Monitoring your home, with DevOps observability tools

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Berlin Buzzwords 2024

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Slides, Code, Config, Scripts

github.com/Gagravarr/BBuzz2024-HomeMonitoring

All code+config mentioned in slides is available from here

Links, build instructions, screenshots etc too

Who was here last year?

Specifically...

Steve L's talk

Alexa, is The Smart Home vision failing?

Good news - no terrible propriatary systems needed!

If you want fancy, open source home automation

If you want fancy, open source home automation

Home Assistant

https://www.home-assistant.io/

But if you're not sure yet...

But if you're not sure yet...

What about just collecting some data?

Gather a baseline, make changes later!

What data?

What data?

- How much power am I using?
- How much power is that using?
- How does my power use vary? And when?
- How much solar energy am I generating?
- How full is my battery?
- What is the temperature?
- How has the temperature changed recently?
- What is the humidity?

These are...

Interesting eco-home questions

Common DevOps questions (ish)

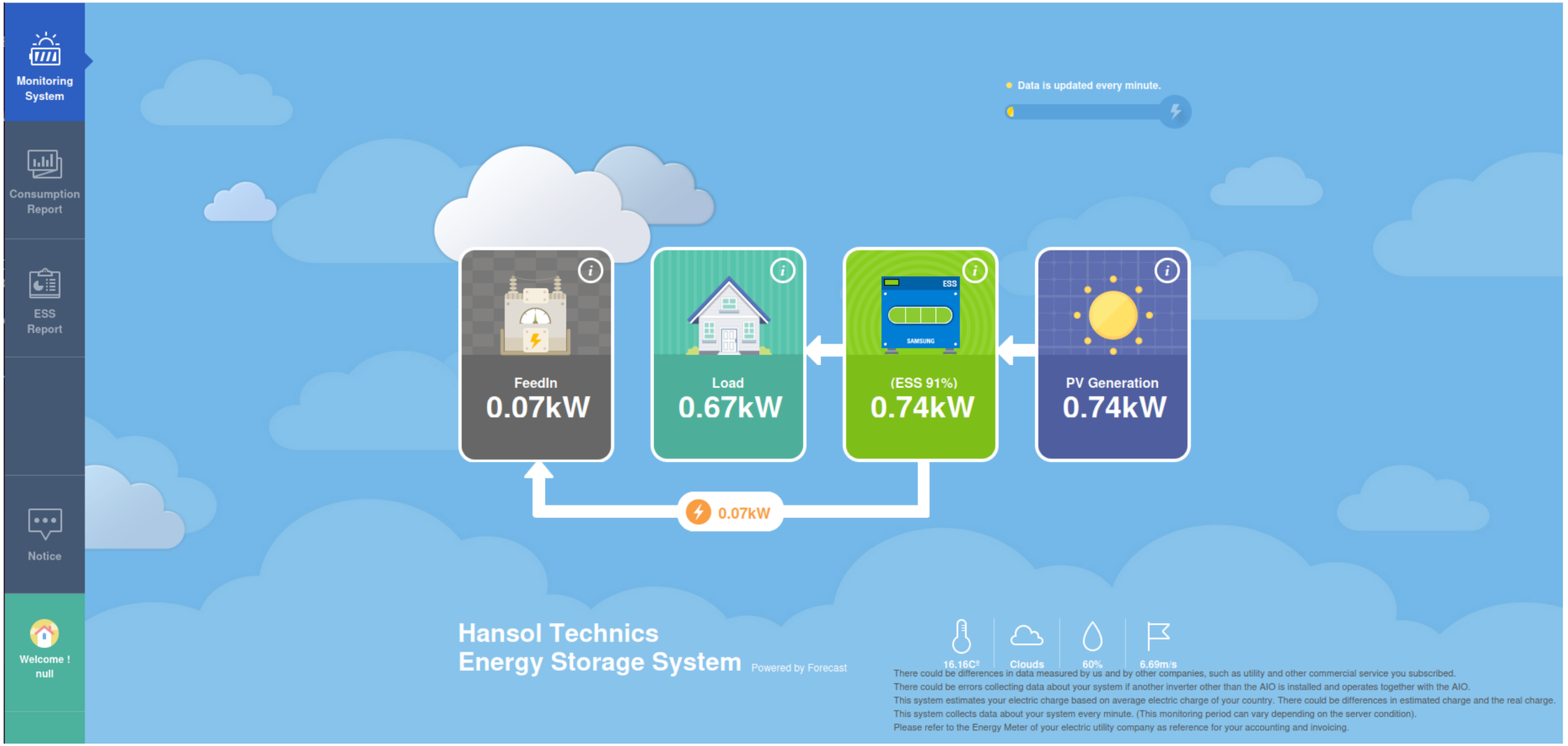
A lot of green-tech / eco-home stuff is half-abondoned, or worse....

A lot of green-tech / eco-home stuff is half-abondoned, or worse....

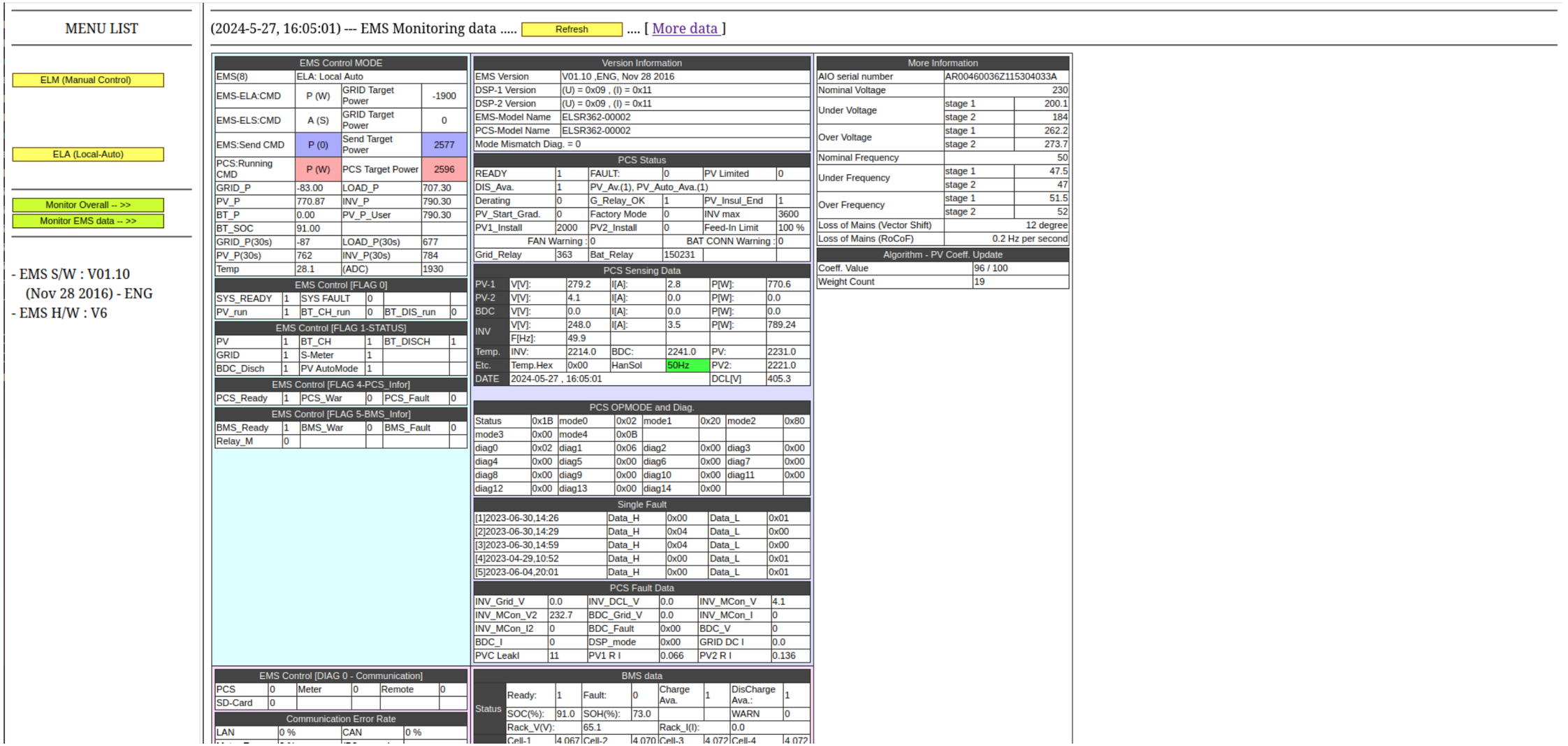
See Steve L's talk from last year for more details!

Also we need a "right to repair" and the right to replace firmware when cloud services are shut down, but that's a different talk...

Welcome! null



Modern, maintained code



MENU LIST

ELM (Manual Control)

ELA (Local-Auto)

Monitor Overall -- >>

Monitor EMS data -- >>

- EMS S/W : V01.10
  (Nov 28 2016) - ENG
- EMS H/W : V6

(2024-5-27, 16:05:01) --- EMS Monitoring data ..... Refresh .... [More data]

EMS Control MODE			
EMS(8)	ELA: Local Auto		
EMS-ELA:CMD	P (W)	GRID Target Power	-1900
EMS-ELS:CMD	A (S)	GRID Target Power	0
EMS:Send CMD	P (0)	Send Target Power	2577
PCS:Running CMD	P (W)	PCS Target Power	2596
GRID_P	-83.00	LOAD_P	707.30
PV_P	770.87	INV_P	790.30
BT_P	0.00	PV_P_User	790.30
BT_SOC	91.00		
GRID_P(30s)	-87	LOAD_P(30s)	677
PV_P(30s)	762	INV_P(30s)	784
Temp	28.1	(ADC)	1930

EMS Control [FLAG 0]					
SYS_READY	1	SYS FAULT	0		
PV_run	1	BT_CH_run	0	BT_DIS_run	0

EMS Control [FLAG 1-STATUS]					
PV	1	BT_CH	1	BT_DISCH	1
GRID	1	S-Meter	1		
BDC_Disch	1	PV AutoMode	1		

EMS Control [FLAG 4-PCS_Infor]					
PCS_Ready	1	PCS_War	0	PCS_Fault	0

EMS Control [FLAG 5-BMS_Infor]					
BMS_Ready	1	BMS_War	0	BMS_Fault	0
Relay_M	0				

EMS Control [DIAG 0 - Communication]					
PCS	0	Meter	0	Remote	0
SD-Card	0				

Communication Error Rate			
LAN	0 %	CAN	0 %

Version Information	
EMS Version	V01.10 ,ENG, Nov 28 2016
DSP-1 Version	(U) = 0x09 , (I) = 0x11
DSP-2 Version	(U) = 0x09 , (I) = 0x11
EMS-Model Name	ELSR362-00002
PCS-Model Name	ELSR362-00002
Mode Mismatch Diag. = 0	

PCS Status					
READY	1	FAULT:	0	PV Limited	0
DIS_Ava.	1	PV_Av.(1), PV_Auto_Ava.(1)			
Derating	0	G_Relay_OK	1	PV_Insul_End	1
PV_Start_Grad.	0	Factory Mode	0	INV max	3600
PV1_Install	2000	PV2_Install	0	Feed-In Limit	100 %
FAN Warning :	0		BAT CONN Warning :		0
Grid_Relay	363	Bat_Relay	150231		

PCS Sensing Data						
PV-1	V[V]:	279.2	I[A]:	2.8	P[W]:	770.6
PV-2	V[V]:	4.1	I[A]:	0.0	P[W]:	0.0
BDC	V[V]:	0.0	I[A]:	0.0	P[W]:	0.0
INV	V[V]:	248.0	I[A]:	3.5	P[W]:	789.24
	F[Hz]:	49.9				
Temp.	INV:	2214.0	BDC:	2241.0	PV:	2231.0
Etc.	Temp.Hex	0x00	HanSol	50Hz	PV2:	2221.0
DATE	2024-05-27 , 16:05:01				DCL[V]	405.3

PCS OPMODE and Diag.							
Status	0x1B	mode0	0x02	mode1	0x20	mode2	0x80
mode3	0x00	mode4	0x0B				
diag0	0x02	diag1	0x06	diag2	0x00	diag3	0x00
diag4	0x00	diag5	0x00	diag6	0x00	diag7	0x00
diag8	0x00	diag9	0x00	diag10	0x00	diag11	0x00
diag12	0x00	diag13	0x00	diag14	0x00		

Single Fault				
[1]2023-06-30,14:26	Data_H	0x00	Data_L	0x01
[2]2023-06-30,14:29	Data_H	0x04	Data_L	0x00
[3]2023-06-30,14:59	Data_H	0x04	Data_L	0x00
[4]2023-04-29,10:52	Data_H	0x00	Data_L	0x01
[5]2023-06-04,20:01	Data_H	0x00	Data_L	0x01

PCS Fault Data					
INV_Grid_V	0.0	INV_DCL_V	0.0	INV_MCon_V	4.1
INV_MCon_V2	232.7	BDC_Grid_V	0.0	INV_MCon_I	0
INV_MCon_I2	0	BDC_Fault	0x00	BDC_V	0
BDC_I	0	DSP_mode	0x00	GRID DC I	0.0
PVC Leakl	11	PV1 R I	0.066	PV2 R I	0.136

BMS data								
Status	Ready:	1	Fault:	0	Charge Ava.	1	DisCharge Ava.:	1
	SOC(%):	91.0	SOH(%):	73.0			WARN	0
	Rack_V(V):		65.1		Rack_I(I):		0.0	
	Cell-1	4.067	Cell-2	4.070	Cell-3	4.072	Cell-4	4.072

More Information		
AIO serial number	AR00460036Z115304033A	
Nominal Voltage		230
Under Voltage	stage 1	200.1
	stage 2	184
Over Voltage	stage 1	262.2
	stage 2	273.7
Nominal Frequency		50
Under Frequency	stage 1	47.5
	stage 2	47
Over Frequency	stage 1	51.5
	stage 2	52
Loss of Mains (Vector Shift)		12 degree
Loss of Mains (RoCoF)		0.2 Hz per second

Algorithm - PV Coeff. Update	
Coeff. Value	96 / 100
Weight Count	19

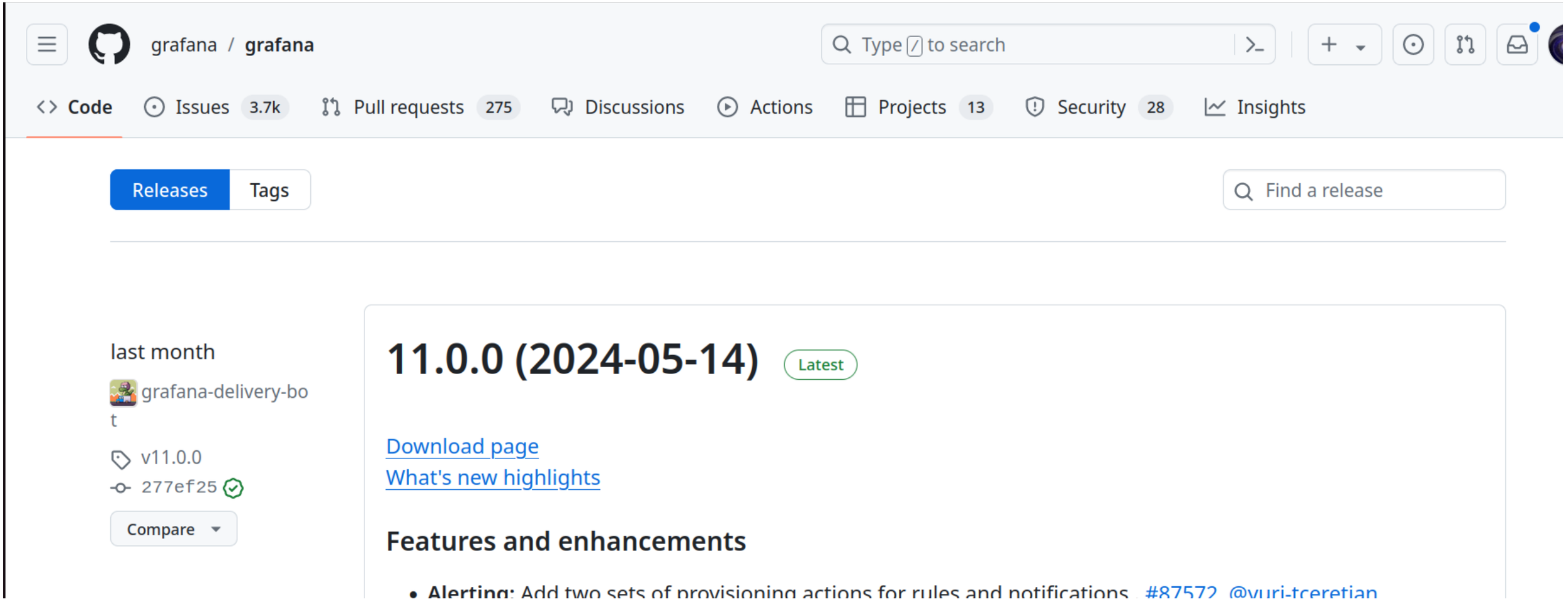
This is my house!

(It's terrible, but it's real...)

DevOps monitoring tools are miles better!


Search or jump to...
ctrl+k
Home › Dashboards › Electrical Monitoring › View panel
Last 6 hours
House Usage
2.40 kW
2.20 kW
2 kW
1.80 kW
1.60 kW
1.40 kW
1.20 kW
1 kW
800 W
600 W
400 W
200 W
0 W
06:00
06:15
06:30
06:45
07:00
07:15
07:30
07:45
08:00
08:15
08:30
08:45
09:00
09:15
09:30
09:45
10:00
10:15
10:30
10:45
11:00
11:15
11:30
11:45
power.mean

DevOps monitoring tools are also supported


grafana / grafana
Type / to search
Code
Issues 3.7k
Pull requests 275
Discussions
Actions
Projects 13
Security 28
Insights
Releases
Tags
Find a release
last month
grafana-delivery-bot
v11.0.0
277ef25
Compare
11.0.0 (2024-05-14)
Latest
Download page
What's new highlights
Features and enhancements
• Alerting: Add two sets of provisioning actions for rules and notifications. #87572 @yuri-tceretian

But how do I get that data for my house?

But how do I get that data for my house?

Won't it be hard?

Won't it be expensive?

You might already have it!

You might already have it!

Especially if you have solar panels

You might already have it!

From your Smart Meter

(But that's very country-specific)

You might already have it!

From your Energy Supplier's website

(But that's very country + supplier specific)

For my house, I have a lot of the energy stuff

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But more on that later!

Otherwise - pre-built hardware is very cheap

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To ship

Order date: Apr 22, 2024
Order ID: 3034537996305256 Copy

Order details >

Choice | IHSENO Store >

1Pcs Tuya Smart Zigbee Temperature And Humidity Sensor Indoor The...

1Pcs Zigbee

£ 3.03 x1

7 day delivery · Free returns · Delivery guarantee

Total: £ 3.64

Edit address

To ship

Order date: Apr 22, 2024
Order ID: 3034537996345256 Copy

Order details >

Choice | SONOFF TECH Store >

Sonoff Zigbee CC2531 USB Dongle Module Bare Board Packet Protocol ...

Zigbee CC2531

£ 3.96 x1

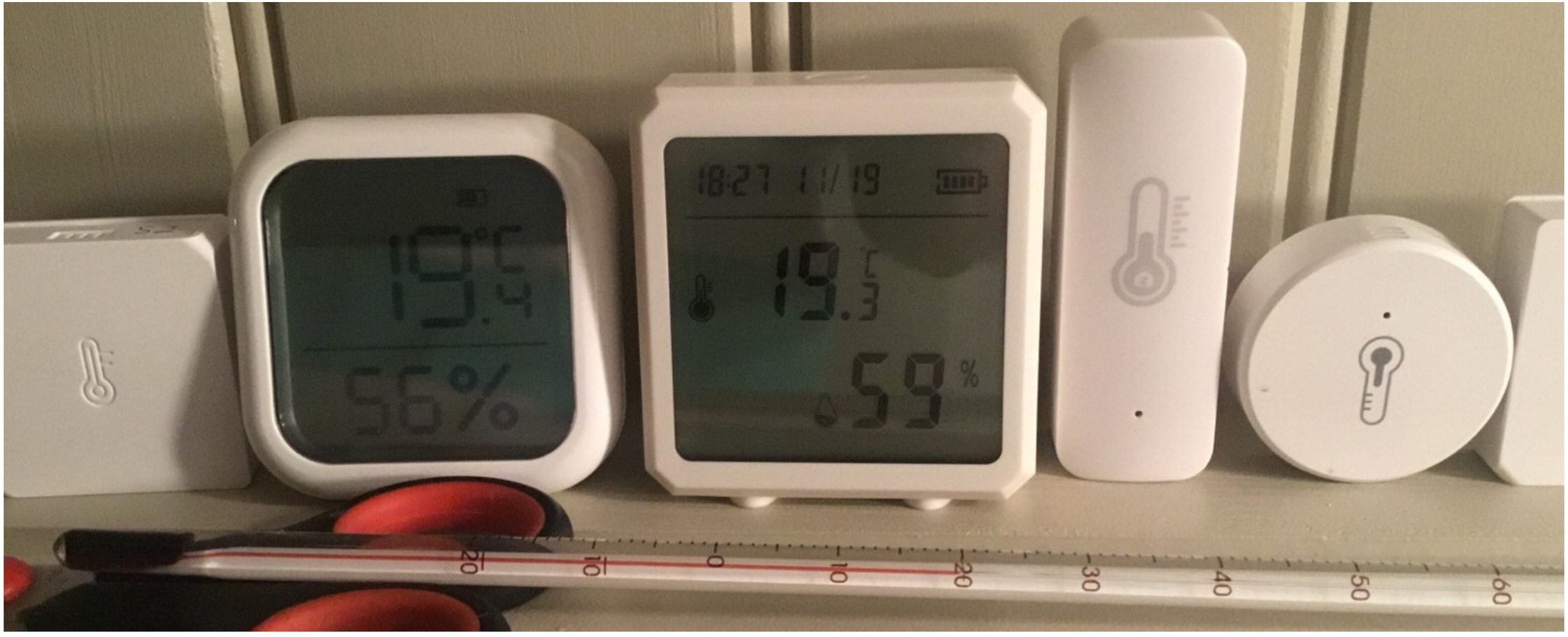
7 day delivery · Free returns · Delivery guarantee

Total: £ 4.65

Edit address

They come in a variety of shapes and sizes

They a pretty well calibrated out-of-the-box



Otherwise - DIY Hardware is also very cheap

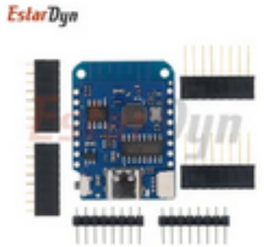
Otherwise - DIY Hardware is also very cheap

Completed

Order date: Nov 15, 2023
Order ID: 8179833644995256 Copy

Order details >

Estardyn Official Store >



D1 Mini ESP8266 ESP-12 ESP-12F CH340G V2 USB WeMos D1 Mini WIFI ...

D1 MINI V4.0.0

£ 1.15 x3

Fast Delivery · Free returns

Total: £ 5.08

Add to cart

Remove

Completed

Order date: Nov 15, 2023
Order ID: 8179833645015256 Copy

Order details >

Simple Robot Store >

HDC1080 module Low Power, GY-213V-HDC1080 High Accuracy Digital ...

£ 1.44 x2

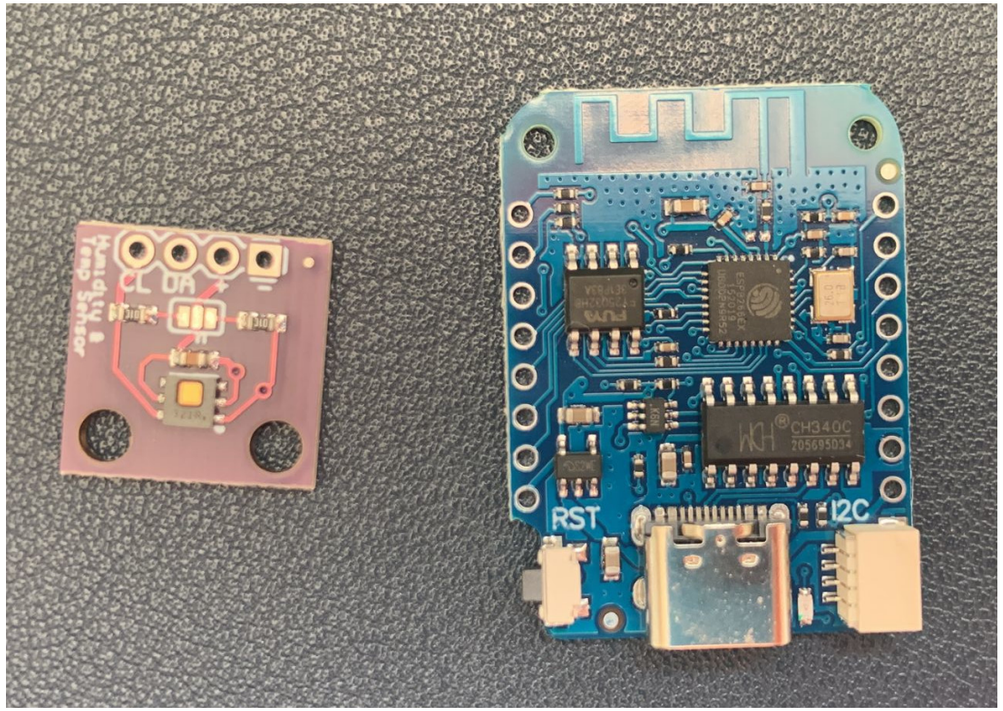
Fast Delivery · Free returns

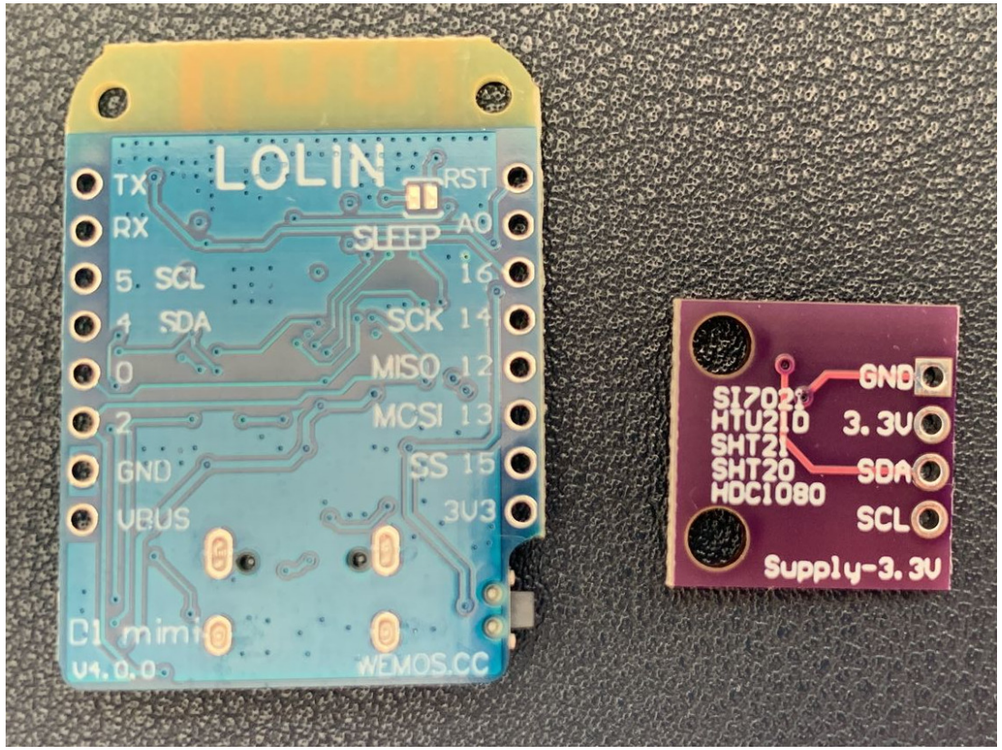
Total: £ 4.12

Add to cart

Remove

Otherwise - DIY Hardware is also very cheap





Otherwise - DIY Hardware is also very cheap

It's also a lot easier to work with than it used to be!

USB-C connectors, Wifi built-in

MicroPython

ESPHome (HomeAssistant)

Otherwise - DIY Hardware is also very cheap

But not all temperature sensors are made equally

An extra €0.20 can get you a big improvement!

Otherwise - Screen Scraping HTML is a thing

- eg Python - Beautiful Soup
- Find the data on your device / the supplier's website
- Write a few lines of selectors and data cleanup
- Then graph it as if they had a proper API!

```
def find_table(soup, heading):
   "Finds the table based on the Heading"
   h = soup.find("td", string=heading)
   if not h:
      raise Exception("Could not find table with heading '%s' in %s" % (heading, url))

   tbl = h.parent.parent
   if tbl.name != "table":
      raise Exception("Table with heading '%s' in the wrong format:\n%s" % (heading, tbl))
   return tbl

def get_value(cell):
   v = cell.text.strip()
   try:
      num = float(v)
      if num.is_integer():
         return int(num)
      return num
   except ValueError:
      return v
```

```
def extract_paired_columns(table):
   "Get the labels and values from a multi-column table"
   data = {}

   # Skip the header row, then odd-column is label, even-column value
   for row in table.find_all("tr")[1:]:
      cells = iter( row.find_all("td") )
      for d, v in zip(cells,cells):
         if d and v and d.text and v.text:
            data[d.text] = get_value(v)
   return data


def extract_vips(table):
   "Extract Voltage/Current/Power for the different components"
   vips = []
   for row in table.find_all("tr"):
      label = row.find("td").text
      vip = VIP(label)

      cells = iter( row.find_all("td")[1:] )
      for d, v in zip(cells,cells):
         if d.text == "V[V]:":
            vip.voltage = float(v.text.strip())
```

Picking a Radio ecosystem

Picking a Radio ecosystem

- Zigbee
- Bluetooth Low Energy
- Wifi
- 433 MHz / 868 MHz etc

Try to pick just one!

Zigbee

Low power

Mesh networking

Dongles are cheap

A lot of smart lights use this, you may already have some

Your smart lights can act as routers, if not switched off!

Bluetooth Low Energy

Low power

Keeps changing name(!)

Many Bluetooth "classic" dongles also support LE

Some mesh networking

But lower chance of already having repeaters

WiFi

(Mostly) high power

Aimed at always-powered devices

Much bigger batteries needed otherwise

Higher range, no new routers / APs needed

Potentially can query on demand, if always online

Custom Radio stuff

eg 433 MHz / 868 MHz

Try to avoid this for you own stuff

But you might have devics that use these

RTL-SDR + RTL_433 to the rescue!

Software Defined Radio with cheap USB sticks + decoder

Gathering the data

Gathering the data - Wifi

Easy!

Just have the device write to your database

Gathering the data - Zigbee / Bluetooth

Devices will periodically wake up, take a reading

Won't push every time, usually needs change or long time

No control of when new values will appear

Probably want something between gateway and database

Zigbee2mqtt

Handles all the Zigbee radio stuff

eg Pairing, Configuration

Pushes all messages to MQTT

Sends data to devices from MQTT (eg lights)

Zigbee2mqtt

Zigbee2MQTT **Devices** Dashboard Map **Settings** Groups OTA Touchlink Logs Extensions Permit join (All)

Enter search criteria

#	Pic	Friendly name	IEEE Address	Manufacturer	Model	LQI	Last seen	Power
1		Floor0/Dining/TemperatureDisplay Tuya temperature display on the Ground Floor in the Dining Room		TuYa	TH01Z	80	4 minutes ago	
2		Floor1/Landing/TemperatureDisplay Moes temperature display on the 1st Floor landing		TuYa	TS0201	196	19 minutes ago	1%
3		Floor0/Kitchen/TemperatureSensor Sonoff square temperature sensor in the kitchen above the doorway		SONOFF	SNZB-02	124	just now	
4		Floor0/Entrance/TemperatureSensor Rectangular temperature sensor in the entrance hall, on top of the coat rack		TuYa	TH02Z	120	26 minutes ago	
5		Floor3/Loft/TemperatureSensor Round temperature sensor in the loft		TuYa	IH-K009	64	6 minutes ago	
6		Floor2/Lounge/TemperatureSensor Rounded-corners temperature + pressure sensor, on the shelves in the lounge		Aqara	WSDCGQ11LM	176	35 minutes ago	
7		Floor2/Bedroom/TemperatureSensor Sonoff square temperature sensor in the main bedroom		SONOFF	SNZB-02	120	19 seconds ago	
8		Floor0/Dining/LightLeft Left hand window lights in the Dining Roon		Lonsonho	ZB-RGBCW	120	2 weeks ago	
9		Floor2/AiringCupboard/TemperatureSensor Sonoff square temperature sensor in the airing cupboard		SONOFF	SNZB-02	104	7 minutes ago	

Zigbee2mqtt

Color Xy

2 weeks ago 120 LQI

Color Xy

2 weeks ago 100 LQI

Humidity Alarm upper_alarm

7 minutes ago 80 LQI

Humidity 64.75 %

29 minutes ago 120 LQI

Floor0/Kitchen/TemperatureSensor

Sonoff square temperature sensor in the kitchen above the doorway

Temperature 17.17 °C
Humidity 59.78 %

2 minutes ago 124 LQI

Floor0/KitchenCupboard/TemperatureSensor

TuYa round temperature sensor in the Kitchen cupboard under the sink

Temperature 15.95 °C
Humidity 66.96 %

20 minutes ago 124 LQI

Floor1/Landing/TemperatureDisplay

Moes temperature display on the 1st Floor landing

Temperature 18.56 °C
Humidity 55.3 %

just now 196 LQI

Floor1/Office/TemperatureSensor

Rectangular temperature sensor in the office, on the shelf by the hifi

Temperature 19.95 °C
Humidity 39.05 %

28 minutes ago 220 LQI

Floor2/AiringCupboard/TemperatureSensor

Sonoff square temperature sensor in the airing cupboard

Temperature 25.91 °C

Humidity 38 %

10 minutes ago 104 LQI

Floor2/Bedroom/TemperatureSensor

Sonoff square temperature sensor in the main bedroom

Temperature 19.66 °C

Humidity 58 %

2 minutes ago 124 LQI

Floor2/Lounge/TemperatureDisplay

Moes temperature display in the 2nd floor lounge

Temperature 20.03 °C

Humidity 52.6 %

7 minutes ago 136 LQI

Floor2/Lounge/TemperatureSensor

Rounded-corners temperature + pressure sensor, on the shelves in the lounge

Temperature 20.07 °C
Humidity 50.65 %
Pressure 1019.3 hPa

37 minutes ago 176 LQI

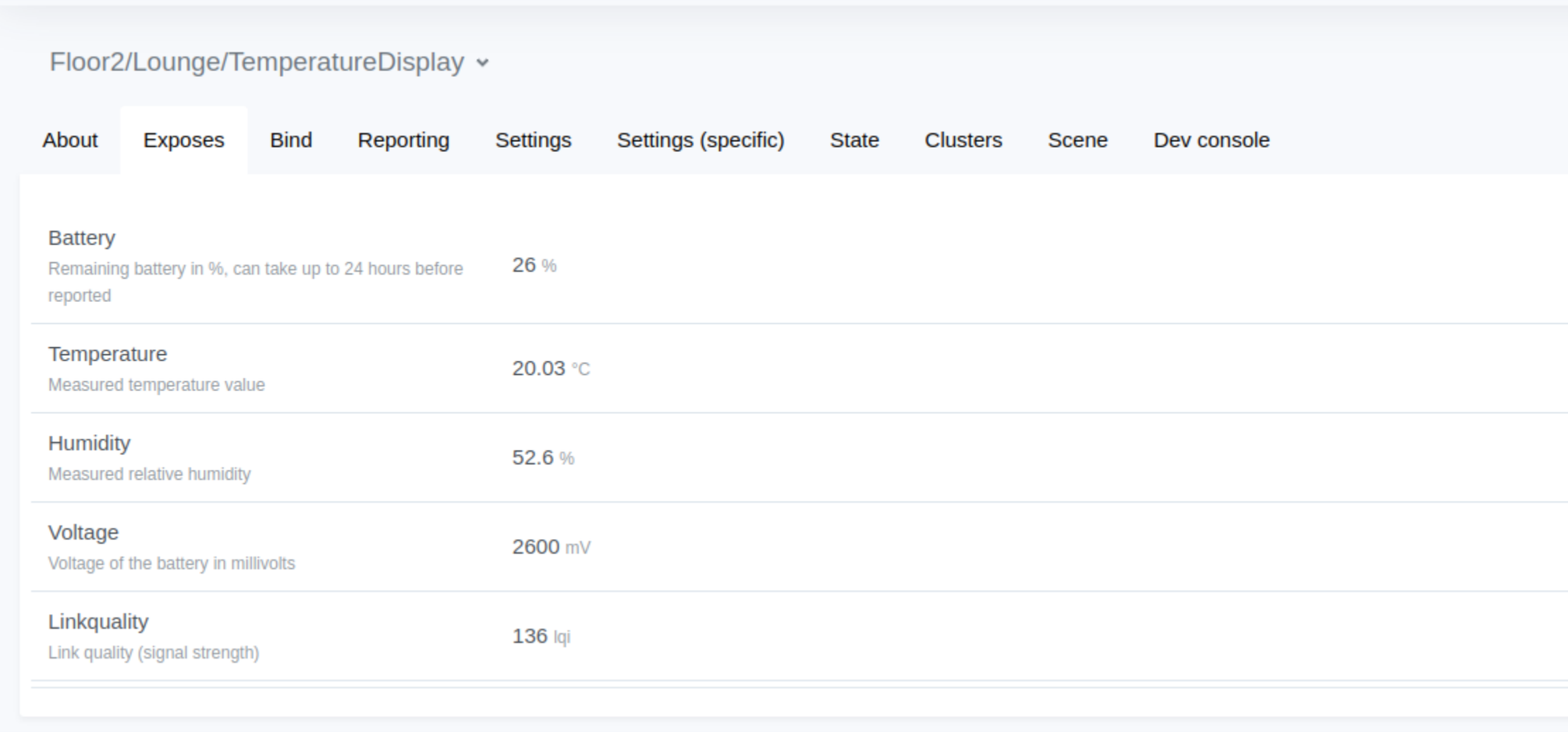
Floor3/Loft/TemperatureSensor

Round temperature sensor in the loft

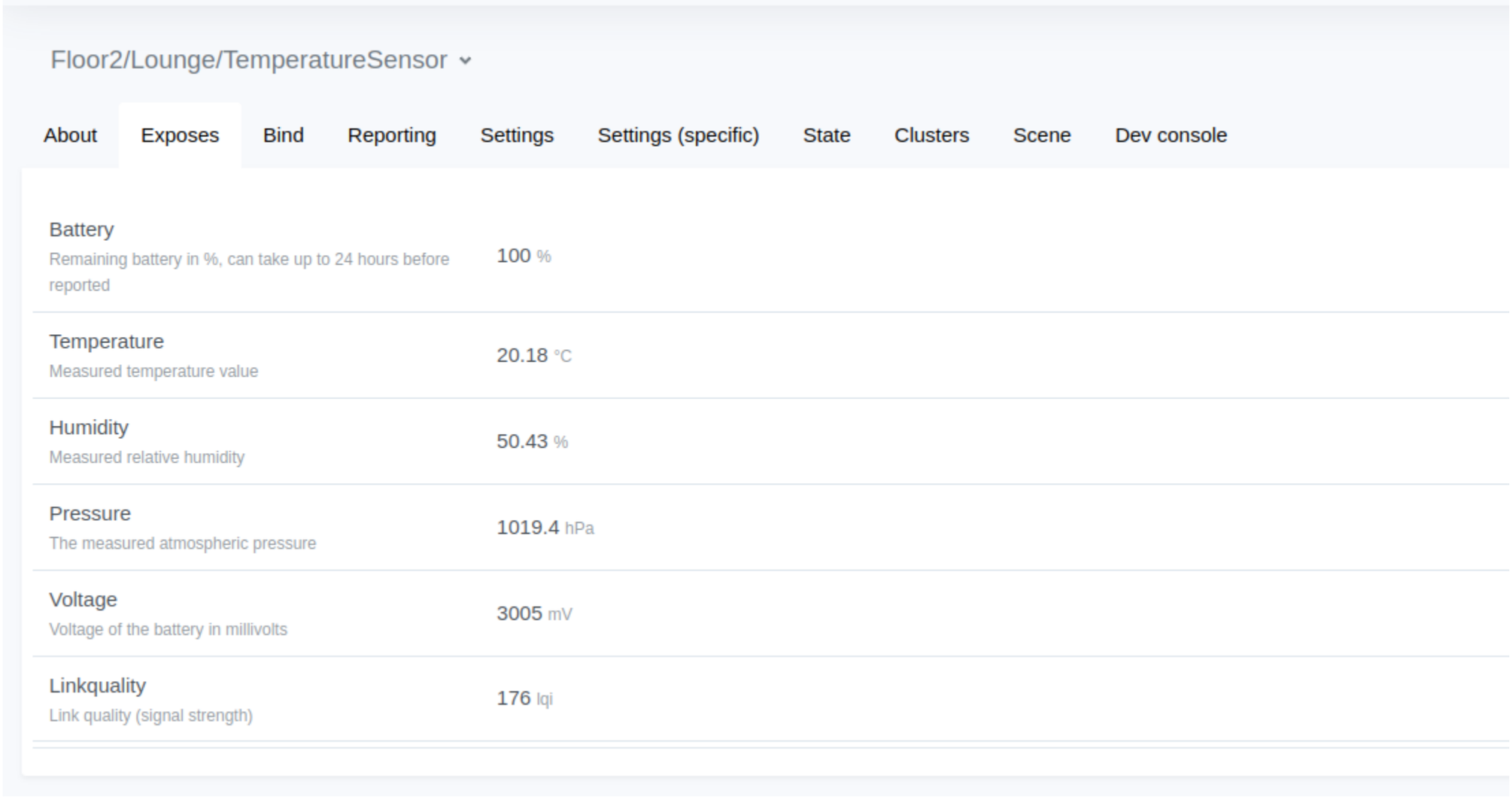
Temperature 20.08 °C
Humidity 55.02 %

8 minutes ago 64 LQI

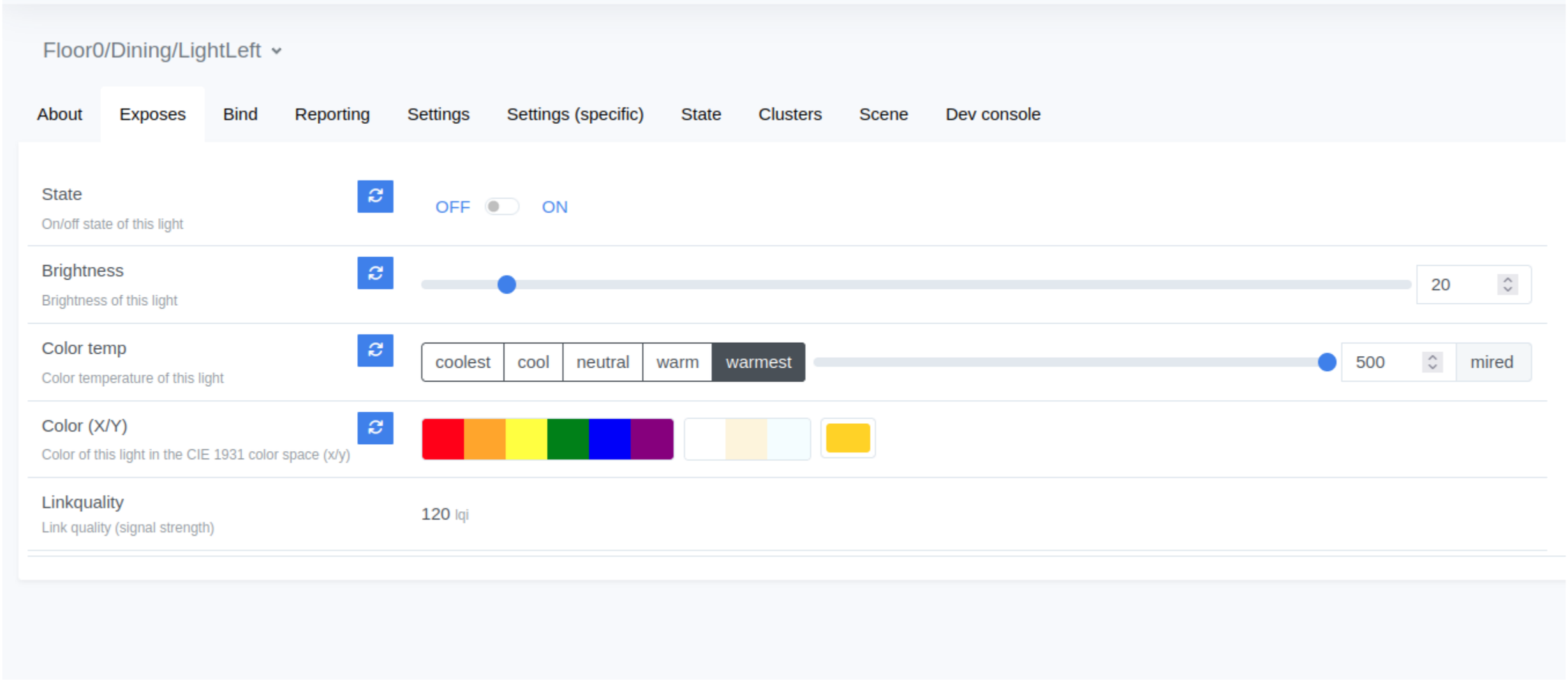
Zigbee2mqtt



Zigbee2mqtt



Zigbee2mqtt



(Or HomeAssistant can do all of this for you)

Storing the Data

Storing the Data

Timeseries Data

Long periods of time with no new value

(Largely) can't poll for new values

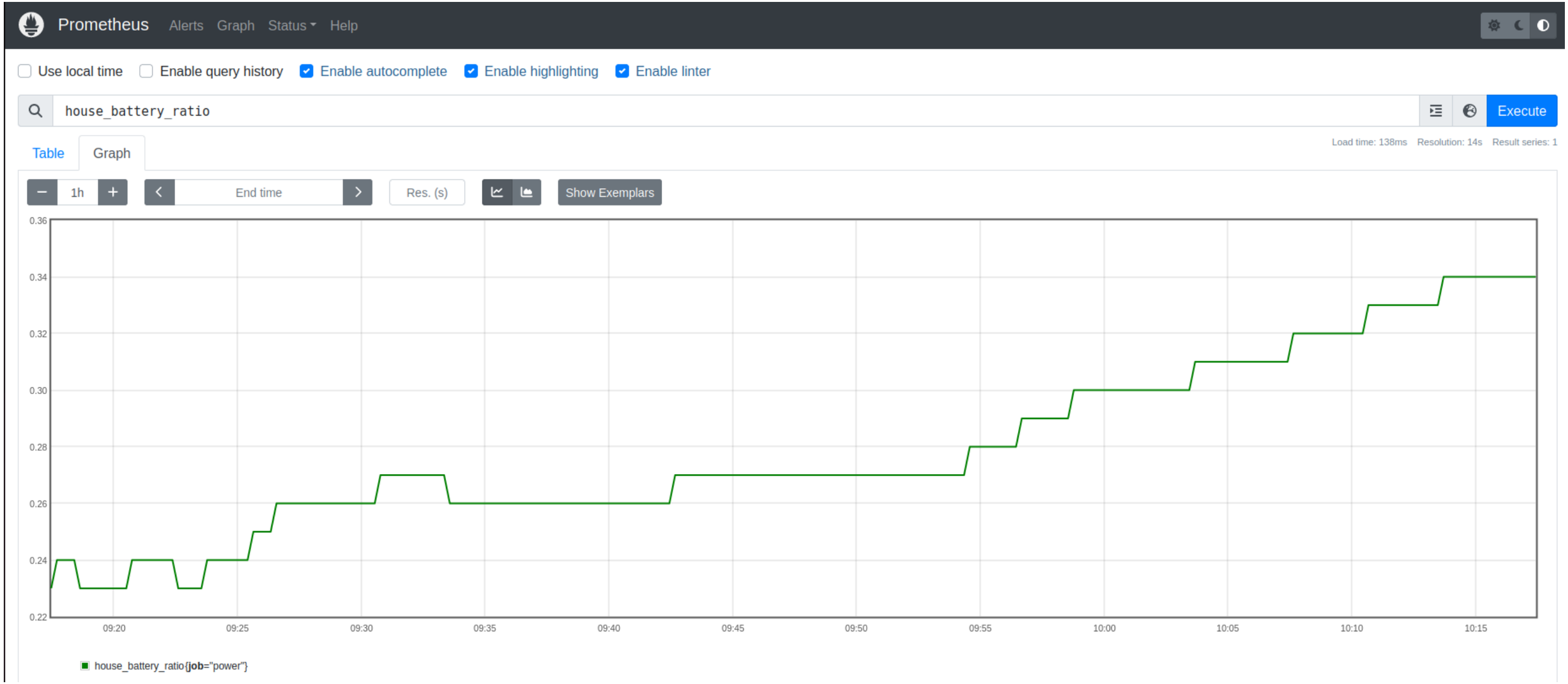
Timeseries Data

Prometheus is popular for DevOps use cases

But it assumes you can always poll the source for new values

No even always true wtih DevOps (eg short-lived pods)

Prometheus


Prometheus
Alerts
Graph
Status
Help
Use local time
Enable query history
Enable autocomplete
Enable highlighting
Enable linter
house_battery_ratio
Execute
Table
Graph
Load time: 138ms
Resolution: 14s
Result series: 1
1h
End time
Res. (s)
Show Exemplars
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
09:20
09:25
09:30
09:35
09:40
09:45
09:50
09:55
10:00
10:05
10:10
10:15
house_battery_ratio{job="power"}

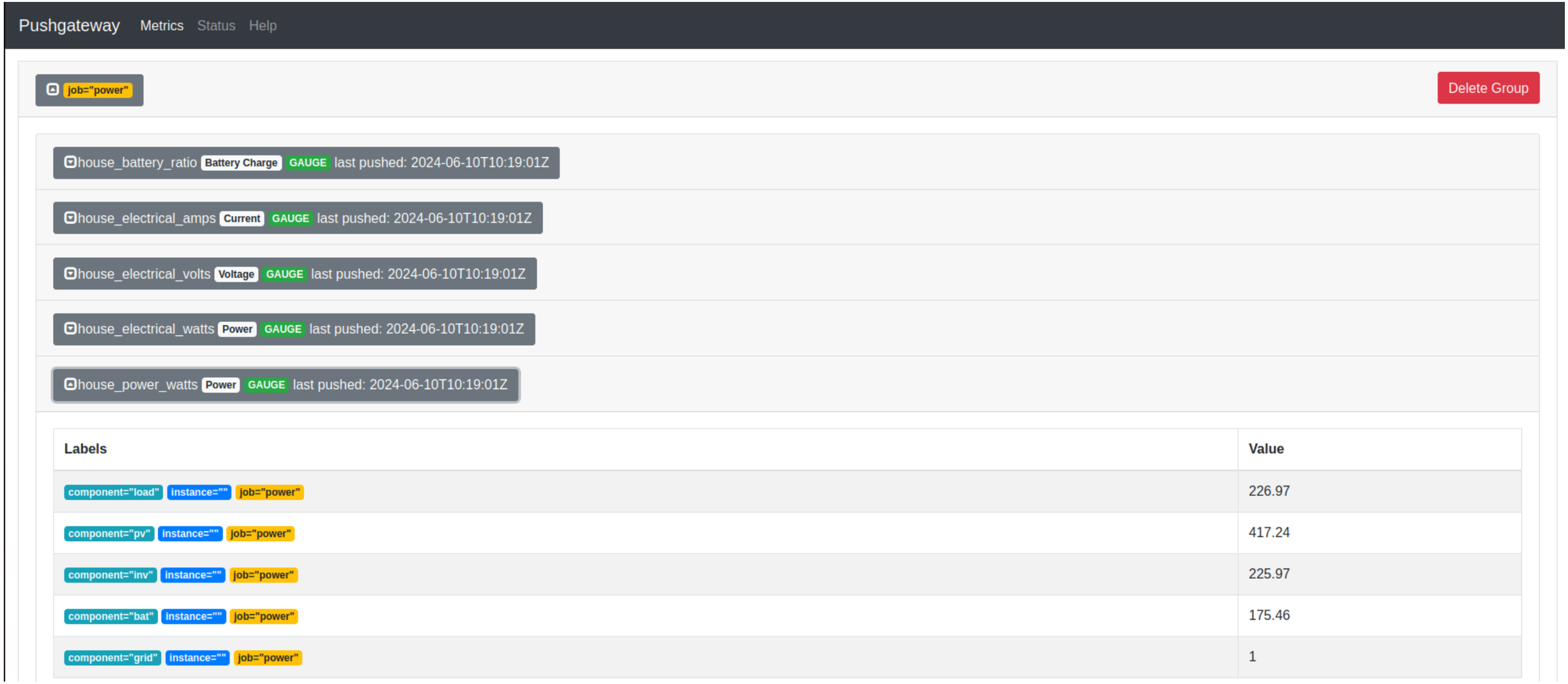
Timeseries Data

Prometheus Push Gateway lets you stash the lastest value somewhere

Main Prometheus then grabs that

Sending to a Push Gateway much simpler than implementing a full endpoint

Prometheus Push Gateway



Timeseries Data

Many other Timeseries databases exist!

See past year's Buzzwords talks for many

Key part of many IoT solutions

Timeseries Data

InfluxDB seems pretty lightweight, and available in most distros

But most package the older one without a Web UI

```
Connected to http://localhost:8086 version 1.6.7~rc0
InfluxDB shell version: 1.6.7~rc0
> show databases
name: databases

_internal
zigbee
power
```

```
> show series on zigbee
key

zigbee,dev=Floor0/Dining/LightLeft,device=LightLeft,floor=Floor0,host=pattertwig,room=Di
zigbee,dev=Floor0/Dining/LightRight,device=LightRight,floor=Floor0,host=pattertwig,room=
zigbee,dev=Floor0/Entrance/TemperatureSensor,device=TemperatureSensor,floor=Floor0,host=
zigbee,dev=Floor0/Kitchen/TemperatureSensor,device=TemperatureSensor,floor=Floor0,host=p
```

Transform the data

Transform the data

Generally, graphing tools don't directly talk to eg MQTT

Need to move the data from collection to the time series database

Telegraf

Swiss army knife of data transformation / plumbing

Might not be suitable for TB of data per day

But works well for small scale data

```
# Read Zigbee sensor data from MQTT
[[inputs.mqtt_consumer]]
  servers = ["tcp://localhost:1883"]
  topics = ["zigbee2mqtt/#"]
  data_format = "json"
  # Use the name of the sensor for the "tag"
  name_override = "zigbee"
  topic_tag = "dev"

  # If the topic is in the Floor/Room/Device format, add extra tags
  [[inputs.mqtt_consumer.topic_parsing]]
    topic = "zigbee2mqtt/+/+/+"
    tags = "_/floor/room/device"

# Strip the base topic (typically "zigbee2mqtt")
# from the dev tag using the regex processor
[[processors.regex]]
  namepass = ["zigbee"]

  [[processors.regex.tags]]
    key = "dev"
    pattern = '^zigbee2mqtt/(?P<device>.+)$'
    replacement = "${device}"

# Don't include messages about the Zigbee2MQTT bridge itself
# (also note the single square brackets used for this)
[inputs.mqtt_consumer.tagdrop]
  dev = ["zigbee2mqtt/bridge/*"]
```

```
# Send to Influx v1
[[outputs.influxdb]]
  urls = ["http://127.0.0.1:8086"]
  namepass = ["zigbee"]
  database = "zigbee"
  skip_database_creation = false

# Send to Cloud-hosted Grafana's Prometheus via Infux emulation
[[outputs.influxdb]]
  urls = ["https://influx-prod-24-prod-eu-west-2.grafana.net/api/v1/push/influx"]
  namepass = ["zigbee"]
  database = "telegraf_metrics"
  skip_database_creation = true
  user_agent = "telegraf"

  username = "1282265"

# Print to stdout for debugging
# Disable this once you're happy everything works!
[[outputs.file]]
  files = ["stdout"]
  data_format = "json"
```

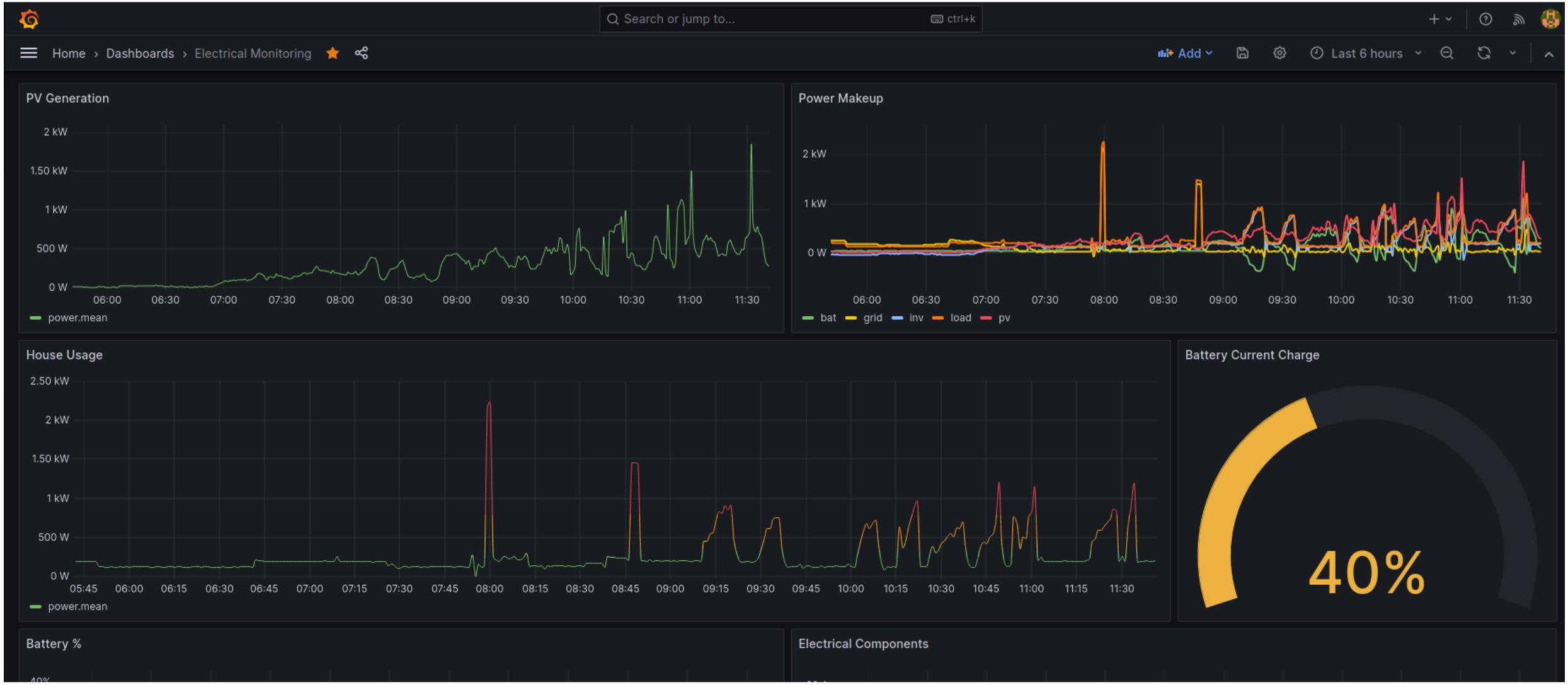
Otherwise write a few lines of Python!

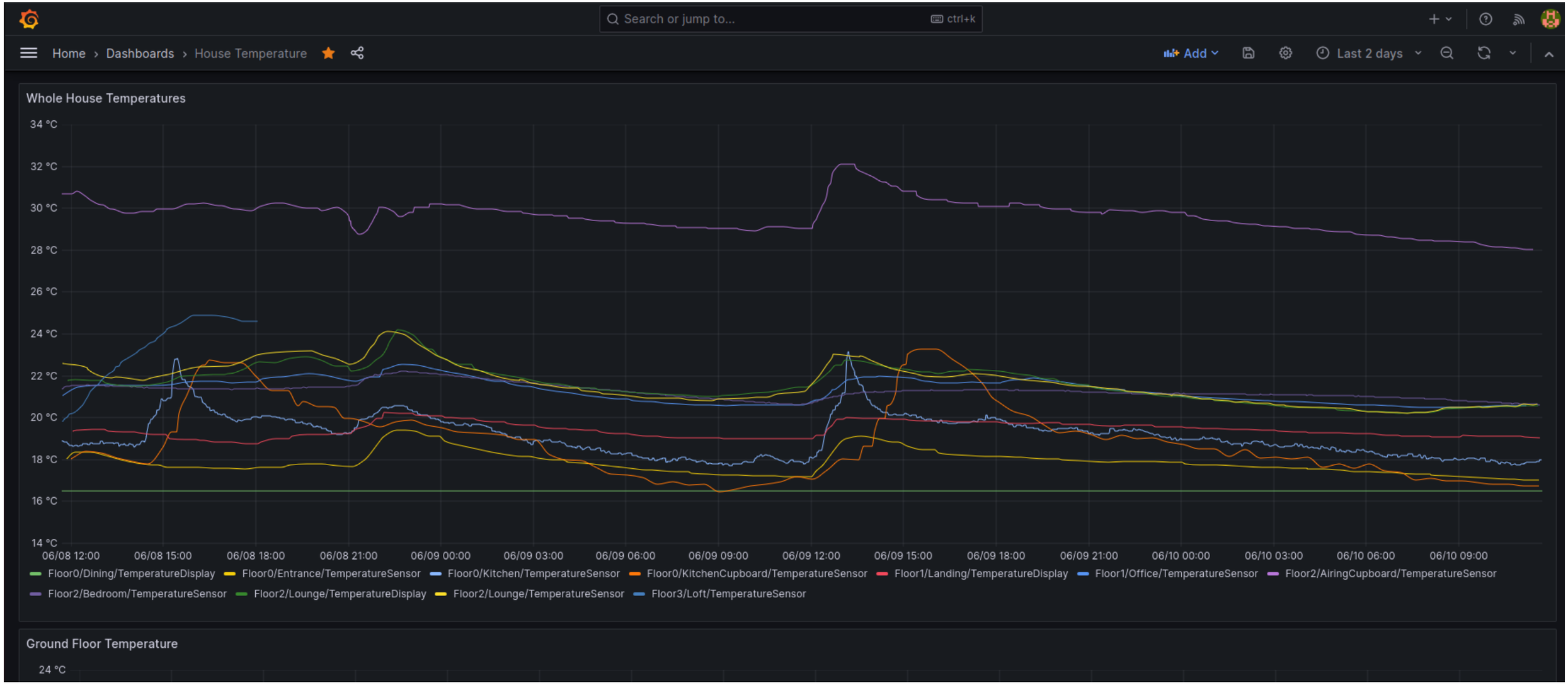
Graphing the data

Graphing the data

Grafana

Kibana


Search or jump to... ctrl+k
Home › Dashboards › Electrical Monitoring
Add
Last 6 hours
PV Generation
2 kW
1.50 kW
1 kW
500 W
0 W
06:00 06:30 07:00 07:30 08:00 08:30 09:00 09:30 10:00 10:30 11:00 11:30
power.mean
Power Makeup
2 kW
1 kW
0 W
06:00 06:30 07:00 07:30 08:00 08:30 09:00 09:30 10:00 10:30 11:00 11:30
bat grid inv load pv
House Usage
2.50 kW
2 kW
1.50 kW
1 kW
500 W
0 W
05:45 06:00 06:15 06:30 06:45 07:00 07:15 07:30 07:45 08:00 08:15 08:30 08:45 09:00 09:15 09:30 09:45 10:00 10:15 10:30 10:45 11:00 11:15 11:30
power.mean
Battery Current Charge
40%
Battery %
Electrical Components


Search or jump to...
ctrl+k
Home › Dashboards › House Temperature
Add
Last 2 days
Whole House Temperatures
34 °C
32 °C
30 °C
28 °C
26 °C
24 °C
22 °C
20 °C
18 °C
16 °C
14 °C
06/08 12:00
06/08 15:00
06/08 18:00
06/08 21:00
06/09 00:00
06/09 03:00
06/09 06:00
06/09 09:00
06/09 12:00
06/09 15:00
06/09 18:00
06/09 21:00
06/10 00:00
06/10 03:00
06/10 06:00
06/10 09:00
Floor0/Dining/TemperatureDisplay
Floor0/Entrance/TemperatureSensor
Floor0/Kitchen/TemperatureSensor
Floor0/KitchenCupboard/TemperatureSensor
Floor1/Landing/TemperatureDisplay
Floor1/Office/TemperatureSensor
Floor2/AiringCupboard/TemperatureSensor
Floor2/Bedroom/TemperatureSensor
Floor2/Lounge/TemperatureDisplay
Floor2/Lounge/TemperatureSensor
Floor3/Loft/TemperatureSensor
Ground Floor Temperature
24 °C

Temperature Monitoring

Temperature Monitoring

What Works / Doesn't

- In-room -, good
- In-cupboard - slow to change due to lack of air circulation
- Entryway etc - devices seem to do some averaging
- Hot water - can't do with cheap devices
- Outside - can't do with cheap devices
- Speed of reporting - mains powered only
- Polling on demand - mains powered only

What next?

Ecological Improvements

- Adjusting when your heating runs
- Adjusting when you have hot water
- Identifying areas with poor insulation
- Identifying radiators that don't work well / aren't big enough
- Home automation - smart radiator controls
- Heat pump before/after

Electrical Monitoring

- Smart sockets
- Power clamps
- Smart lights
- LED strips
- Baseline for solar
- Baseline for battery
- Electric car

Next Steps

- See if you already have some data sources in your house
- If you have sensors on a propriatary system, consider making your own open gateway and re-pointing a few of them
- If you have some arduinos, consider buying some temperature sensors for them and starting that way
- Otherwise go on aliexpress / ebay / etc, order a few things, and have a play!

Want to see some of this in action?

Join me in the coffee break at 4pm for a demo!

Code / Config / Slides

Github: @gagravarr

@nick@social.earth.li

Find me at 4pm, or during the evening reception!