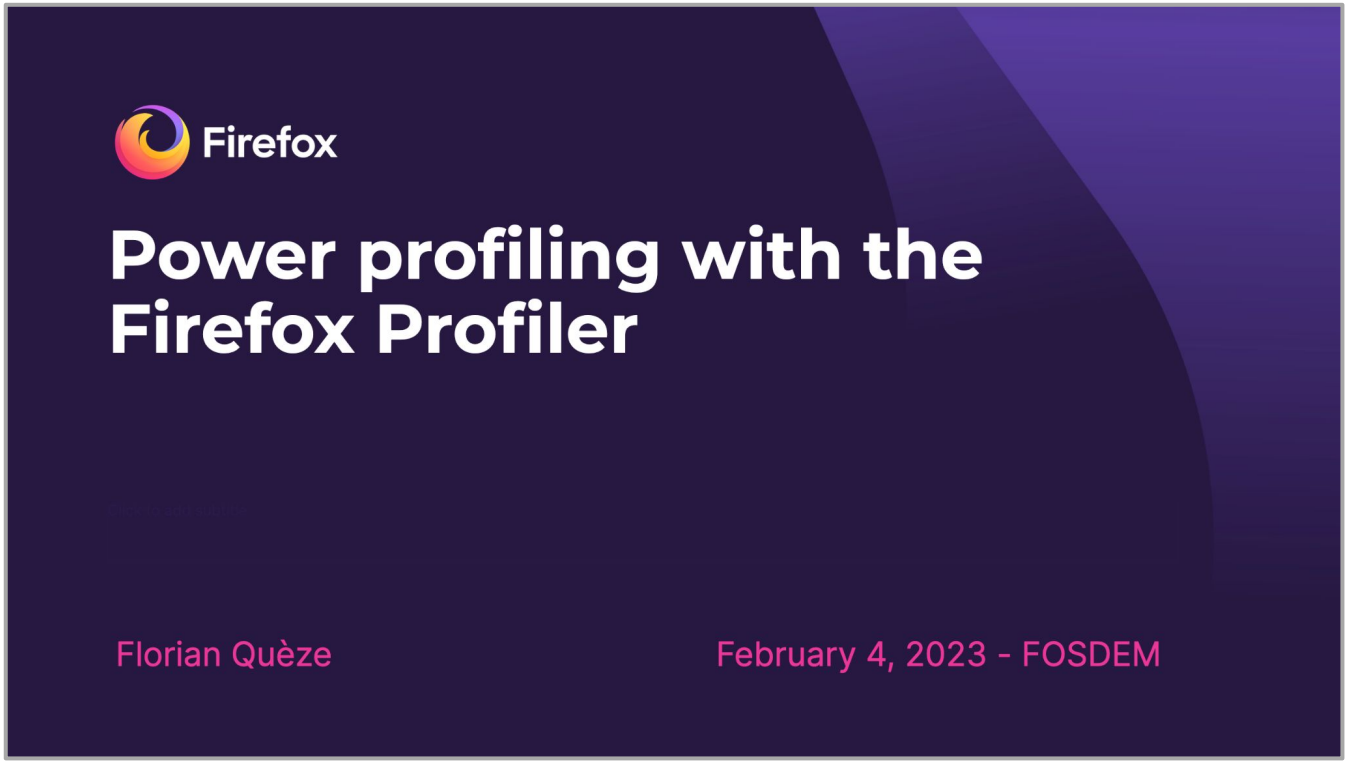
Power profiling my entire house with the Firefox Profiler

Florian Quèze

February 3, 2024 - FOSDEM

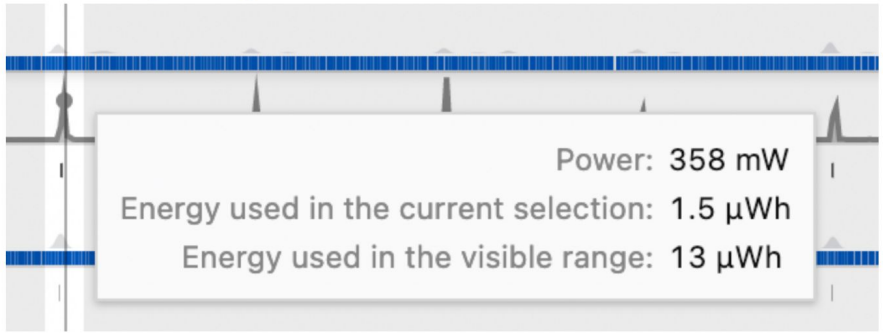
Last year...


Firefox
Power profiling with the Firefox Profiler
Florian Quèze
February 4, 2023 - FOSDEM

Last year...

Blinking the cursor

Measure tiny things:



Ever wondered how much power it takes to blink the caret in the address bar?
Now you can know! https://share.firefox.dev/3U8hLgp

32

More about web sustainability

Extended and updated version of my talk

- Main track (Jason)
- Sunday, 1pm

Table of contents

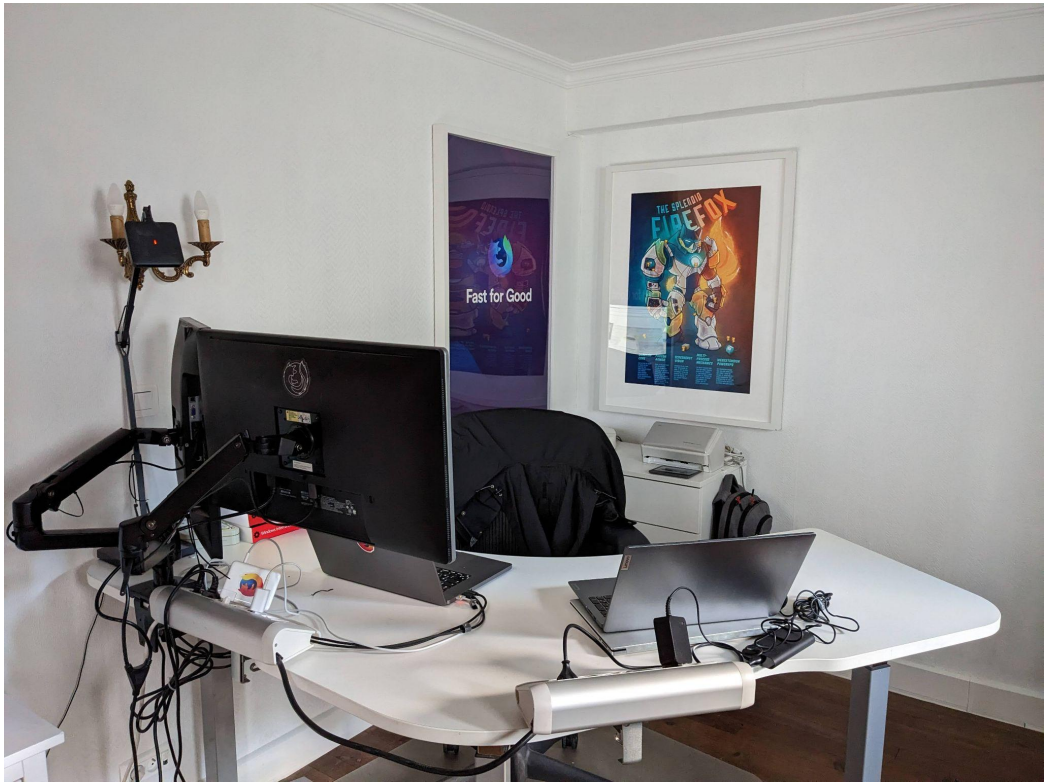
- Story
- Technical details
- Examples

Story

A more personal story...

A more personal story...

Can this power...



Questions need answers

Shelly 3EM

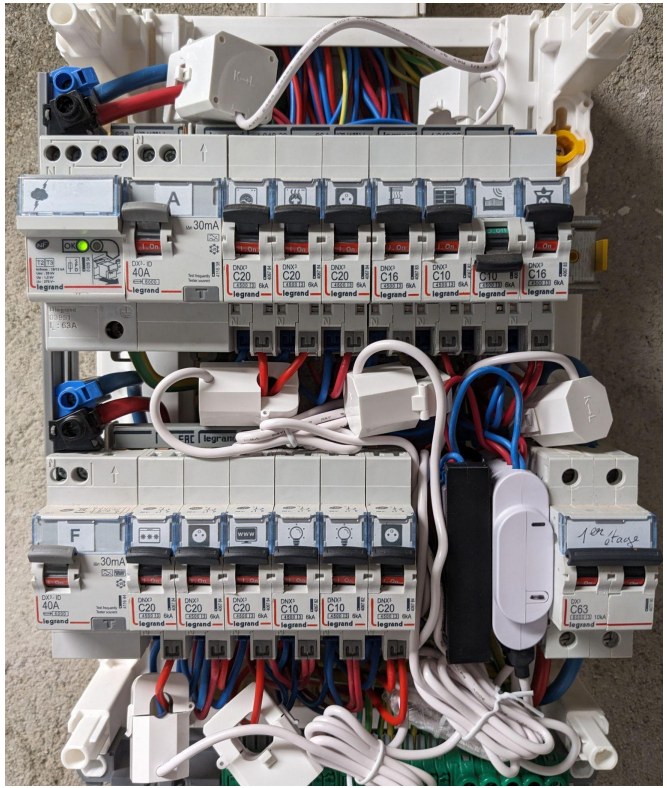
WiFi-operated 3 Phase Energy Meter

Metering:

- Link with the grid
- PV panels on the wall
- Home office

More questions

More energy meters



+ 2 * Shelly EM

Metering:

- The link with upstairs
- The freezer
- The boiler
- The washing machine / dryer

More energy meters

+ 2 * smart plugs

Metering:

- The bottle warmer
- The milk pump

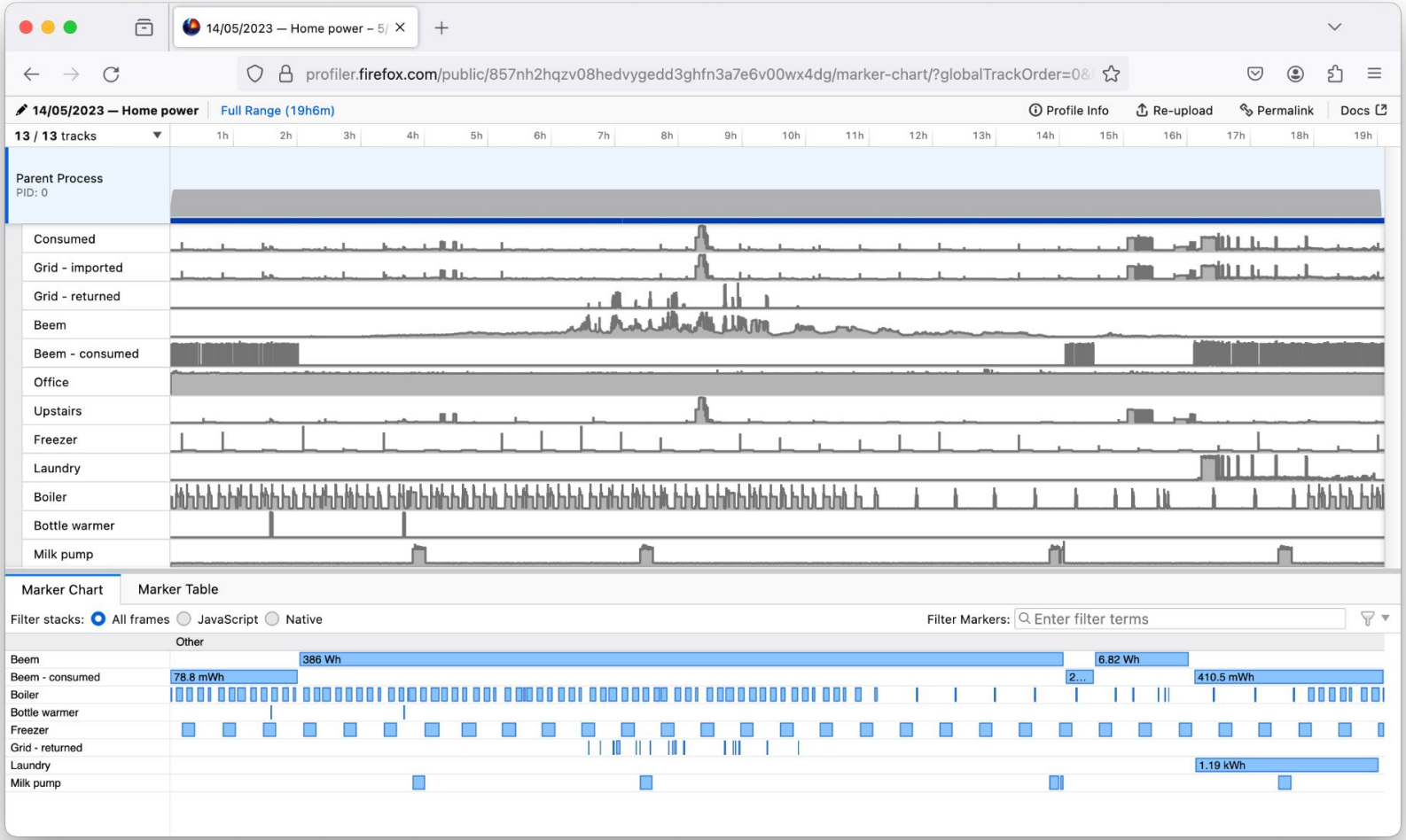
Technical details

Collecting, storing

- Nothing in the cloud
- power meters connected through wifi, and ‘parental control’ denying them Internet access
- They send data through MQTT (1Hz)
- An Ubuntu VM runs mosquitto (MQTT server)
- Scripts using mosquitto_sub and logrotate store the data on disk

Visualizing

- A node script reads files on the disk and returns a JSON file in the Firefox Profiler format
- Profiles contain:
  - Power counters
  - Markers



Oldest home power profile - https://share.firefox.dev/42mKIdm

What worked well

- Short hacking sessions at night
- Mozilla’s generous 12 weeks parental leave
- Quickly generating JSON that the profiler understands
- Generating links the profiler can open: https://profiler.firefox.com/from-url/http://mqtt.local/profile?20230514

What needed adjustments

- Units!

Add the minute and hour units for duration formats (eg. profile range duration). (PR #4621)

 fqueze committed 9 months ago · ✕ 8 / 9

Add the kWh unit for tooltips of power tracks. (PR #4622)

 fqueze committed 9 months ago · ✕ 8 / 9

What needed adjustments

- Performance

Draw power tracks faster by skipping samples that would be displayed on the same pixel.

fqueze committed 9 months ago · ✓ 17 / 18

What needed adjustments

- Custom carbon intensity

Add an optional gramsOfCO2ePerKWh field to the meta data of processed profile to enable customizing the carbon intensity of power tracks. (PR #4672)

 fqueze committed 8 months ago · ✓ 11 / 11

What needed adjustments

- Showing when something happened

Display the vertical line in the timeline when hovering the marker chart or stack chart (PR #4742)

 fqueze committed 5 months ago · ✓ 11 / 11

Show the hovered time in the ruler at the top of the timeline. (PR #4748)

 fqueze committed 5 months ago · ✗ 12 / 14

Display nicer time units in the timeline ruler for values that are better expressed in minutes or hours. (PR #4774)

 fqueze committed 4 months ago · ✗ 12 / 14

What needed adjustments

- Colors

Examples

Doing laundry

Washing (792 Wh)

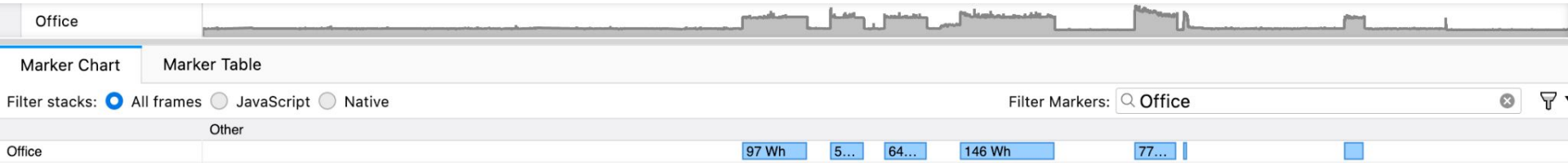
Washing (excluding the water heating)

Drying (754 Wh)

(modern dryer with a heat pump)

Home office

- Typical work day…



Power use show whenever I returned to my desk

- Unusual day

- Sunday

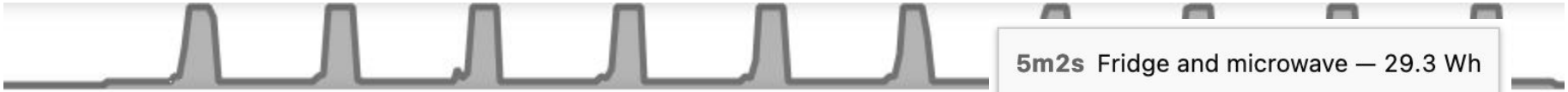
Office days - https://share.firefox.dev/3SrztvS https://share.firefox.dev/483NqWm

Breakfast

Using a microwave from the 90s

(inherited from my grandmother)

- Unfreezing bread for 5min (29Wh)



- Heating milk for 2min30s (64Wh)

5m2s Fridge and microwave — 29.3 Wh

Start time:	09:25:45
Total energy:	29.3 Wh
Cost:	0.6 c€
CO_2e Equivalent:	0.69 g
Maximal power:	1482.9 W
Average power:	348.93 W
Thread:	Parent Process

Quizz: Freezer vs fiber modem?

Freezer: 1.4kW for a few seconds then 70W for 14min, many times a day.

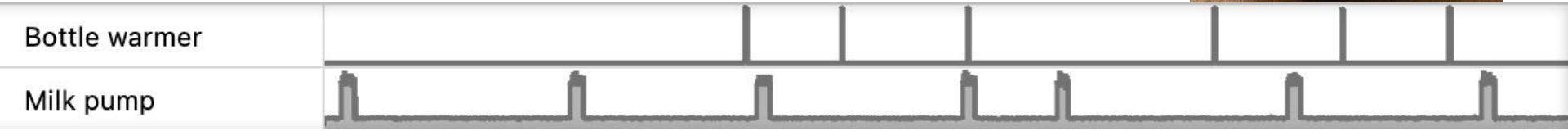
Modem: 27W, all day long.

Answer:

Breast milk

Milk pump: 7W for 15min
1.8 Wh

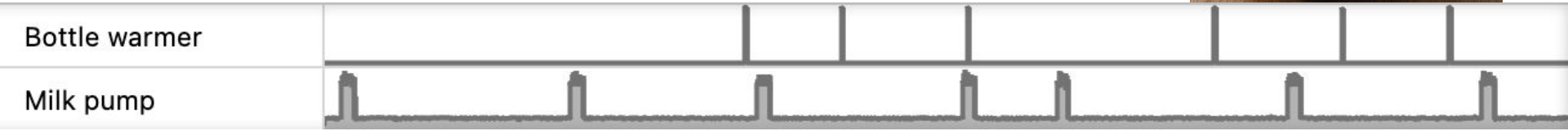
Bottle warmer: 400W for 2min
13 Wh



Breast milk max storage time

Pumped: 4h.

Refrigerated and reheated: 2h.



Breast milk

- Timings recorded from the power meters can also be re-used outside the profiler...

Breast milk - https://share.firefox.dev/480a16m

Summer break... visiting my parents

3kWc of PV panels had just been installed above their kitchen.

Enphase gateway

Measures power used and produced on each of the 3 phases.

- Sends data to the cloud.

  1 data point every 15min.
- Has a local HTTP API

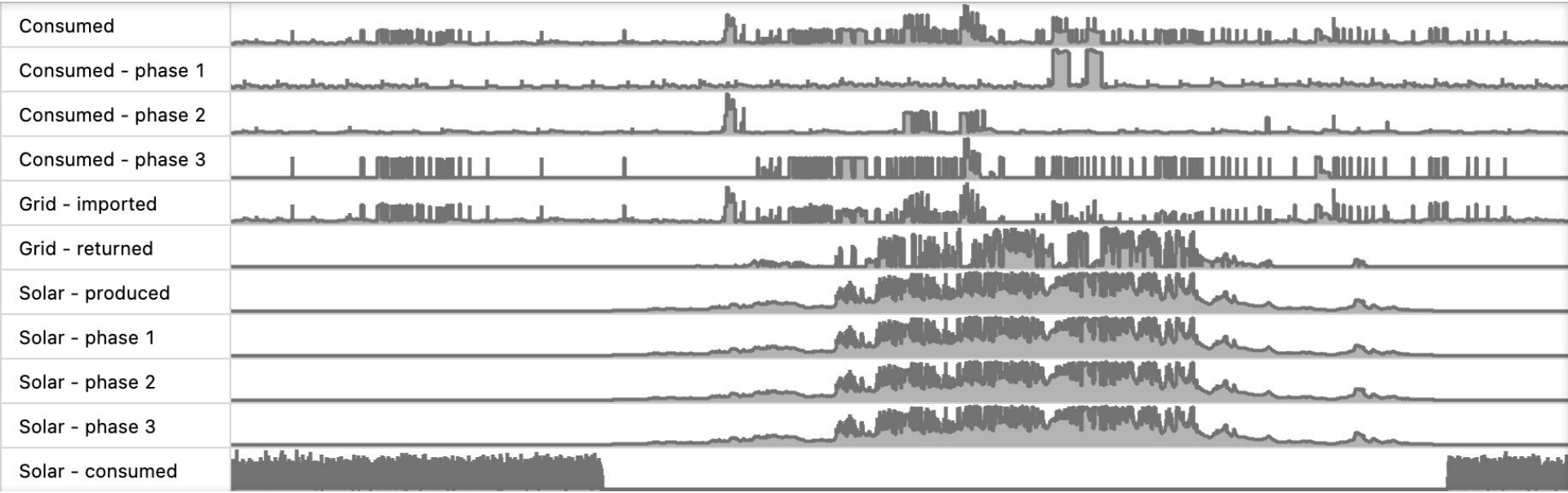
  Up to 1 data point per second.

  Per panel data every 5 minutes.

I put a Raspberry Pi that queries it every second.

Can (of course!) produce profiles.

Profiling their house (summer)

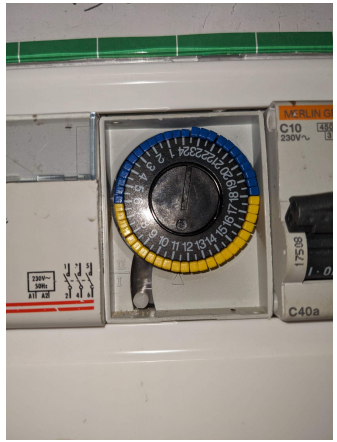


High power use throughout the day on phase 3 was strange.

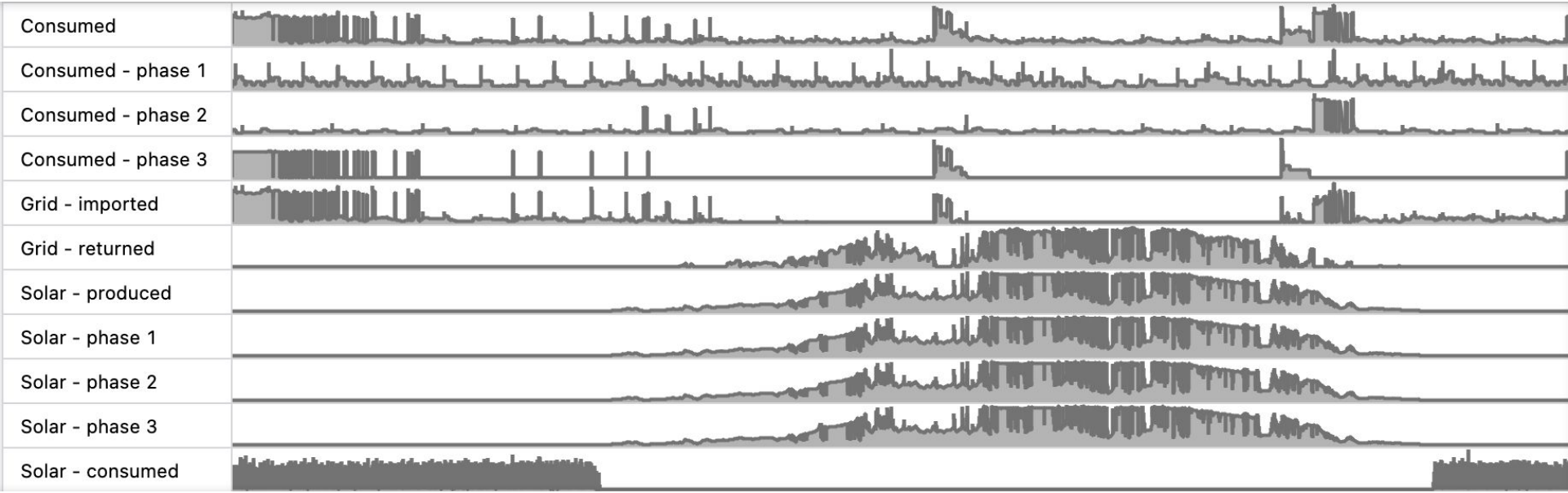
Enphase 3 phase profile - https://share.firefox.dev/3Sqt43X

Water heater

- 2.25 kW
- Supposed to run off-peak hours.
- The day/night contactor was on the “force on” position.



The next day

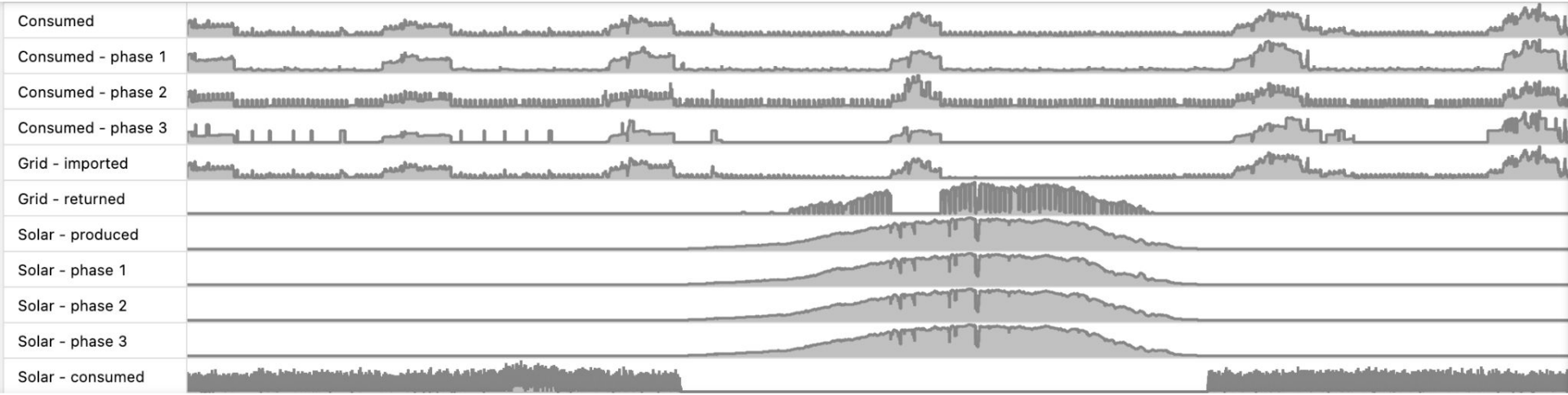


Fixed it! Water heating happened from 11:30pm until 7:30am.

Enphase 3 phase profile - https://share.firefox.dev/3Ot7Tgv

(large) heat pump with accumulator

(large) heat pump with accumulator



Circulator: 1.5 kW on phase 2

Heat pump: up to 10 kW, spread on the 3 phases

Heat pump - https://share.firefox.dev/3SFStlj

Back at home, magic happened

Fast forward… December and another baby picture

- She’s grown quite a bit.
- She has a passion for trees.
- We had to get her a nice Xmas tree.

Quizz

Xmas tree

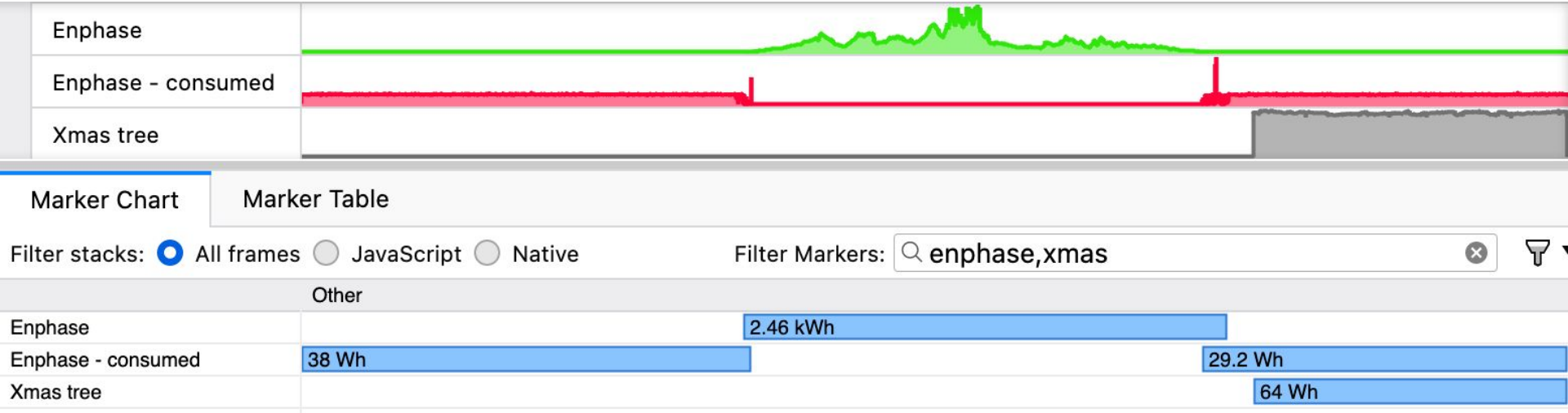
- Turns on at sunset
- Turns off at midnight

Enphase system

- Produces power during daylight
- Idle power use at night

At night - https://share.firefox.dev/49laVeE

Quizz - answer



Xmas tree:
Enphase system at night:
(but produced 2.47 kWh during the day)

At night - https://share.firefox.dev/49laVeE

Bonus

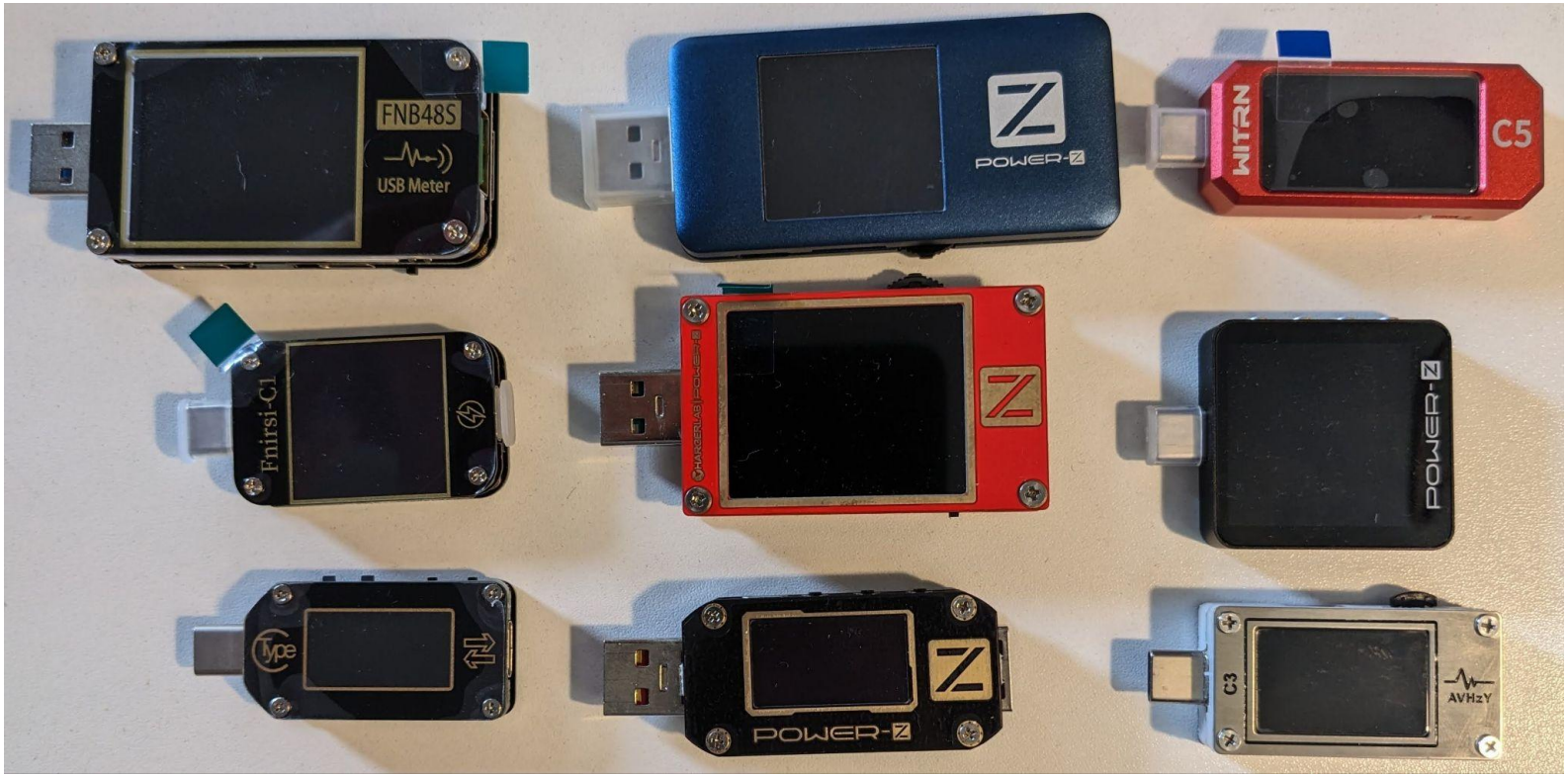
A few more things

More power meters

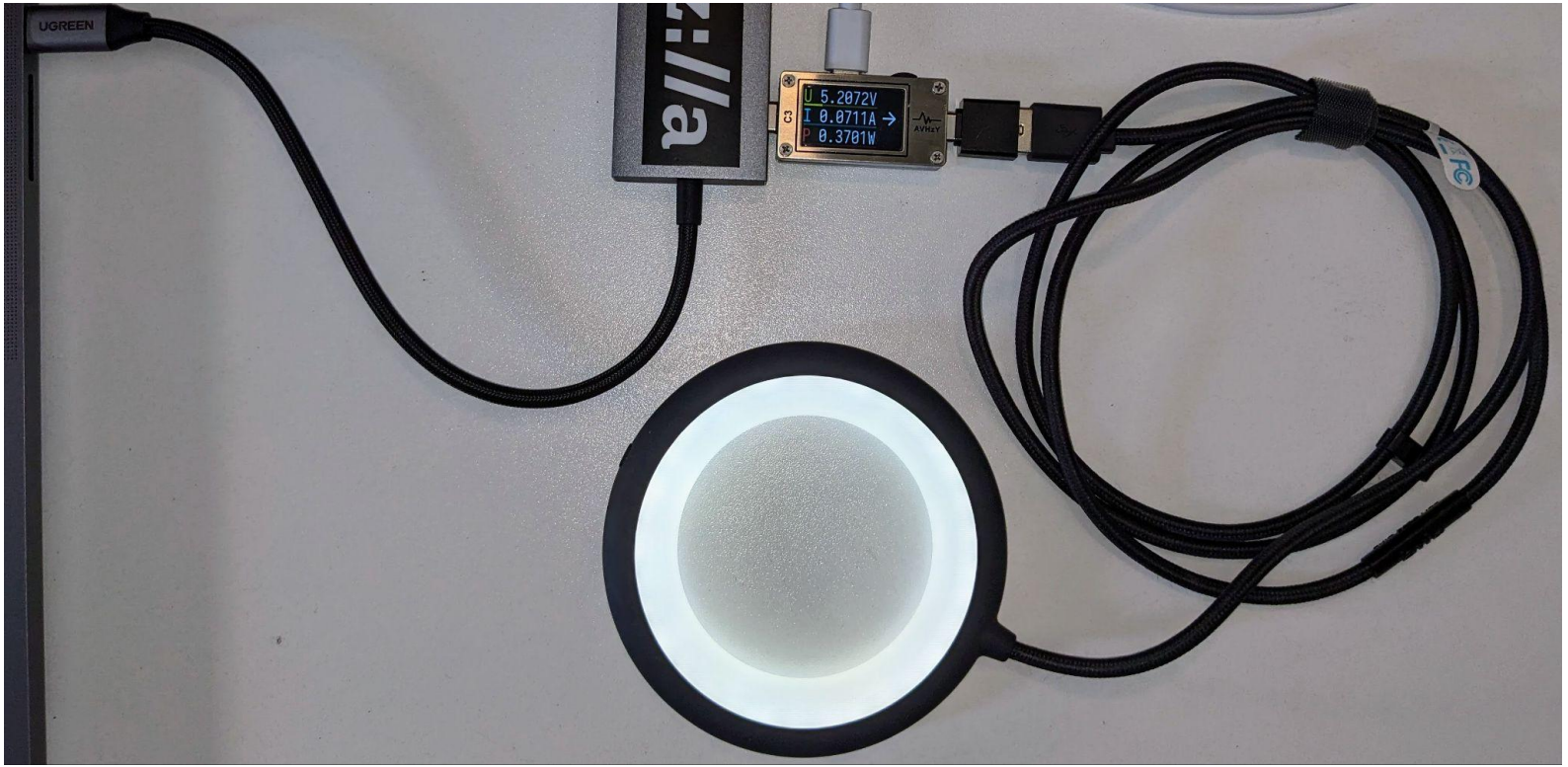
PowerSpy2

- Sends data other bluetooth
- 50Hz sampling

USB power meters



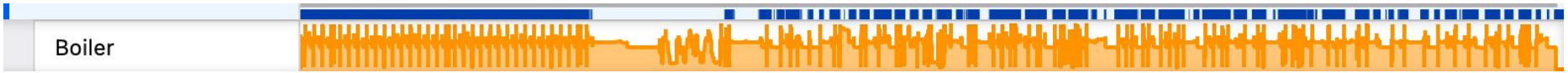
USB power meters



https://github.com/fqueze/usb-power-profiling

Next

- Figure out a way to recover data when the wifi is unstable:



profile of the boiler, with many missing samples - https://share.firefox.dev/49o2cZr

- Clean-up the code to make it easy to use by others.
- Blog some power profiles of appliances and devices.

Conclusion

Power profiling at a high sampling rate helps to:

- understand how things work (for curiosity’s sake)
- find and fix ‘bugs’ (eg. water heater at my parents’)
- optimize consumption of power from PV panels.

Thanks! Questions?

- Questions: florian@mozilla.com
- Talk tomorrow at 1pm in Janson,

  Firefox power profiling:

  A powerful visualization of web sustainability