washer/Dishwasher	Current:	0.7 Wh	Average:	32.8 Wh	Min:	0.0 Wh	Max:	675.7 Wh
■ All Lights	Current:	9.0 Wh	Average:	60.4 Wh	Min:	7.8 Wh	Max:	515.6 Wh
■ Kitchen Fridge	Current:	17.0 Wh	Average:	74.2 Wh	Min:	15.8 Wh	Max:	412.6 Wh
■ Kitchen Plugs/Microwave	Current:	22.2 Wh	Average:	38.8 Wh	Min:	20.6 Wh	Max:	2514.4 Wh
■ Garage Plugs2/Fridge/Yard Lights	Current:	20.1 Wh	Average:	119.4 Wh	Min:	16.2 Wh	Max:	500.1 Wh
■ MythTV/AV System/FMR Plugs	Current:	199.4 Wh	Average:	325.9 Wh	Min:	195.7 Wh	Max:	851.7 Wh
■ Computer Closet	Current:	326.1 Wh	Average:	307.1 Wh	Min:	244.8 Wh	Max:	380.8 Wh
■ Furnace and Fans	Current:	8.0 Wh	Average:	105.6 Wh	Min:	7.7 Wh	Max:	1108.3 Wh
■ AC	Current:	0.0 Wh	Average:	0.0 Wh	Min:	0.0 Wh	Max:	0.0 Wh
■ Unmonitored House Use	Current:	116.4 Wh	Average:	103.2 Wh	Min:	-11.7 Wh	Max:	141.5 Wh
■ ALL ITEMS	Current:	0.0 Wh	Average:	1139.2 Wh	Min:	0.0 Wh	Max:	3264.6 Wh
■ Total House Use	Current:	781.8 Wh	Average:	1245.4 Wh	Min:	724.6 Wh	Max:	3318.0 Wh

Measuring Power Use

- You pay for Watts
- $\text{Watts} = \text{Volts} * \text{Current} * \text{Power Factor}$
- This is why VA (given on UPSes) is different from Watts
- Power Factor is offset between Current and Voltage curves
- PF can be as low as 60% on motors or some PC power supplies.
- **Any power solution that only measures current is worthless for giving you watts and real power use.**

Power Factor

- Having a PF close to 1 lowers line transmission losses, not just for the power company, but you too.
- Device needs watts, if PF is low, VA is higher, so A is higher, therefore more voltage and power lost due to wiring losses.
- I have seen 120V lines with 110V or less due to wiring losses

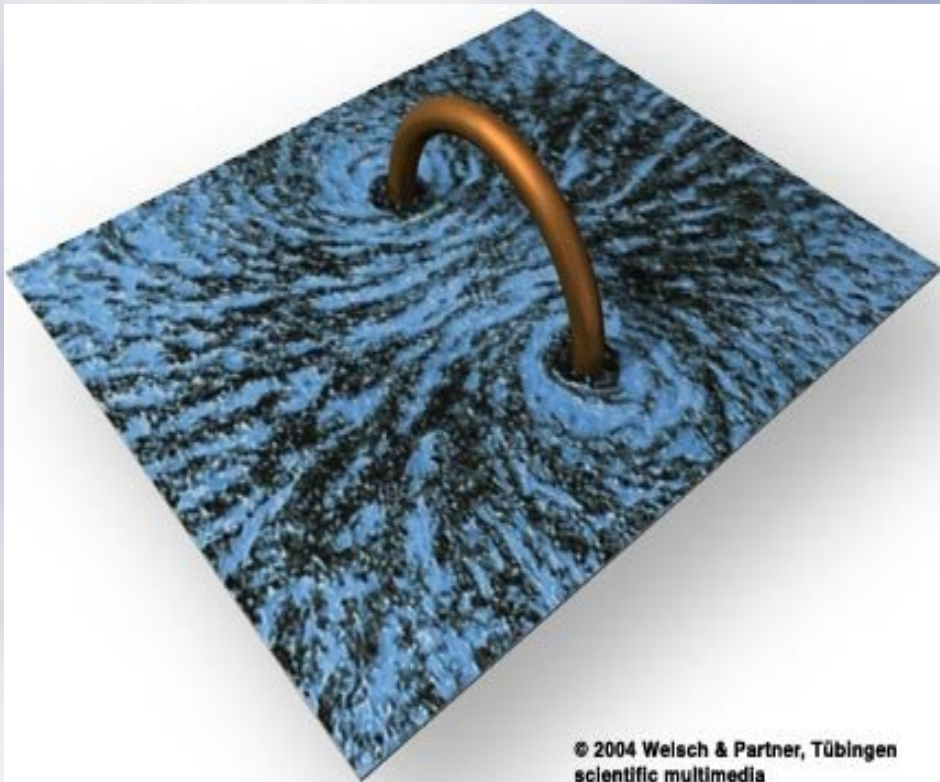


Measuring devices

- Clamp
- Cheap In line adapter (Watt's up)
- UPS
- Circuit Breaker Panel probes

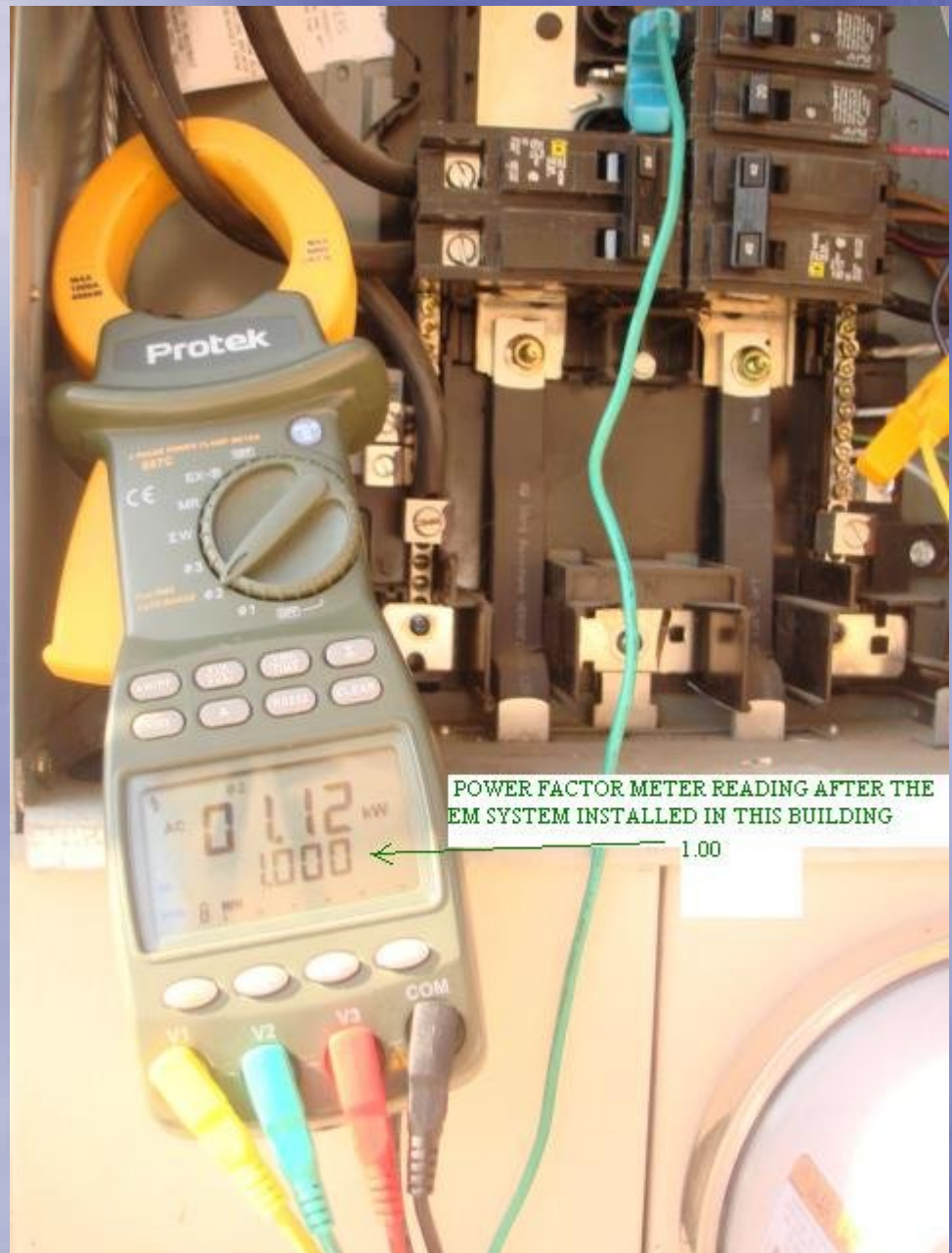
Clamp Meters

- Picks up magnetic field generated by AC current
- Current creates magnetic field
- Loop of copper in magnetic field picks up current (that's how a dynamo works)



Clamp Meters with PF

- Some clamps can give you real watts and PF
- Requires getting voltage sine wave for offset computation



Watts Up / Kill a Watt

- Kill a Watt meters are cheap (\$40-ish).
- They're pretty accurate
- Only useful close to the end devices
- Mostly no logging or remote capability.
- Well... until...



Zigbee / Xbee

XBEE MODULES



Zigbee / Xbee

- Simple, small and cheap serial radios
- RS232 interface
- Analog and digital IO can be sampled and transmitted
- Can be run independently (without a computer or arduino).
- Series 1 modules are Point to Point or Broadcast
- Series 2 (aka 2.5) support Mesh Networking for greater range.
- Coordinator, Routers, and End device modules as determined by which firmware you flashed.

Zigbee / Xbee

- Module takes care of routing in mesh networks and retransmission of lost data (up to a buffer size).
- Analog and digital IO can be sampled and transmitted
- Low power use (10mA when not sleeping)
- Xbee Pro modules transmit at 60mW instead of 1mW
- Can run on 3.3V or somewhat less
- Perfect for embedded use
- Here comes tweet-a-watt

Tweet a Watt

- <http://www.ladyada.net/make/tweetawatt/> (\$120)



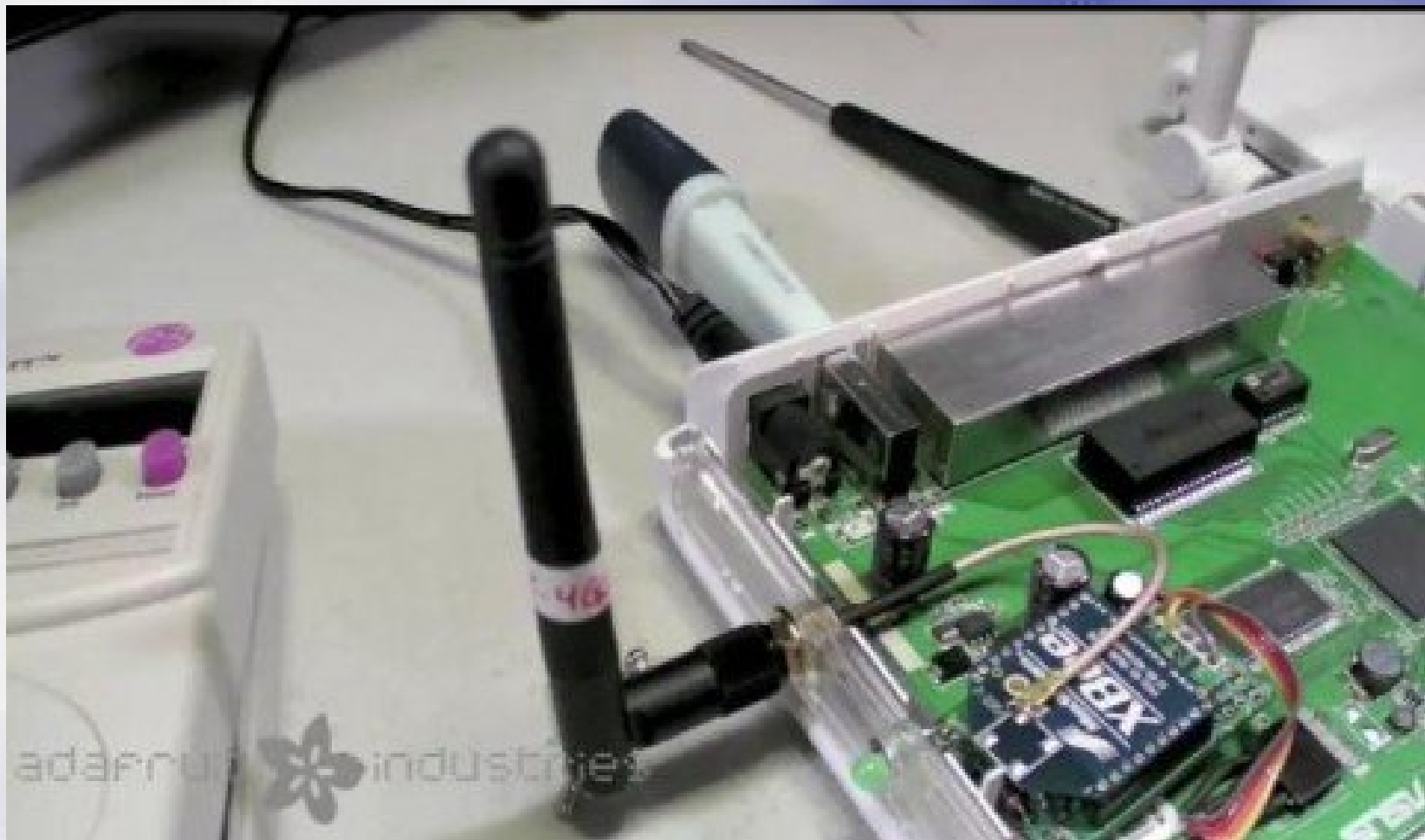
Xbee receiving on PC

- PC USB/serial interface from sparkfun or adafruit



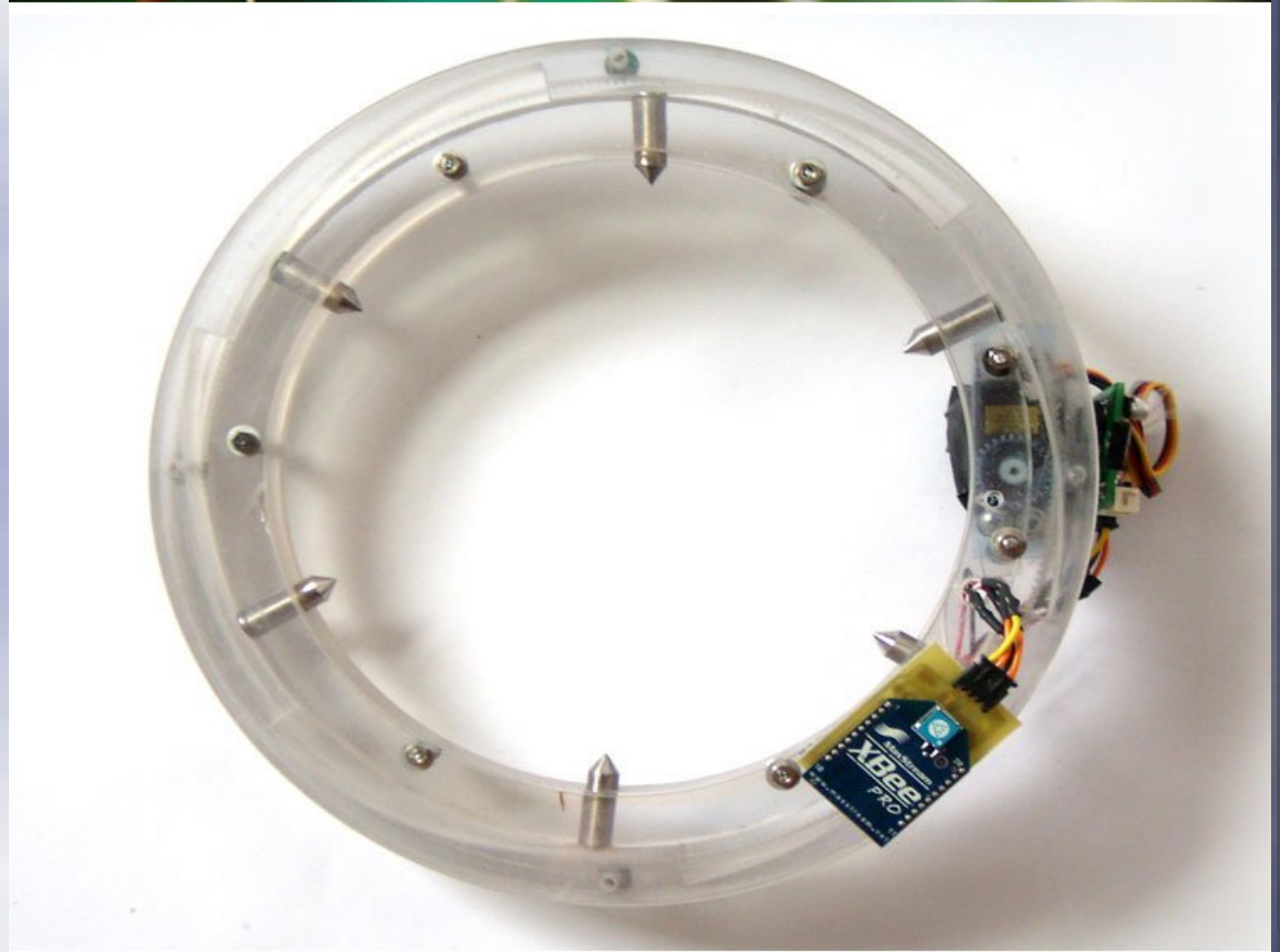
Xbee receiving on router/arduino

- If receiving from a PC is not desirable (remote locations, power usage or uptime of monitor), a 5W wireless router can be used, or a $<100\text{mW}$ arduino.



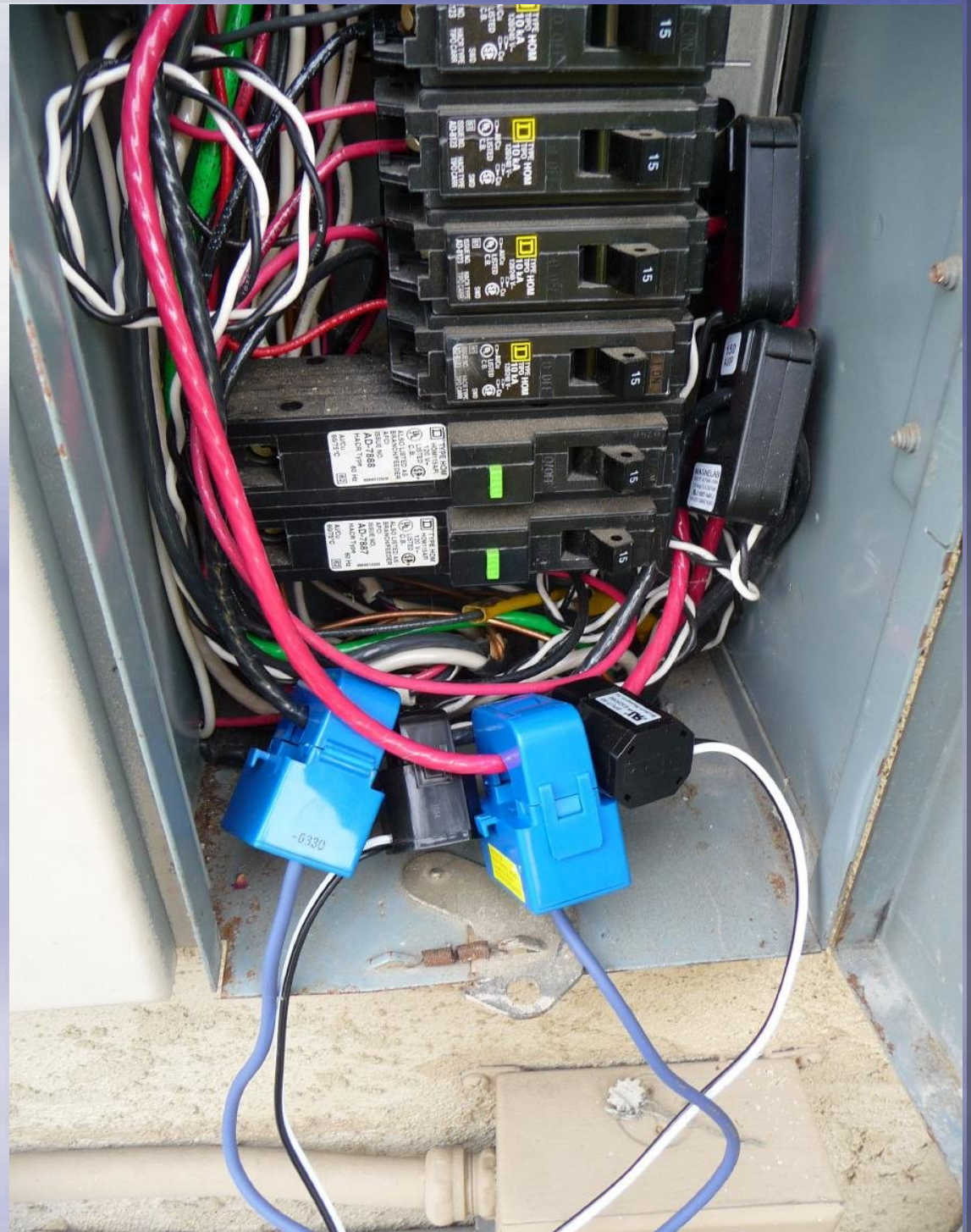
Alternate Xbee Receiver

- A user contributed receiver can educate the user into using less power :)



Direct Panel Monitoring

- Several solutions use Cts (current transducers)
- Do not trust them unless they monitor voltage too.
- Relatively safe to install.



XPL

- XPL is a network protocol to broadcast sensor data
- Rfxcom receivers work with xpl-rfxcom or Iranger's rfx-xpl.
- <http://misterhouse.wikispaces.com/X10RFX10SecRFXCOM>
- Rfxcom can be used to receive power data from rfxmeters
- Sample (non power) data received via rfxcom/rfx-xpl:

```
STR918,WGR918 addr: 232, chan: 0 wind: 33 ° NNE, speed 1.20 m/s / 2 kts average 1.00 m/s / 1 kts battery level 100%
RGR126,RGR682,RGR918 addr: 147, chan: 0 rain: total 1157 mm, 0 mm/hr, count 9
STR918,WGR918 addr: 232, chan: 0 wind: 48 ° NE, speed 1.60 m/s / 3 kts average 1.00 m/s / 1 kts battery level 100%
THGR918 addr: 225, chan: 1 temp: 23.70 °C / 74.66 °F hum: 43 % comfort battery level 80%
STR918,WGR918 addr: 232, chan: 0 wind: 49 ° NE, speed 1.60 m/s / 3 kts average 1.00 m/s / 1 kts battery level 100%
BTHR918N,BTHR968 addr: 230, chan: 0 temp: 26.50 °C / 79.70 °F hum: 45 % normal baro: 1014 Hg / 29.94 inHg, forecast: partly cloudy
STR918,WGR918 addr: 232, chan: 0 wind: 42 ° NE, speed 2.20 m/s / 4 kts average 1.00 m/s / 1 kts battery level 100%
THGR918 addr: 225, chan: 1 temp: 23.70 °C / 74.66 °F hum: 43 % comfort battery level 80%
STR918,WGR918 addr: 232, chan: 0 wind: 357 ° N, speed 1.40 m/s / 2 kts average 1.00 m/s / 1 kts battery level 100%
RGR126,RGR682,RGR918 addr: 147, chan: 0 rain: total 1157 mm, 0 mm/hr, count 9
```


Rfxmeter Monitoring

- 433.92Mhz rfxcom based
- Needs one monitor per leg
- Relatively expensive.
- Requires an rfxcom receiver (\$150-ish)



Ted 1001/5000-G

- CTs in the breaker panel.
- MTU reads CTs and encodes values over power line.
- Receiver in the house reads encoded data and displays or sends over the internet.
- Easy install.
- Does not play well with X10 or Insteon.
- Powerline coms not super reliable in some houses.
- **Only monitors house use, does not support power generation.**

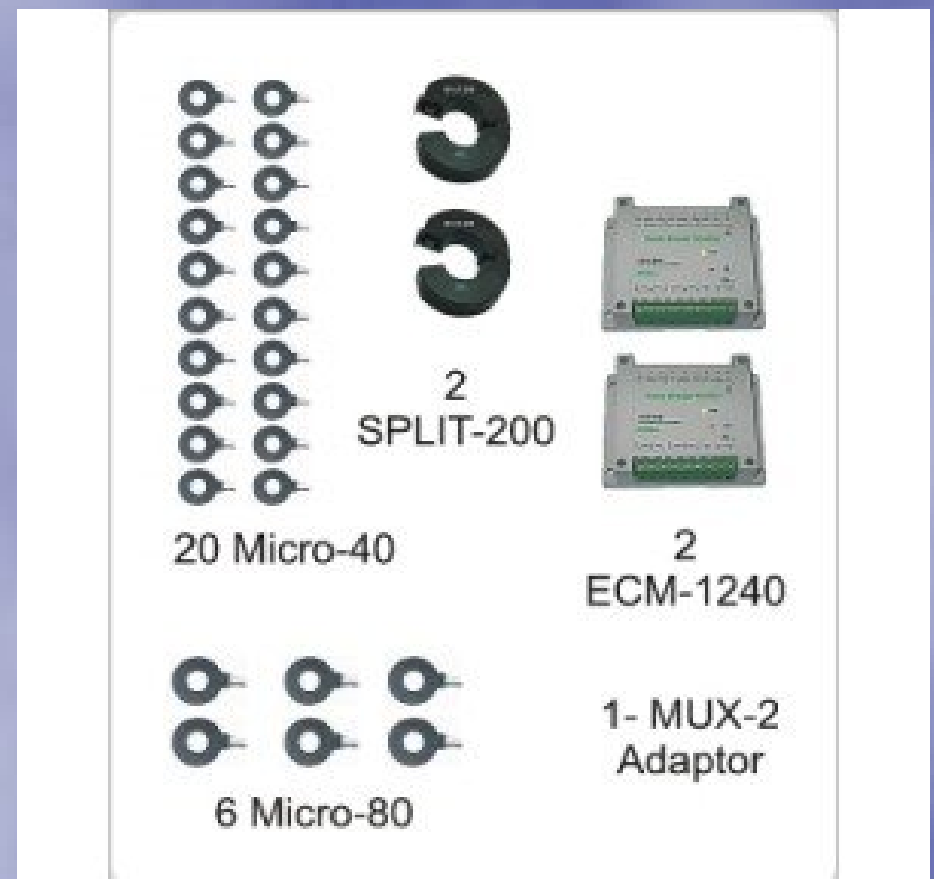


Brultech ECM1240

- Uses an AC to AC converter to pick up phase offset between current and voltage and compute PF.
- 120 and 240V compatible.
- Can sample 7 currents, 2 of which directional (allows for solar panels and other generation).
- Lots of CTs (current transducers) to choose from.
- Serial, ethernet, or Zigbee (wireless) interface.
- Cheap (starts around \$200). Cheapest entire granular house monitoring option I found.
- Needs windows to configure, but platform independent python code to query the data (up to once a second).

Brultech ECM1240 options

- Choice of the most cost and space efficient CTs for each install. Multiple CTs can be bundled on one channel.
- Lots of monitoring for cheap. Options for \$176 and \$370.





1 Energy
ECM 1240
Renewable Energy Controller

2 Energy
ECM 1240
Renewable Energy Controller

CLASS 2 TRANSFORMER
MODEL: MHA12-500
INPUT: AC120V 50/60Hz 15W
OUTPUT: AC12V 500mA
DATE: 9906
MADE IN CHINA

12114812
CAT...
DATE...
12114812



us E325096
Bullech Research Inc

MICRO-40
us E325096
Bullech Research Inc

AD-9123
ISSUE NO.
HACR TYPE
TPO-CARR
SNB
LISTED
C.B.
A/CU
10 KA
120/240 V
TYPE HOM

AB-4710
ISSUE NO.
HACR TYPE
TPO-CARR
LISTED
C.B.
A/CU
10 KA
120/240 V
TYPE HOM

8162
TYPE/TPO HOMT
(1) 2P & (2) 1P
LISTED C.B.
AD-4348
ISSUE NO.
A/CU
HACR TYPE
TPO-CARR
120/240 V - CTL
468-200204501

Outside Poles
Non-Common Trip
Poles extencors.
disparo no comun
pôles extencurs
dechenement
non-commun
10 KA

ECM1240 Log Gathering

- ECM 1240 only has one device by your breaker panel
- Data is sent to a receiving PC or any device that can receive serial data and log it (wireless router with usb to serial port adapter, or even arduino with SD card if needed).
- Communication is over serial port (3 wires needed, more than one ECM can share the same cable), wireless serial via Zigbee, or ethernet to serial adapters.
- If at all possible, running a cat-5 cable and putting DB-9s on each side is the most reliable and cheapest.

ECM1240 Logs and ecmread.py

- Ecmread.py dumps data from serial port.
- Samples Voltage and 7 Watt.second counters
- The 2 main channels count amps in both directions (solar panels).
- Multiple CTs can be linked to one channel (house lights).

```
2010/05/28 20:00:21: Volts:                120.00V
2010/05/28 20:00:21: Ch1 Watts:            -2.104KWh ( 1995W) < PG&E
2010/05/28 20:00:21: Ch1 Positive Watts:   78.890KWh ( 1995W)
2010/05/28 20:00:21: Ch1 Negative Watts:  80.995KWh (  0W)
2010/05/28 20:00:21: Ch2 Watts:           -140.897KWh ( -14W) < PV
2010/05/28 20:00:21: Ch2 Positive Watts:   0.012KWh (  0W)
2010/05/28 20:00:21: Ch2 Negative Watts: 140.909KWh ( 14W)
2010/05/28 20:00:21: Aux1 Watts:          40.387KWh ( 306W) < Computer Closet
2010/05/28 20:00:21: Aux2 Watts:          31.272KWh ( 200W) < MythTV/AV System
2010/05/28 20:00:21: Aux3 Watts:           4.456KWh (  51W) < Computer Office/BR4
2010/05/28 20:00:21: Aux4 Watts:           0.000KWh (  0W) < AC
2010/05/28 20:00:21: Aux5 Watts:           8.665KWh (  20W) < Kitchen Fridge
```

ecmread.py and parseecmpower

- ECM can send ASCII data, but only at 0.5Hz. 1Hz refresh rate is obtained by sending binary updates.
- Ecmread.py decodes the binary, computes the positive and negative counters.
- Ecmread.py can do basic data uploading to some cloud services, but not recommended due to possible data glitches. It does not track historical data at parsing time (stateless logging).
- Parseecmpower reads logged data, filters out bad data samples due to serial port glitches as well as counter jumps and resets.
- Raw data stored on disk can be used by parseecmpower to be (re-)parsed and uploaded to cacti, or any cloud service (current data and old data can be back-filled).

Parseecmpower daily report

```
gargamel:/var/log/ecm# PLOGFILE=archive/201108/ecmread1.20110808 parseecmpower --ecm1 20110808
Get timer offsets from /var/tmp/parseecmpower_tmp.counter_offsets
```

Hourly Differences

00_:	0.8Kwh/\$0.1	House1	0.0Kwh/\$0.0	ACI	0.8Kwh/\$0.1	HouseNoACI	0.0Kwh/\$0.0	PVI	0.8Kwh/\$0.1	PG&E I
01_:	0.8Kwh/\$0.1	House1	0.0Kwh/\$0.0	ACI	0.8Kwh/\$0.1	HouseNoACI	0.0Kwh/\$0.0	PVI	0.8Kwh/\$0.1	PG&E I
02_:	0.9Kwh/\$0.1	House1	0.0Kwh/\$0.0	ACI	0.9Kwh/\$0.1	HouseNoACI	0.0Kwh/\$0.0	PVI	0.9Kwh/\$0.1	PG&E I
03_:	0.8Kwh/\$0.1	House1	0.0Kwh/\$0.0	ACI	0.8Kwh/\$0.1	HouseNoACI	0.0Kwh/\$0.0	PVI	0.8Kwh/\$0.1	PG&E I
04_:	0.8Kwh/\$0.1	House1	0.0Kwh/\$0.0	ACI	0.8Kwh/\$0.1	HouseNoACI	0.0Kwh/\$0.0	PVI	0.8Kwh/\$0.1	PG&E I
05_:	1.0Kwh/\$0.1	House1	0.0Kwh/\$0.0	ACI	1.0Kwh/\$0.1	HouseNoACI	0.0Kwh/\$0.0	PVI	1.0Kwh/\$0.1	PG&E I
06_:	0.8Kwh/\$0.1	House1	0.0Kwh/\$0.0	ACI	0.8Kwh/\$0.1	HouseNoACI	0.0Kwh/\$0.0	PVI	0.8Kwh/\$0.1	PG&E I
07_:	1.4Kwh/\$0.1	House1	0.0Kwh/\$0.0	ACI	1.4Kwh/\$0.1	HouseNoACI	-0.4Kwh/\$0.0	PVI	1.0Kwh/\$0.1	PG&E I
08_:	1.3Kwh/\$0.1	House1	0.0Kwh/\$0.0	ACI	1.3Kwh/\$0.1	HouseNoACI	-1.7Kwh/\$0.1	PVI	-0.4Kwh/\$0.0	PG&E I
09_:	0.9Kwh/\$0.1	House1	0.0Kwh/\$0.0	ACI	0.9Kwh/\$0.1	HouseNoACI	-3.2Kwh/\$0.3	PVI	-2.4Kwh/\$0.2	PG&E I
10_:	0.9Kwh/\$0.1	House1	0.0Kwh/\$0.0	ACI	0.9Kwh/\$0.1	HouseNoACI	-4.1Kwh/\$0.6	PVI	-3.2Kwh/\$0.5	PG&E I
11_:	0.8Kwh/\$0.1	House1	0.0Kwh/\$0.0	ACI	0.8Kwh/\$0.1	HouseNoACI	-4.5Kwh/\$0.7	PVI	-3.7Kwh/\$0.5	PG&E I
12_:	0.9Kwh/\$0.1	House1	0.0Kwh/\$0.0	ACI	0.9Kwh/\$0.1	HouseNoACI	-4.7Kwh/\$0.7	PVI	-3.8Kwh/\$0.6	PG&E I
13 ^o :	1.4Kwh/\$0.4	House1	0.0Kwh/\$0.0	ACI	1.4Kwh/\$0.4	HouseNoACI	-4.6Kwh/\$1.3	PVI	-3.2Kwh/\$0.9	PG&E I
14 ^o :	1.1Kwh/\$0.3	House1	0.0Kwh/\$0.0	ACI	1.1Kwh/\$0.3	HouseNoACI	-4.2Kwh/\$1.2	PVI	-3.1Kwh/\$0.9	PG&E I
15 ^o :	0.9Kwh/\$0.3	House1	0.0Kwh/\$0.0	ACI	0.9Kwh/\$0.3	HouseNoACI	-3.1Kwh/\$0.9	PVI	-2.2Kwh/\$0.6	PG&E I
16 ^o :	0.9Kwh/\$0.3	House1	0.0Kwh/\$0.0	ACI	0.9Kwh/\$0.3	HouseNoACI	-1.8Kwh/\$0.5	PVI	-0.9Kwh/\$0.3	PG&E I
17 ^o :	1.0Kwh/\$0.3	House1	0.0Kwh/\$0.0	ACI	1.0Kwh/\$0.3	HouseNoACI	-0.5Kwh/\$0.1	PVI	0.5Kwh/\$0.2	PG&E I
18 ^o :	0.9Kwh/\$0.3	House1	0.0Kwh/\$0.0	ACI	0.9Kwh/\$0.3	HouseNoACI	-0.1Kwh/\$0.0	PVI	0.8Kwh/\$0.2	PG&E I
19 ^o :	0.8Kwh/\$0.2	House1	0.0Kwh/\$0.0	ACI	0.8Kwh/\$0.2	HouseNoACI	-0.0Kwh/\$0.0	PVI	0.8Kwh/\$0.2	PG&E I
20_:	0.8Kwh/\$0.1	House1	0.0Kwh/\$0.0	ACI	0.8Kwh/\$0.1	HouseNoACI	0.0Kwh/\$0.0	PVI	0.8Kwh/\$0.1	PG&E I
21_:	0.8Kwh/\$0.1	House1	0.0Kwh/\$0.0	ACI	0.8Kwh/\$0.1	HouseNoACI	0.0Kwh/\$0.0	PVI	0.8Kwh/\$0.1	PG&E I
22_:	1.1Kwh/\$0.1	House1	0.0Kwh/\$0.0	ACI	1.1Kwh/\$0.1	HouseNoACI	0.0Kwh/\$0.0	PVI	1.1Kwh/\$0.1	PG&E I
23_:	1.4Kwh/\$0.1	House1	0.4Kwh/\$0.0	ACI	1.0Kwh/\$0.1	HouseNoACI	0.0Kwh/\$0.0	PVI	1.4Kwh/\$0.1	PG&E I

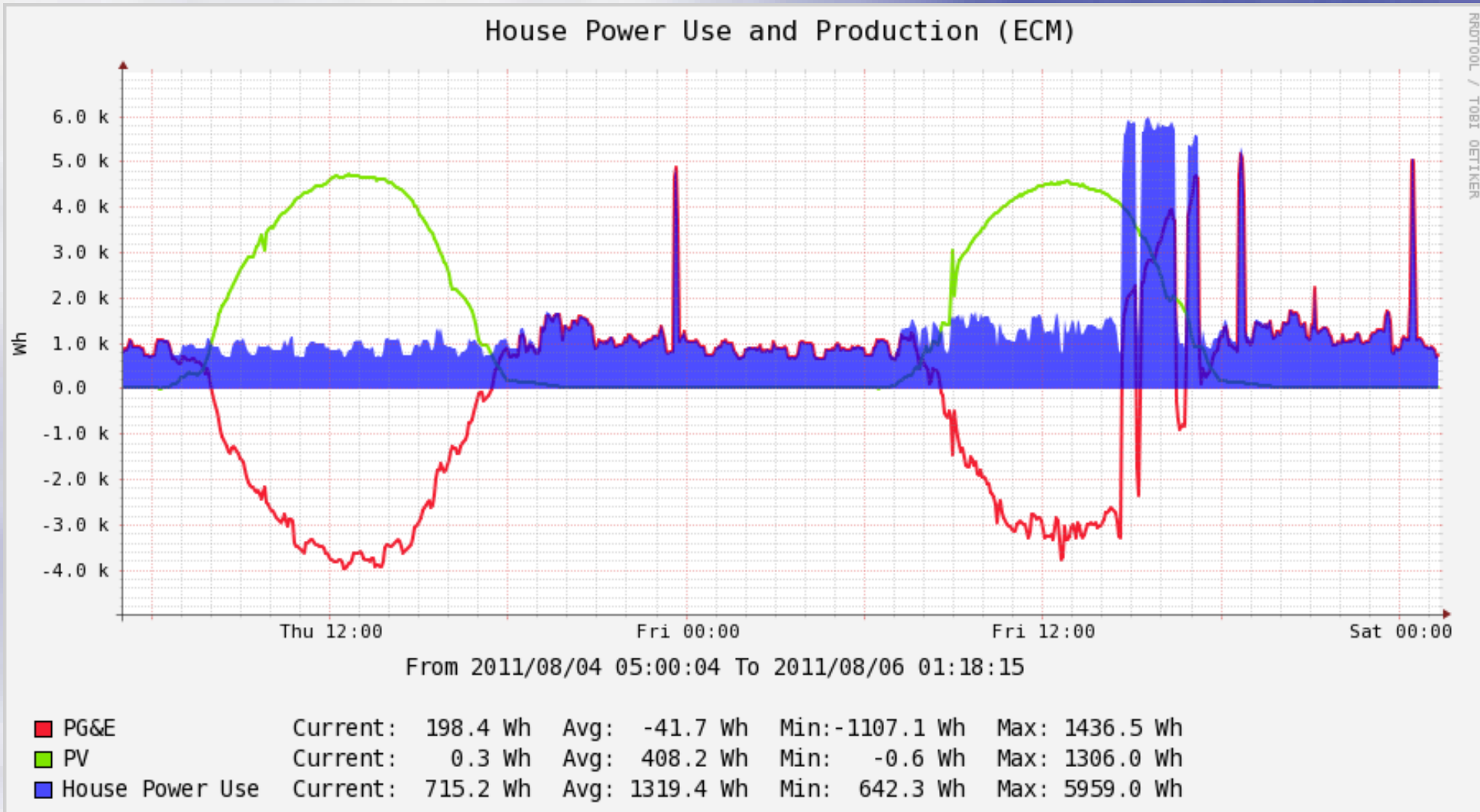
Mont: 23.9Kwh/ \$3.7House1 0.4Kwh/ \$0.0ACI 23.5Kwh/ \$3.7HouseNoACI 33.6Kwh/-\$6.6PVI -9.8Kwh/-\$2.9PG&E I

Split per rate:

\$.08	12.0Kwh/\$1.02	House1	0.4Kwh/\$0.03	ACI	11.6Kwh/\$0.98	HouseNoACI	-5.4Kwh/\$0.46	PVI	6.6Kwh/\$0.56	PG&E I
\$.14	4.3Kwh/\$0.63	House1	0.0Kwh/\$0.00	ACI	4.3Kwh/\$0.63	HouseNoACI	-13.3Kwh/\$1.92	PVI	-9.0Kwh/\$1.30	PG&E I
\$.29	7.1Kwh/\$2.10	House1	0.0Kwh/\$0.00	ACI	7.1Kwh/\$2.10	HouseNoACI	-14.4Kwh/\$4.21	PVI	-7.2Kwh/\$2.11	PG&E I

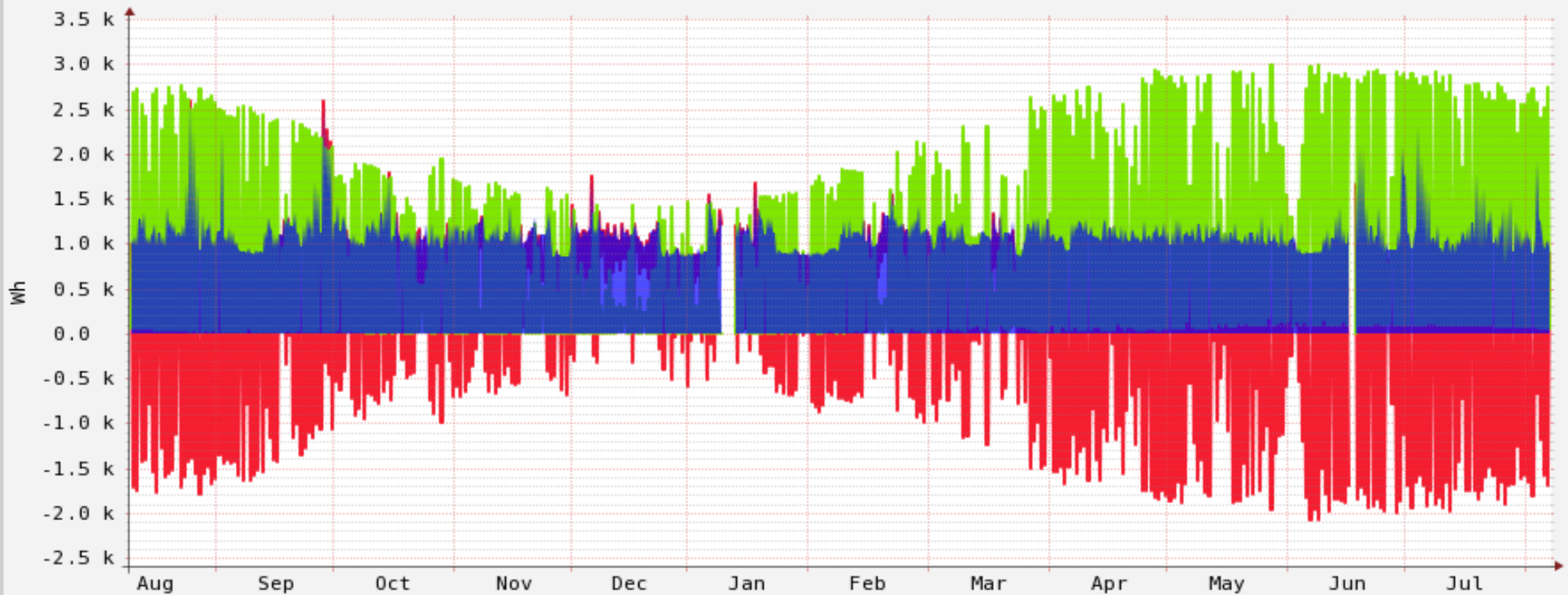
Solar panels produced 33.6Kwh during 11.80h, between 06:57:00 and 18:45:00

Graphing with Cacti



Graphing with Cacti

House Power Use and Production (ECM)

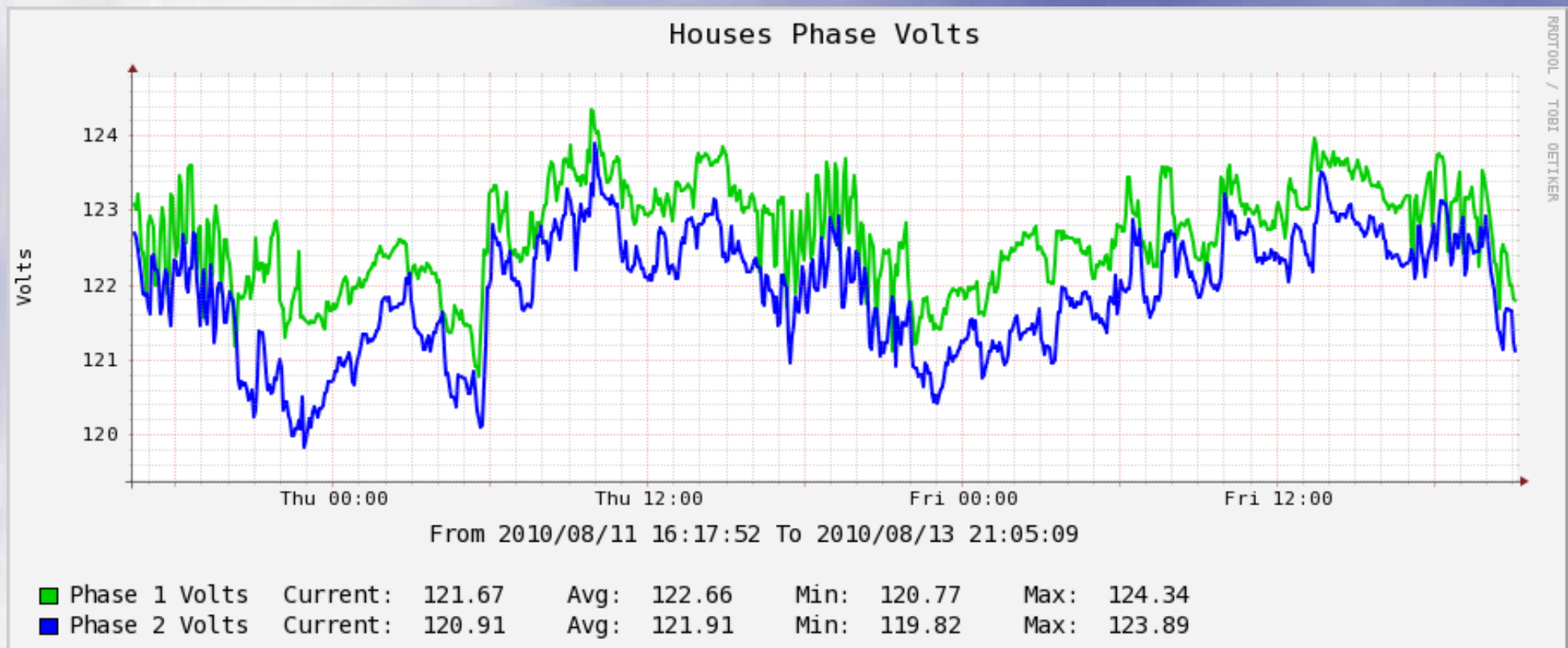


RRDTOOL / TOBI OETIKER

PG&E	Current: 247.7 Wh	Avg: 43.5 Wh	Min: -578.9 Wh	Max: 722.1 Wh
PV	Current: 15.1 Wh	Avg: 265.3 Wh	Min: 0.0 Wh	Max: 832.4 Wh
House Power Use	Current: 946.1 Wh	Avg: 1111.7 Wh	Min: 748.7 Wh	Max: 2612.6 Wh

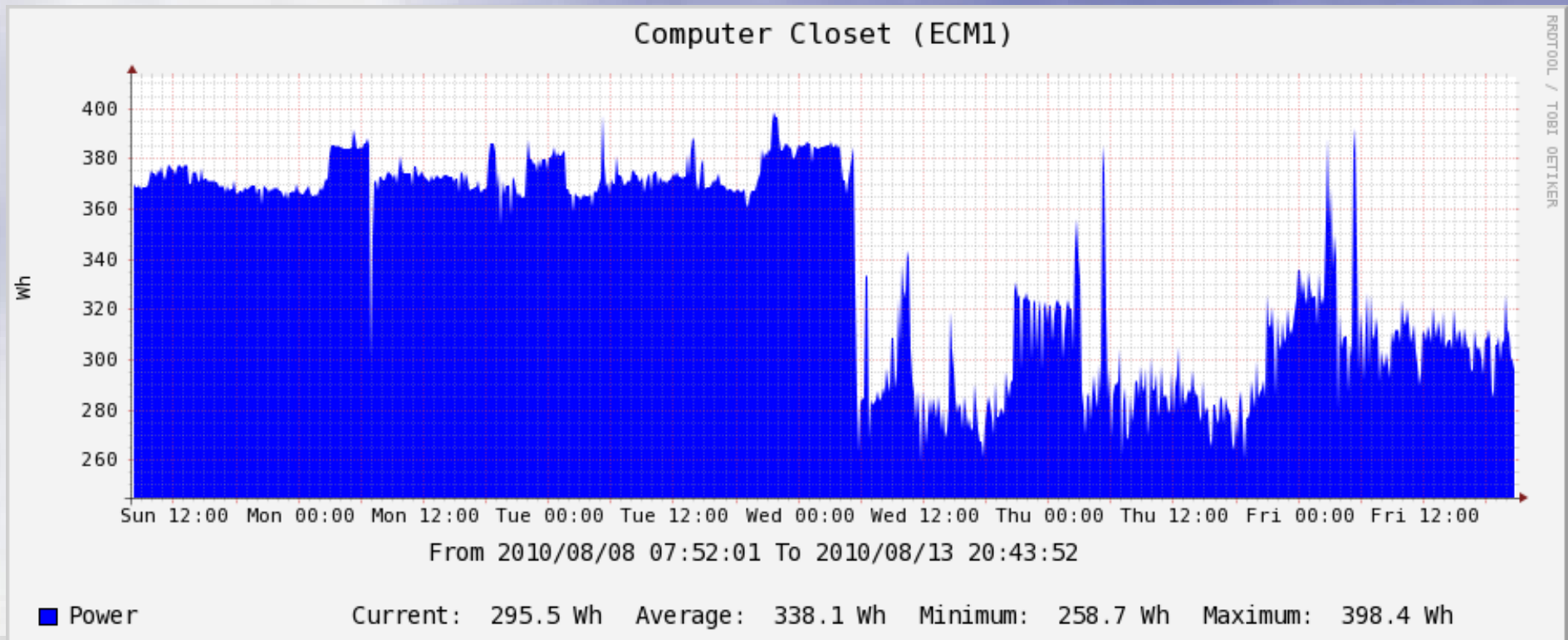
Phase volts mismatch

- It's good for a monitor to match the right phase voltage for each leg being monitored
- Phase mismatch is due to load imbalances between both phases.



Understanding the monitored loads

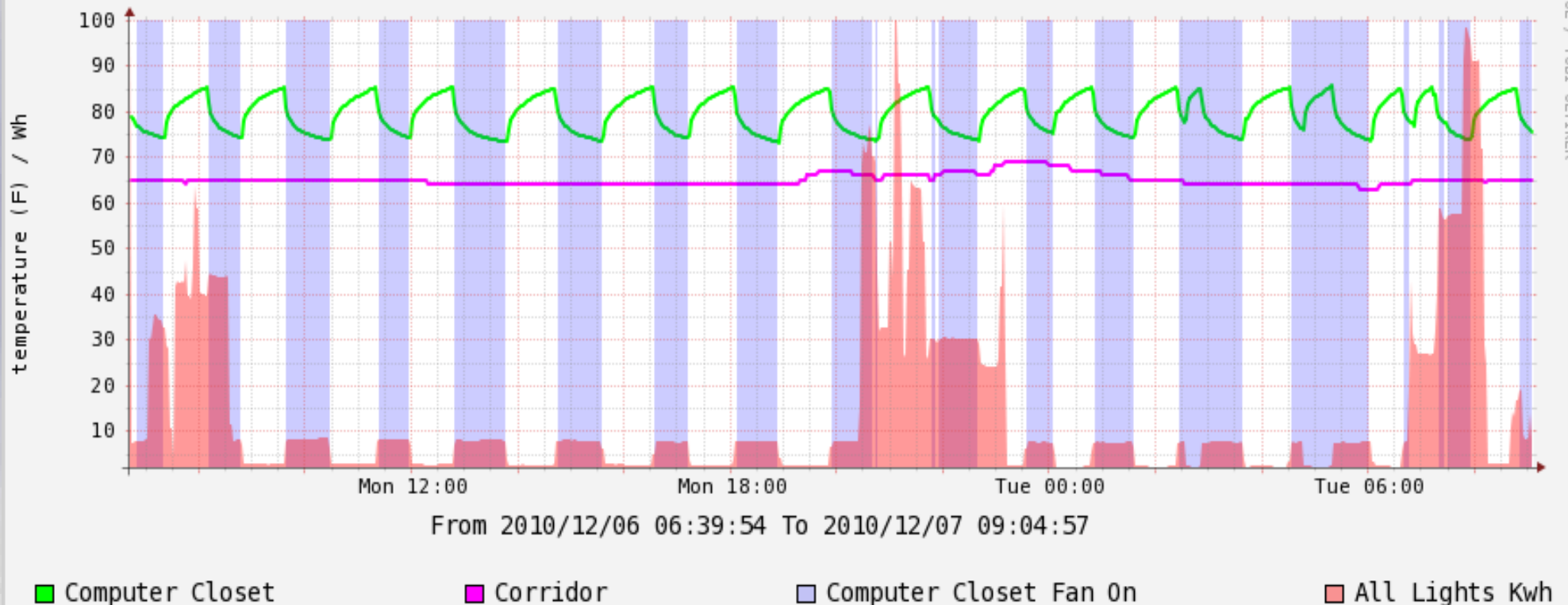
- You can see how much power each washing option in your dishwasher or washer uses, and decide.
- Use power at night if you can to balance the grid and if you have time of use pricing.
- Spin down unused hard drives in your disk arrays.



Composite cacti graphs

- It may be difficult to locate which circuit each one of your devices is on.
- In more tricky cases, a composite graph can show a fan turning on vs home automation logs and temperature changes

Computer Closet Fan vs Power Used on All Lights Breaker



Cacti Primer

- Full doc: <http://www.cacti.net/downloads/docs/html/>
- http://sysadmin.miniconf.org/2006/andrew-mcmillan-using_cacti.html
- Cacti is based on rrdtool, which stores data in single database-like files, RRDs (round robin database).
- Cacti is a web frontend to make rrdtool create, rrdtool update, and rrdtool graph more user friendly
- On the fly graph creation and data zooming/panning
- Graphs can be created based on data from multiple data sources (DS), even stored across multiple RRD files.
- RRD files are based on DS definitions and RRA (round robin archives) data aggregation rules.
- Use DERIVE for DS (counter that can go down).
- Data stored in RRD files but config data stored in mysql.

Cacti RRAs

- RRA (round robin archive) is meant to keep recent data for high precision time and switch to bigger time aggregates for older data.
- Because disk is cheap, I don't use aggregation much, see “no data loss” config tips:
http://docs.cacti.net/manual:087:8_rrdtool.03_big_rra
- Rrdtool graph will take the highest resolution data for any time period requested
- For graphing purposes to make cacti happy, good to define weekly and monthly ranges with AVG and MAX aggregation.
- Beware of the 2GB RRD file limit on 32bit systems.

Cacti Primer, RRA definitions

- RRAs are defined for step (minutes between samples), rows (how many minutes of data to store), and timespan (how wide the graph for that RRA should be).
- Cacti does not support updates of less than 1mn but rrdtool does => requires direct rrdtool update from cron instead of the cacti update job.

The screenshot shows the Cacti web interface. At the top, there are two buttons: 'console' (red) and 'graphs' (blue). Below them, the breadcrumb 'Console -> Round Robin Archives' is visible on the left, and 'Logged in as admin (Logout)' is on the right. A sidebar on the left contains a menu with items: 'Create', 'New Graphs', 'Management', 'Graph Management', 'Graph Trees', 'Data Sources', '--- RRAs', 'Devices', 'Collection Methods', 'Data Queries', 'Data Input Methods', 'Templates', 'Graph Templates', 'Host Templates', 'Data Templates', and 'Color Templates'. The main content area displays a table titled 'Round Robin Archives' with columns: 'Name', 'Steps', 'Rows', 'Timespan**', and 'Add'. The table lists various RRA configurations with their respective parameters and an 'Add' button (marked with a red 'X') for each.

Name	Steps	Rows	Timespan**	Add
Hourly (10sec avg for 1 month) / 1 hour range	1	446400	3600	X
Hourly (1 Minute Avg for 5Y) / 4 hour range	1	2628000	14400	X
Hourly (1 Minute Avg for 1Y) / 4 hour range	1	525600	14400	X
Daily (5 Minute Avg for 5Y) / 2 days range	5	525600	172800	X
Daily (5 Minute Avg for 30Y) / 2 days range	5	3153600	172800	X
Daily (5 Minute Avg/Max for 30Y) / 2 days range	5	3153600	172800	X
Weekly (30 Minute Avg/Max for 30Y) / 7 day range	30	525600	604800	X
Monthly (2 Hour Min/Avg/Max for 30Y) / 1 month range	120	131400	2678400	X
3 Month Per Day (1 Day Min/Avg/Max for 30Y)	1	10950	7884000	X
Yearly (1 Day Min/Avg/Max for 30Y) / 1 year range	1440	10950	31536000	X
Yearly Per Day (1 Day Min/Avg/Max for 30Y)	1	10950	31536000	X

Cacti: Planning RRDs

- RRDs are hard to manipulate and usually need to be re-generated from scratch when data fields need to be added, or precision needs to be changed.
- You can plan ahead by looking at the RRD that cacti generated (use debug mode), and recreate the same RRD file, but with dummy fields that can be changed to data fields later.
- Other RRD changes typically require regenerating the RRD file and resending all historical data (which parseecmpower can do).
- Remember to use 'turn on debug mode' in cacti's upper right corner for “data sources” and “graph management”.
- When needed, you can run your own rrdtool commands.

Cacti: Source Setup 1

console graphs

Console -> Data Sources -> (Edit)

House Power ECM1 Source

Data Template Selection [edit: House Power ECM1 Source]

Selected Data Template
The name given to this data template.

Host
Choose the host that this graph belongs to.

Data Source

Name
Choose a name for this data source.

Data Source Path
The full path to the RRD file.

Data Input Method
The script/source used to gather data for this data source.

Associated RRA's
Which RRA's to use when entering data. (It is recommended that you select all of these values).
 Hourly (1 Minute Avg for 5Y) / 4 hour range
 Hourly (1 Minute Avg for 1Y) / 4 hour range
 Daily (5 Minute Avg for 5Y) / 2 days range
 Daily (5 Minute Avg for 30Y) / 2 days range

Step
The amount of time in seconds between expected updates.

Data Source Active
Whether Cacti should gather data for this data source or not. Data Source Active

1: AC ✖ 2: Computer_Closet ✖ 3: Computer_Office-BR4 ✖ 4: Kitchen_Fridge ✖ 5: MythTV-AV_System ✖ 6: PGE ✖ 7: PV ✖ 8: spare0 ✖ 9: sp...

Data Source Item [edit: AC]

Internal Data Source Name
Choose unique name to represent this piece of data inside of the rrd file.


Minimum Value
The minimum value of data that is allowed to be collected.

Maximum Value
The maximum value of data that is allowed to be collected.

Data Source Type
How data is represented in the RRA.

Heartbeat
The maximum amount of time that can pass before data is entered as "unknown". (Usually 2x300=600)

Output Field
When data is gathered, the data for this field will be put into this data source.



Cacti: Source Setup 2

1: AC ✖	2: Computer_Closet ✖	3: Computer_Office-BR4 ✖	4: Kitchen_Fridge ✖	5: MythTV-AV_System ✖	6: PGE ✖	7: PV ✖	8: spare0 ✖	9: sp
Data Source Item [edit: AC]								
Internal Data Source Name Choose unique name to represent this piece of data inside of the rrd file.							<input type="text" value="AC"/>	
Minimum Value The minimum value of data that is allowed to be collected.							<input type="text" value="-1000000000"/>	
Maximum Value The maximum value of data that is allowed to be collected.							<input type="text" value="1000000000"/>	
Data Source Type How data is represented in the RRA.							DERIVE ▼	
Heartbeat The maximum amount of time that can pass before data is entered as "unknown". (Usually 2x300=600)							<input type="text" value="600"/>	
Output Field When data is gathered, the data for this field will be put into this data source.							AC - AC Use ▼	

Custom Data [data input: House Power ECM1]

No Input Fields for the Selected Data Input Source

Data Source Debug

```
/usr/bin/rrdtool create \  
/var/lib/cacti/rra/houseecm1_25.rrd \  
--step 10 \  
DS: Computer_Closet: DERIVE: 600: -1000000000: 1000000000 \  
DS: spare0: DERIVE: 600: -1000000000: 1000000000 \  
DS: spare1: DERIVE: 600: -1000000000: 1000000000 \  
DS: spare2: DERIVE: 600: -1000000000: 1000000000 \  
DS: spare3: DERIVE: 600: -1000000000: 1000000000 \  
DS: spare4: DERIVE: 600: -1000000000: 1000000000 \  
DS: Volts: GAUGE: 600: 0: 250 \  
DS: Kitchen_Fridge: DERIVE: 600: -1000000000: 1000000000 \  
DS: Computer_Office-BR4: DERIVE: 600: -1000000000: 1000000000 \  
DS: PV: DERIVE: 600: -1000000000: 1000000000 \  
DS: AC: DERIVE: 600: -1000000000: 1000000000 \  
DS: PGE: DERIVE: 600: -1000000000: 1000000000 \  
DS: MythTV-AV_System: DERIVE: 600: -1000000000: 1000000000 \  
DS: spare5: DERIVE: 600: -1000000000: 1000000000 \  
RRA: AVERAGE: 0.9: 1: 446400 \  
RRA: AVERAGE: 0.9: 1: 2628000 \  
RRA: AVERAGE: 0.9: 1440: 10950 \  
RRA: AVERAGE: 0.9: 120: 131400 \  
RRA: AVERAGE: 0.9: 5: 3153600 \  
RRA: MIN: 0.9: 1440: 10950 \  
RRA: MIN: 0.9: 120: 131400 \  
RRA: MAX: 0.9: 1440: 10950 \  
RRA: MAX: 0.9: 5: 3153600 \  
RRA: MAX: 0.9: 120: 131400 \  

```


Other Cacti Tips

- In `RRA:AVERAGE:0.5:1:446400` '1' means that points are averaged from 1 samples, `--step 10` given in `rrdtool create` actually sets the update interval (10 seconds)
- You can modify/recreate an RRD from the command line after cacti made one and remove/add AVG/MAX/MIN RRAs. They only help what `rrdtool` graph can display
- Cacti depends on mysql to work, backup your mysql data.
- Keep raw data outside of cacti in case you need to recreate your RRAs later.
- Look up `rrdtool` information when in doubt, cacti is just a frontend to `rrdtool`.
- You can create composite graphs from multiple data sources: <http://forums.cacti.net/viewtopic.php?p=195379> (for instance, unmonitored power data is meter data minus all monitored items)

Cacti: More than 1 update per minute

- Cacti has its own cron job that updates all its rrrds once per minute.
- If you uncheck 'data source active' in Data Source, cacti will not update the RRD, and you can do it yourself.
- Simple cronjob to do updates yourself.
- Such RRD updates continue even if mysql/cacti is broken.
- <http://forums.cacti.net/viewtopic.php?f=6&t=38765>

```
***** root for i in 1 2 3 4 5 6; do
  /usr/bin/rrdtool update /var/lib/cacti/rra/houseecm1_26.rrd
  --template `parseecmpower --ecm1 --cacti-dump-header`
  `/var/local/scr/parseecmpower --ecm1 --rrdtool`;
  sleep 9;
done
```

Power Monitoring Tips

- Consider logging your data in UTC more than local time. Daylight saving time switches will make your logging unhappy (parseecmpower will handle most artificial data jumps when time jumps back 1H and eventually data from 2:00 to 2:01 jumps by 1 hour's worth).
- When you wire multiple CTs to the same input (like multiple breakers for lights), make sure to orient each CT donut according to the phase so that you don't end up having lights on one phase canceling out induced current from lights on another phase.
- Setup monitoring to see when things go wrong. I had a mysql upgrade which contained a moronic change which moved logging to /var/run/mysql (thank you whoever did that) which will fill up /var/run tmpfs, cause mysql to crash, and cacti logging to stop.

Recreating an RRD after the fact

```
RRD=/var/lib/cacti/rra/houseecm1_25.new.rrd; /bin/rm $RRD
/usr/bin/rrdtool create $RRD --start 1274796960 --step 10 \
DS:Volts:GAUGE:600:0:250 \
DS:PGE:DERIVE:600:-1000000000:1000000000 \
DS:PV:DERIVE:600:-1000000000:1000000000 \
RRA:AVERAGE:0.5:1:2628000 \
RRA:AVERAGE:0.5:120:131400 RRA:MAX:0.5:120:131400 \
RRA:AVERAGE:0.5:1440:10950 RRA:MAX:0.5:1440:10950 \
RRA:AVERAGE:0.5:5:3153600 RRA:MAX:0.5:5:3153600
chown www-data.www-data $RRD
export PPLOGFILE="-"
( for i in /var/log/ecm/archive/20*/ecmread1.*.lzma; do xzcat $i;
done; for i in /var/log/ecm/archive/20*/ecmread1.*[0-9]; do cat $i;
done; cat /var/log/ecm/ecmread1 ) | stdbuf -oL parseecmpower
--ecm1 --cacti-dump > dump.ecm1 || exit

date; sort -u < dump.ecm1 | time xargs rrdtool update $RRD
--template `parseecmpower --ecm1 --cacti-dump-header`
date; /bin/mv houseecm1_25.rrd houseecm1_25.old.rrd
/bin/mv $RRD houseecm1_25.rrd
```


References

- http://marc.merlins.org/perso/linuxha/post_2010-08-13_Fine-grained-house-wid
- <http://www.ladyada.net/make/tweetawatt/>
- <http://www.slashgear.com/tweet-a-watt-prompts-xbee-router-hack-0640203/>
- <http://board.homeseer.com/showthread.php?t=126106>
- <http://www.theenergydetective.com/led-1001-footprints>
- http://www.brultech.com/home/store/product.php?id_product=39
- <http://www.cacti.net/downloads/docs/html/>
- <http://oss.oetiker.ch/rrdtool/tut/rrd-beginners.en.html>

Questions?

- This talk and documents:

<http://marc.merlins.org/linux/talks/PowerMonitoring/>