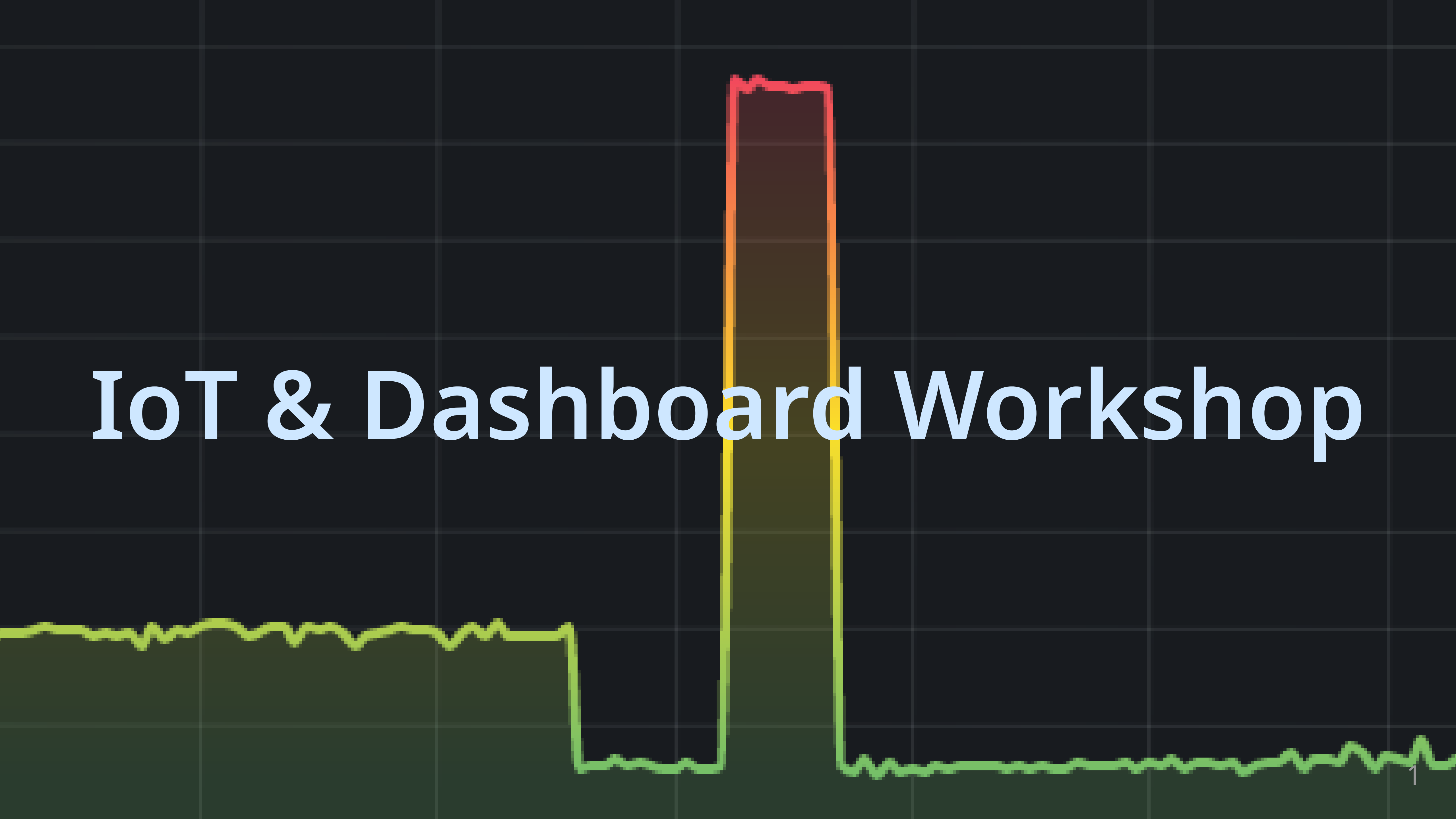


IoT & Dashboard Workshop

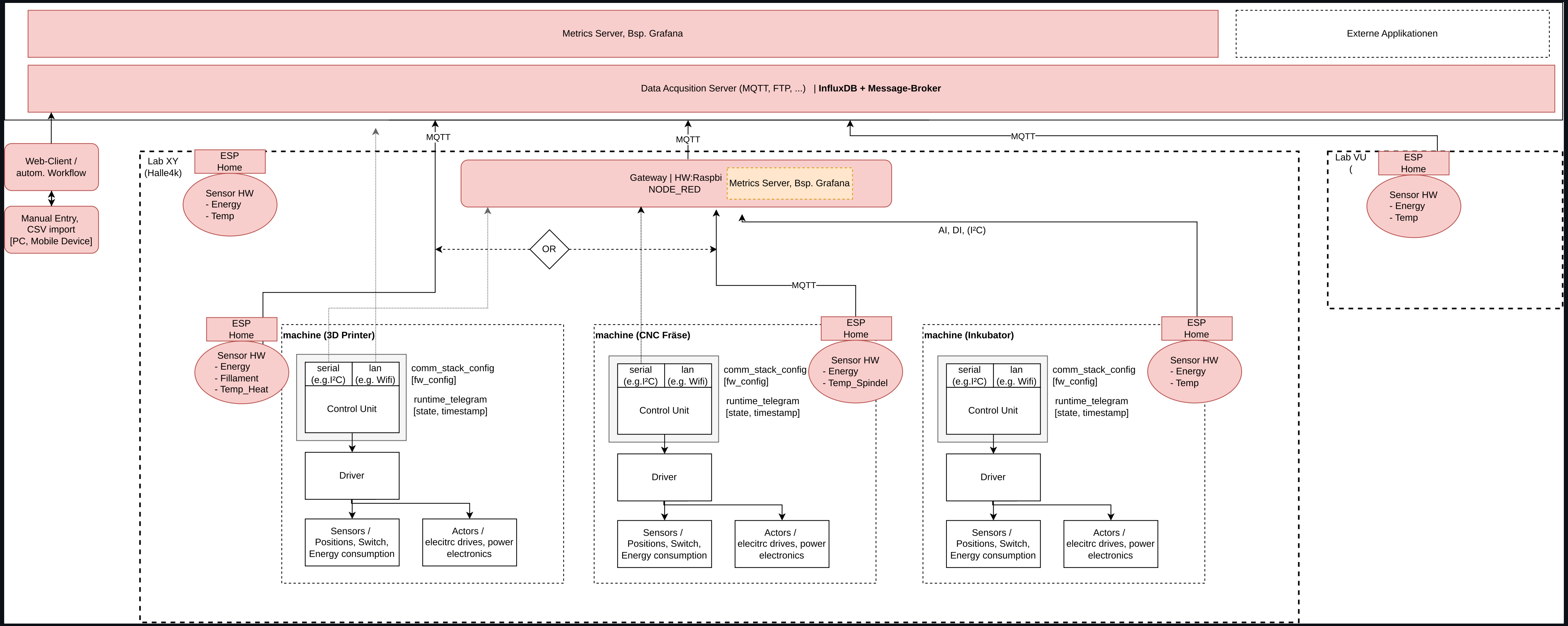
Matrix Chat

To exchange information digitally during and after the workshop we use Matrix as a chat solution. You don't know this yet? Don't be hesitant and join us!

https://matrix.to/#/#iot-platform:curious.bio

Fab City Dashboard

This is a prototype of data management platform for Fab City Hamburg based on existing open source solutions.


Metrics Server, Bsp. Grafana
Externe Applikationen
Data Acqusition Server (MQTT, FTP, ...) | **InfluxDB + Message-Broker**
MQTT
MQTT
MQTT
Web-Client / autom. Workflow
Manual Entry, CSV import [PC, Mobile Device]
Lab XY (Halle4k)
ESP Home
Sensor HW - Energy - Temp
Gateway | HW:Raspbi NODE_RED
Metrics Server, Bsp. Grafana
AI, DI, (I²C)
OR
MQTT
Lab VU (
ESP Home
Sensor HW - Energy - Temp
ESP Home
Sensor HW - Energy - Fillament - Temp_Heat
machine (3D Printer)
serial (e.g.I²C)
lan (e.g. Wifi)
Control Unit
comm_stack_config [fw_config]
runtime_telegram [state, timestamp]
Driver
Sensors / Positions, Switch, Energy consumption
Actors / elecitrc drives, power electronics
machine (CNC Fräse)
serial (e.g.I²C)
lan (e.g. Wifi)
Control Unit
comm_stack_config [fw_config]
runtime_telegram [state, timestamp]
ESP Home
Sensor HW - Energy - Temp_Spindel
Driver
Sensors / Positions, Switch, Energy consumption
Actors / elecitrc drives, power electronics
machine (Inkubator)
serial (e.g.I²C)
lan (e.g. Wifi)
Control Unit
comm_stack_config [fw_config]
runtime_telegram [state, timestamp]
ESP Home
Sensor HW - Energy - Temp
Driver
Sensors / Positions, Switch, Energy consumption
Actors / elecitrc drives, power electronics

Features

- Eclipse Mosquitto: MQTT broker
- Node-RED: Flow-based development tool for visual programming and data flow automation
- InfluxDB: High-performance data storage
- Grafana: Real-time data visualization and monitoring dashboard

Today's Goal

- install the stack
- configure one or two data sources
- transform data and store them in a database
- visualize data stored in the database

Architecture

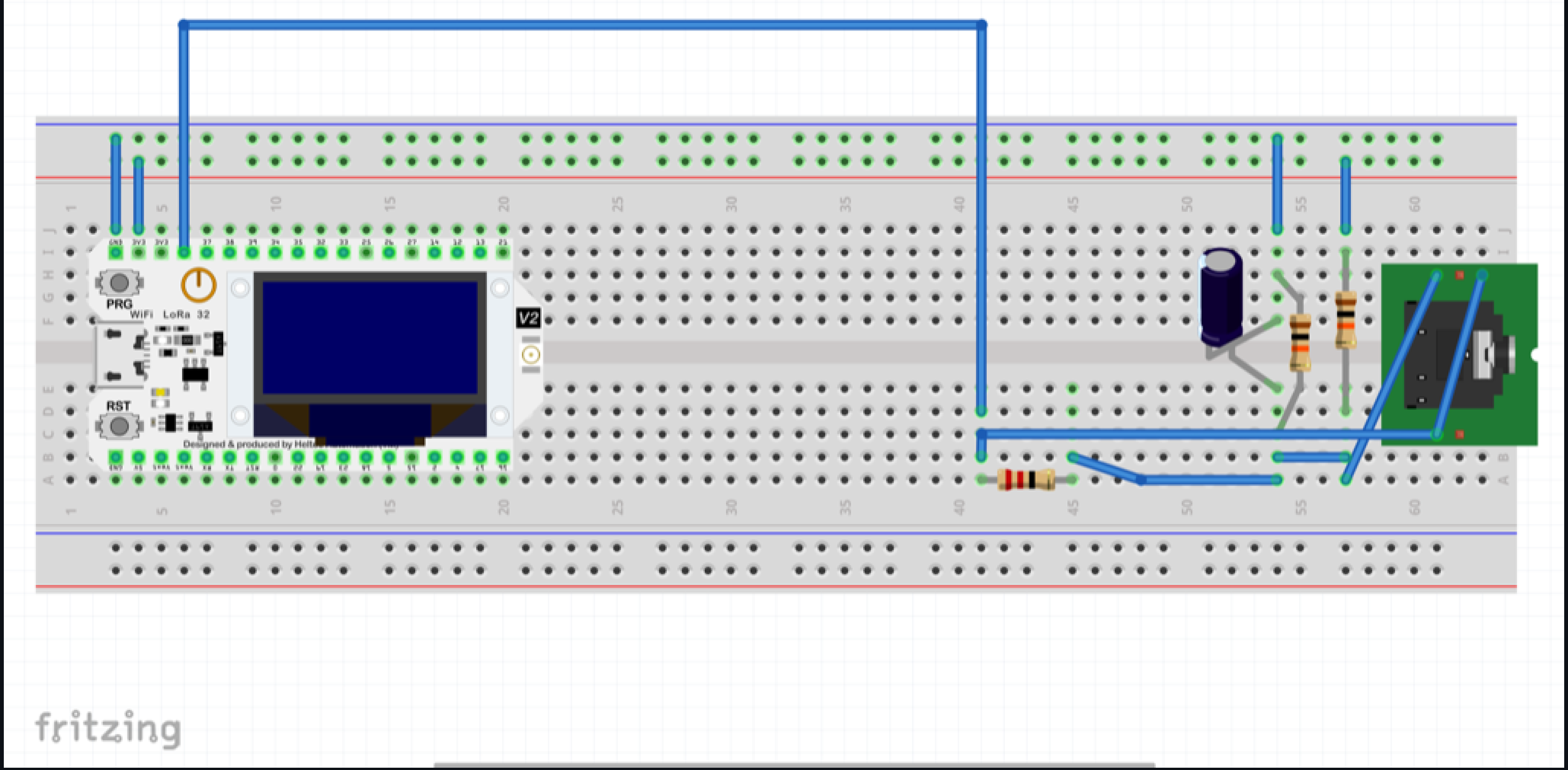
- Data is collected by IoT devices, e.g. an ESP32 based power monitor. These devices publish their data via MQTT into a topic in a message broker. We use Eclipse Mosquitto as a MQTT message broker.
- Node-RED is used to read and transform or combine data and to implement more sophicsticated use cases like notifications or worksflow. Node-RED subscribes to topics in Mosquitto and can be used to save transformed data into a database.
- As our data is bases on time, we are using a time series database to store information. We used InfluxDB as this database.
- Dashboards can already be created in Node-RED, but to be more flexible (and include more options) we are using Grafana. Grafana reads data from our database and other sources (like CSV files on the Internet) and displays them in a nice dashboard.

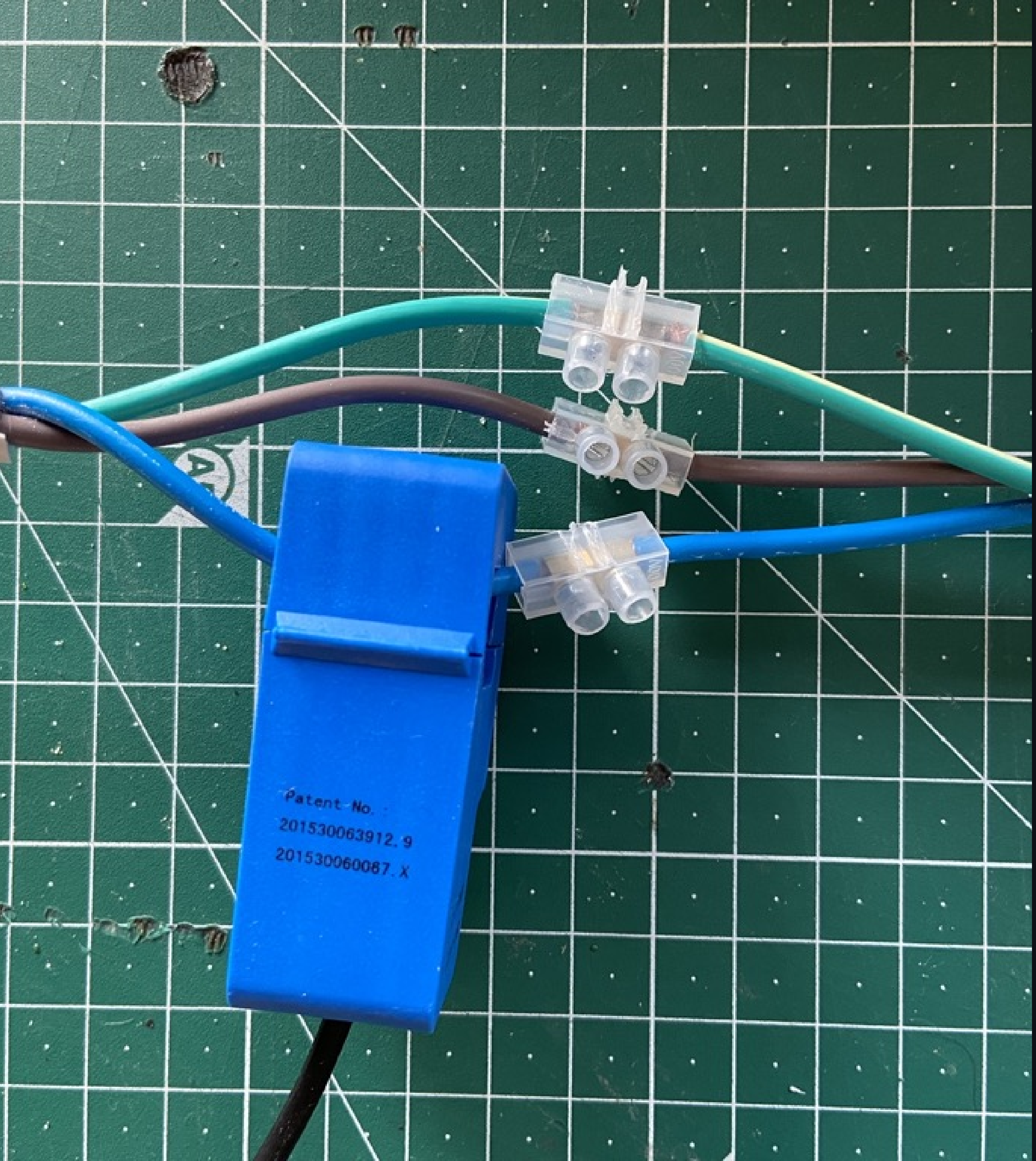
Sensor level: Physical acquisition of measured values

Sensors can be build or bought:

- Sensor head
  - ESP32 or equivalent
  - OpenHardware or COTS (commercially of the self)
  - Analog/Digital acquisition
  - Communication gateway via WLAN / MQTT
- Examples measurements
  - Energy measurement
  - Temperature sensor -> temperature measurement
  - Pulse sensor -> incremental measurement of filament

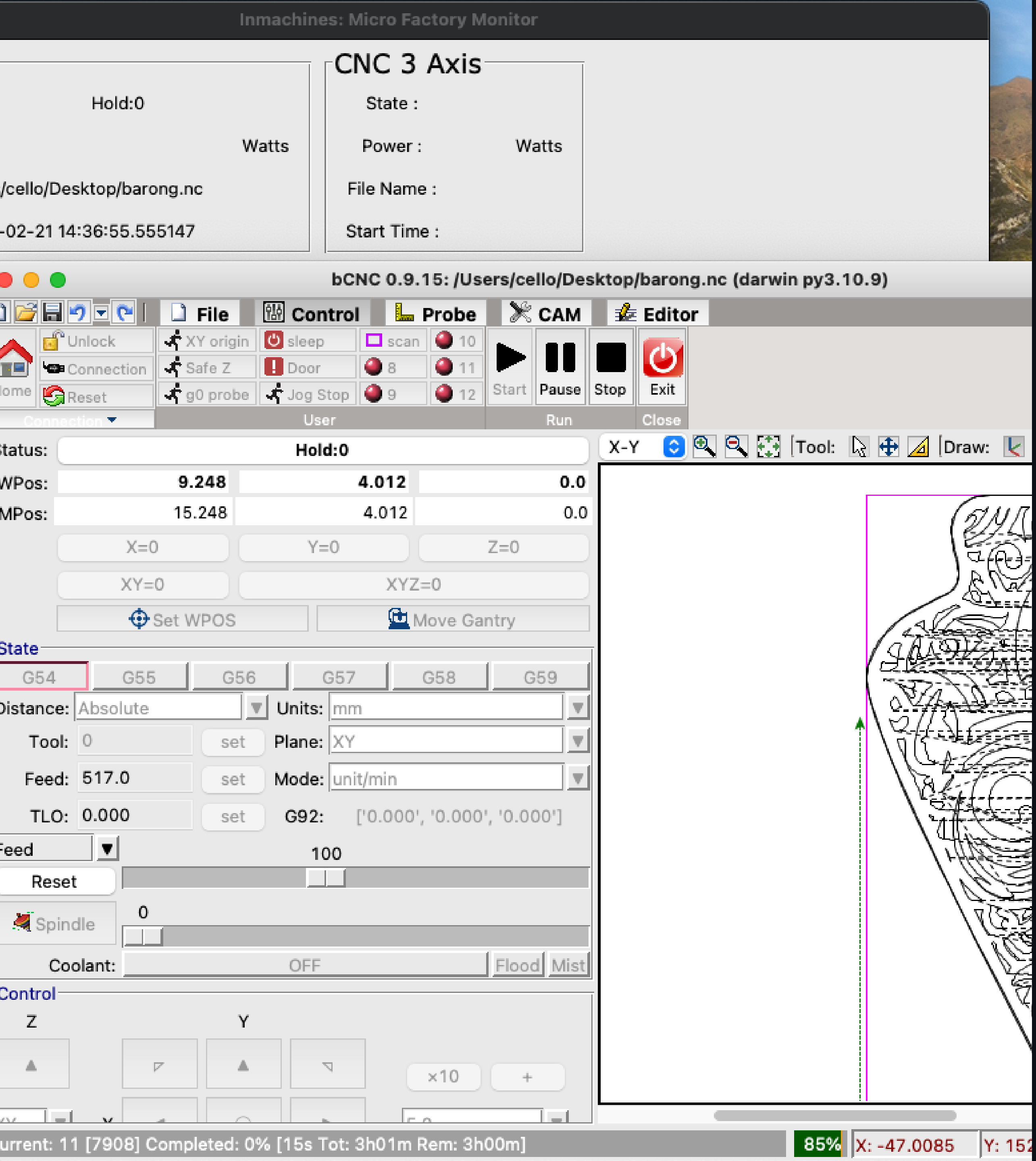
Example sensor - Open Engergy Monitor





Example sensor - Open Engergy Monitor

Example sensor - Shelly Plug



Inmachines: Micro Factory Monitor

Hold:0

Watts

/cello/Desktop/barong.nc

-02-21 14:36:55.555147

CNC 3 Axis

State :

Power : Watts

File Name :

Start Time :

bCNC 0.9.15: /Users/cello/Desktop/barong.nc (darwin py3.10.9)

tatus: Hold:0

WPos: 9.248 4.012 0.0

MPos: 15.248 4.012 0.0

State

G54 G55 G56 G57 G58 G59

istance: Absolute Units: mm

Tool: 0 Plane: XY

Feed: 517.0 Mode: unit/min

TLO: 0.000 G92: ['0.000', '0.000', '0.000']

eed 100

0

Coolant: OFF

urrent: 11 [7908] Completed: 0% [15s Tot: 3h01m Rem: 3h00m] 85% X: -47.0085 Y: 152

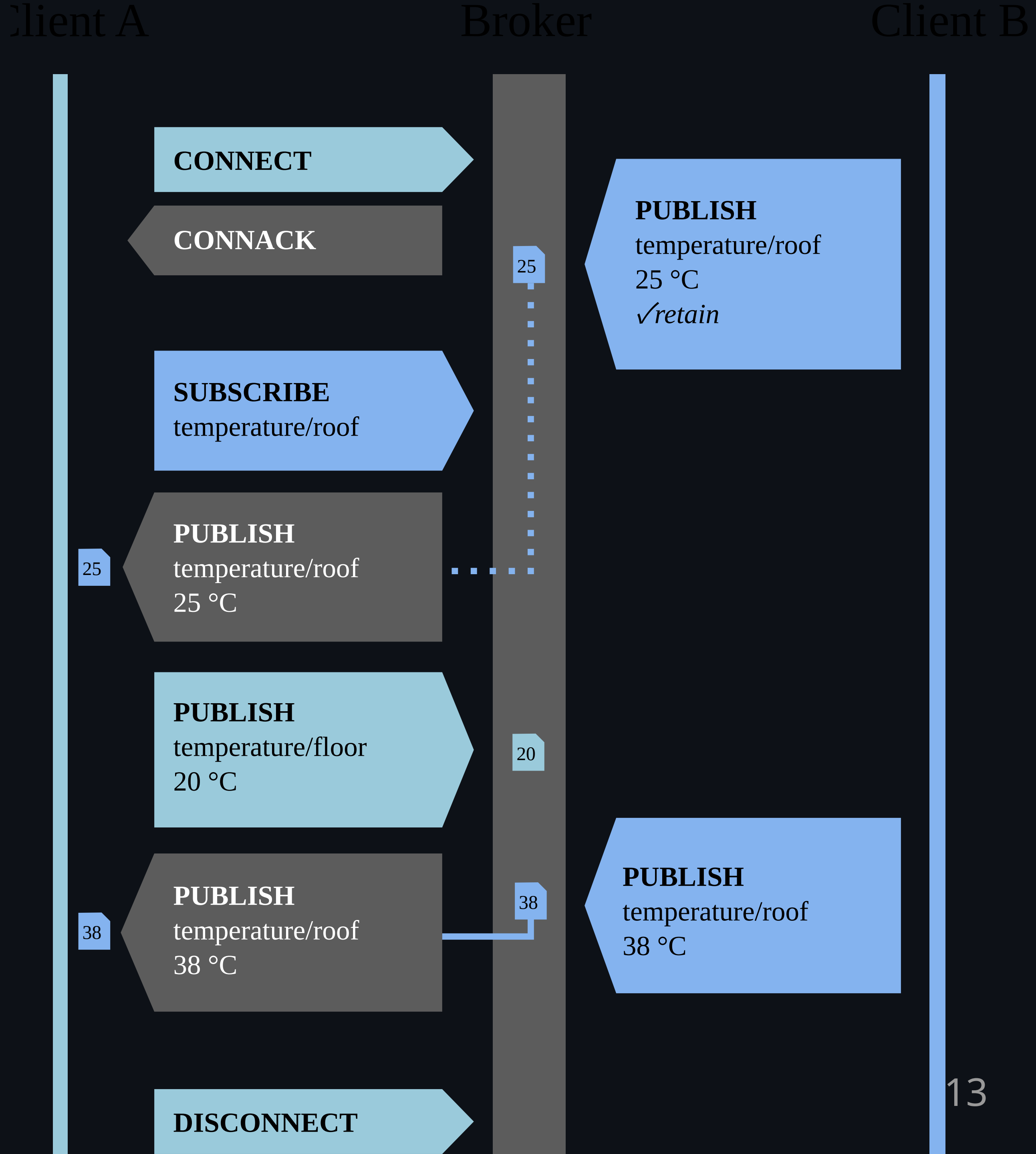
Example sensor - GCode Sender

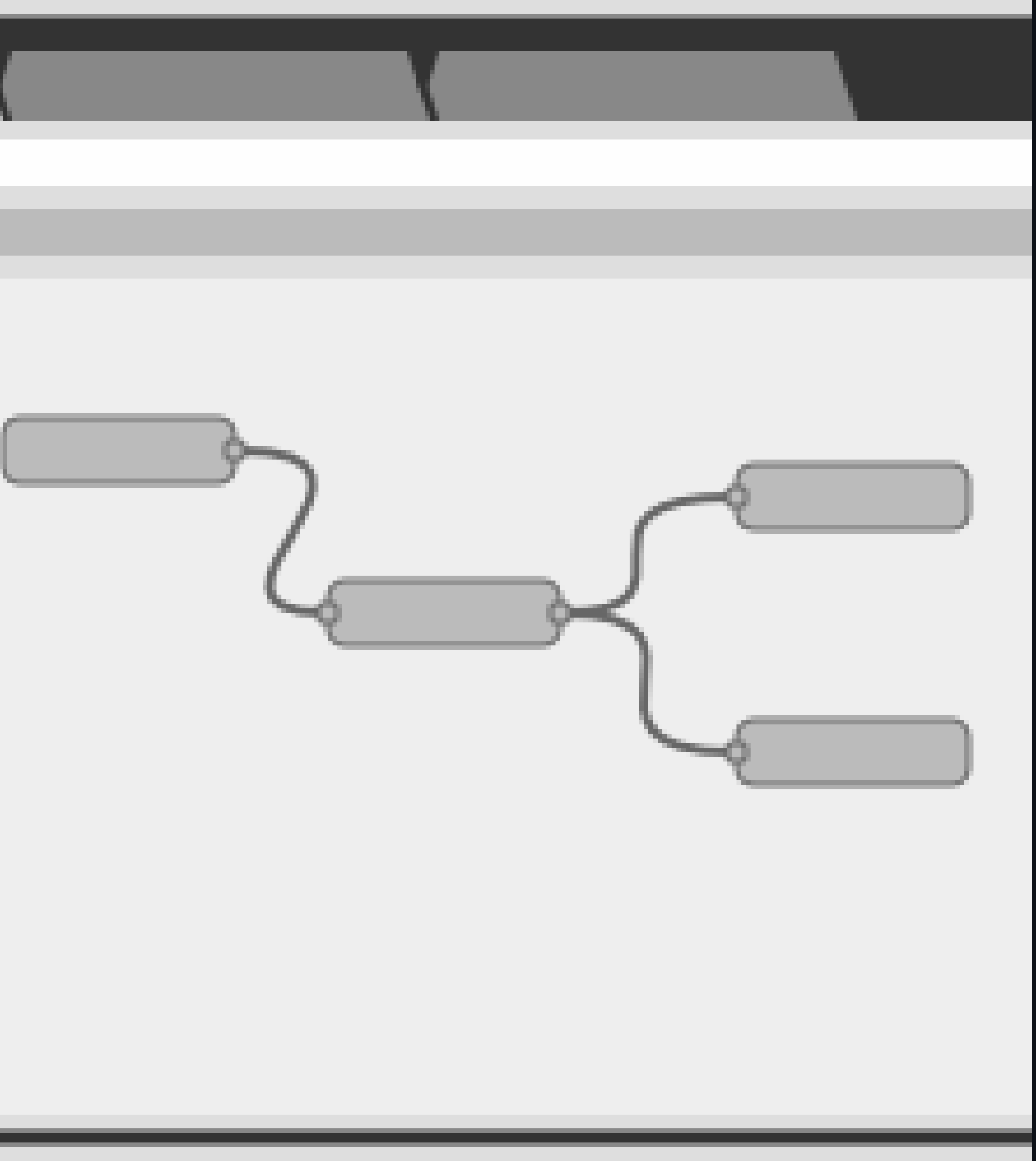
MQTT (Message Queuing Telemetry Transport)

- publish-subscribe, machine to machine network protocol
- designed for connections with remote locations
    - devices with resource constraints
    - limited network bandwidth
    - Internet of Things (IoT)
- runs on top of TCP/IP, QUIC (UDP) or Bluetooth

MQTT - Components

- one message broker (Mosquitto) and many clients
- broker receives published messages from clients
- routes them to subcribed clients
- clients subscribe to topic patterns





Flow - Node-RED

The idea behind it is to make it very easy to connect APIs, hardware devices, and anything else accessible over some type of network connection.

- open-source
- low-code
- visual programming tool
- flow-based development

Node-RED - Core Concepts

Nodes are the important part of Node-RED, they:

- are triggered by either receiving a message object from a previous node or an external event like an MQTT event
- process messages or events and then passes them on to the next node

A node can:

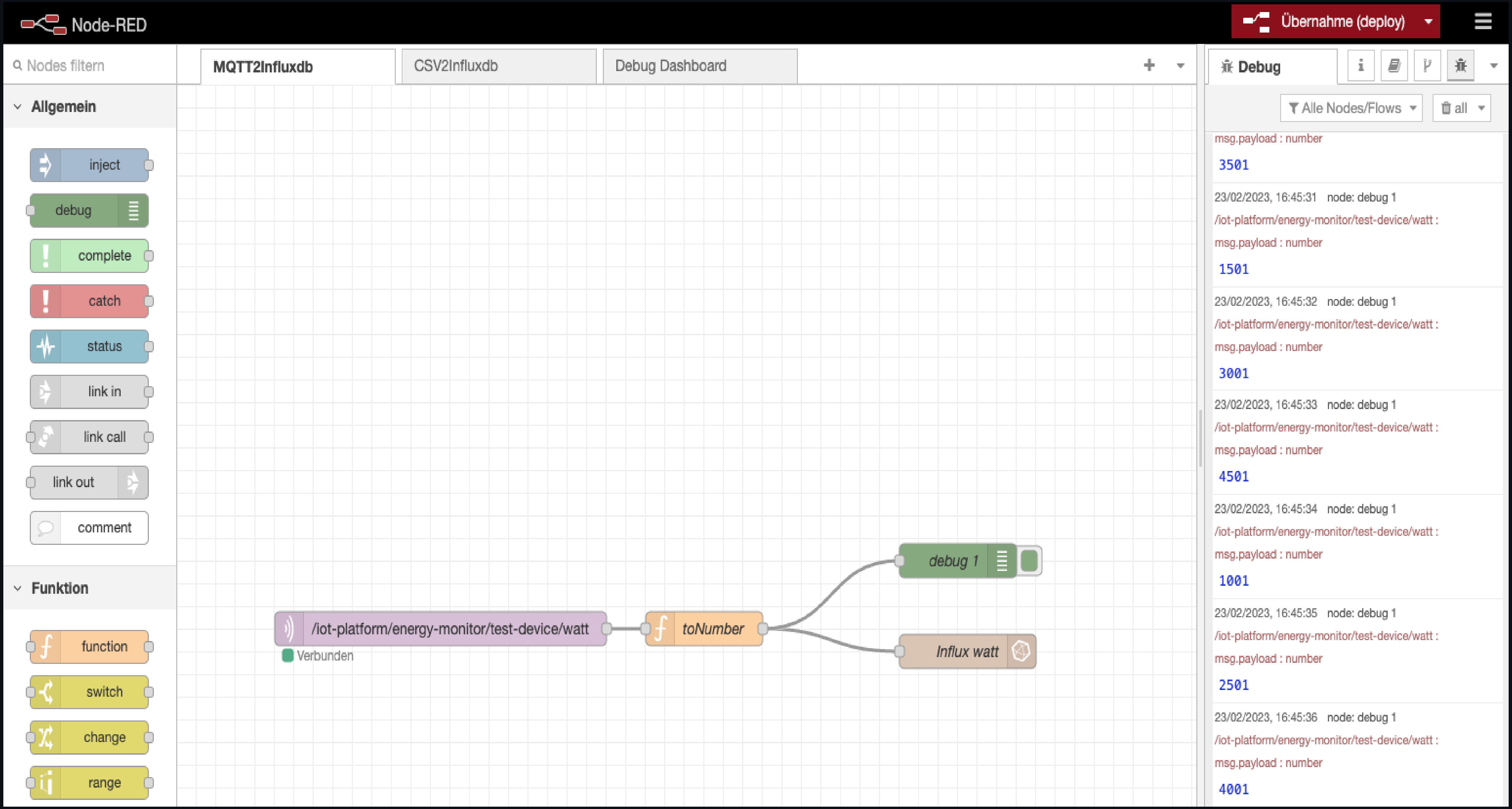
- Inject: Starts a flow by injecting a message or a payload.
- Change: Here you can do basic transformation or modification on the message object.
- Debug: Can be used to help developing flows by sending messages to the side bar.
- Switch: Here you can add logic (like sending the message to different nodes).
- Function: Add custom JavaScript for uses cases where simple nodes do not do the trick.

Node-RED - Plugins

Node-RED uses plugins:

- extend functionality (like dashboard)
- connectors (like influxdb)
- libraries (like aggregating watts and transform them to khw)

Node-RED - Simple Flow



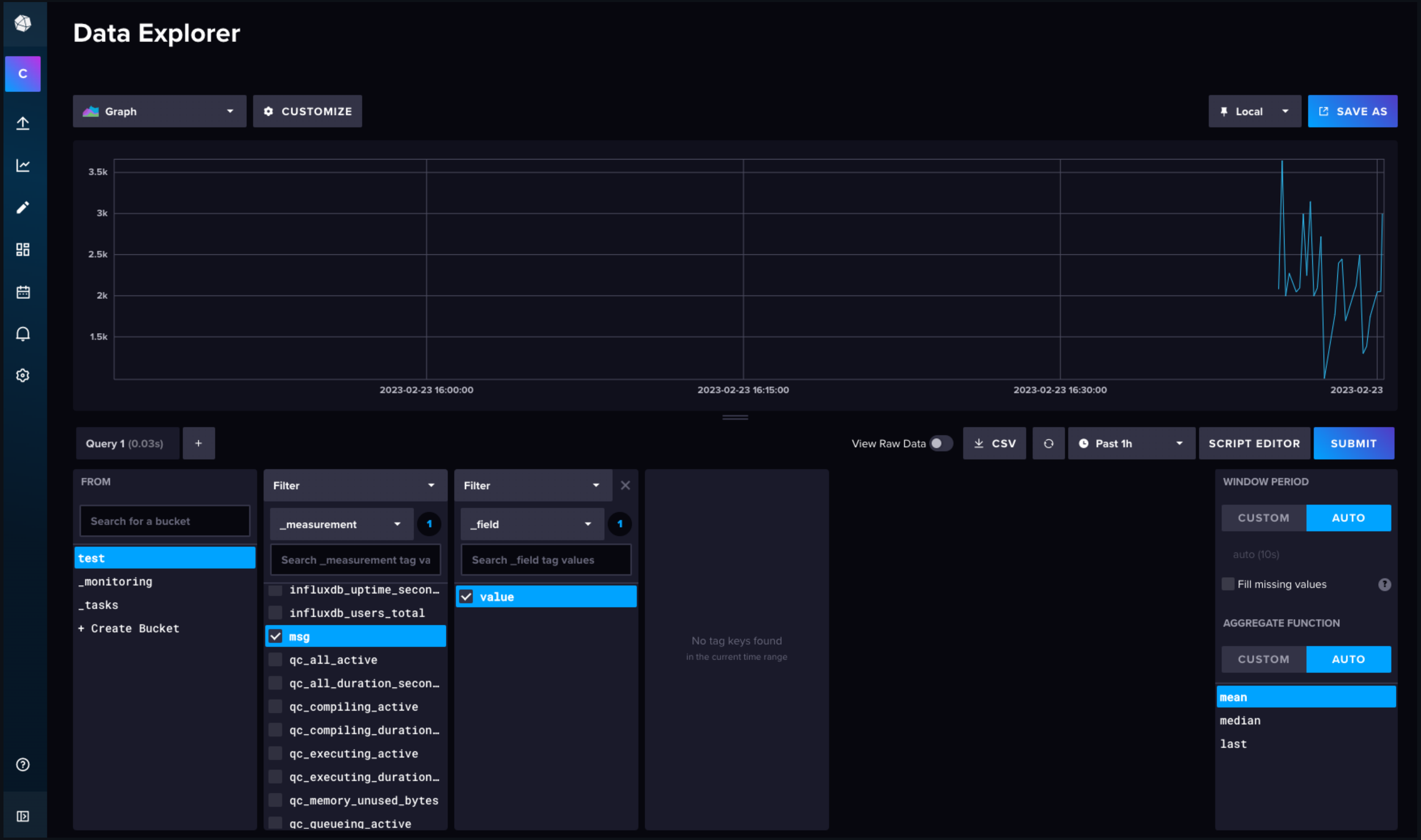
```
msg.payload : number
3501
23/02/2023, 16:45:31   node: debug 1
/iot-platform/energy-monitor/test-device/watt :
msg.payload : number
1501
23/02/2023, 16:45:32   node: debug 1
/iot-platform/energy-monitor/test-device/watt :
msg.payload : number
3001
23/02/2023, 16:45:33   node: debug 1
/iot-platform/energy-monitor/test-device/watt :
msg.payload : number
4501
23/02/2023, 16:45:34   node: debug 1
/iot-platform/energy-monitor/test-device/watt :
msg.payload : number
1001
23/02/2023, 16:45:35   node: debug 1
/iot-platform/energy-monitor/test-device/watt :
msg.payload : number
2501
23/02/2023, 16:45:36   node: debug 1
/iot-platform/energy-monitor/test-device/watt :
msg.payload : number
4001
```

Database - InfluxDB

InfluxDB is a database for any time series data. Time series data is everywhere, since time is a constituent of everything that is observable. As our world gets increasingly instrumented, sensors and systems are constantly emitting a relentless stream of time series data. For example:

- Electrical activity in the brain
- Rainfall measurements
- Monthly subscribers
- Heartbeats per minute
- Electricity consumed by a chain saw

Database - InfluxDB

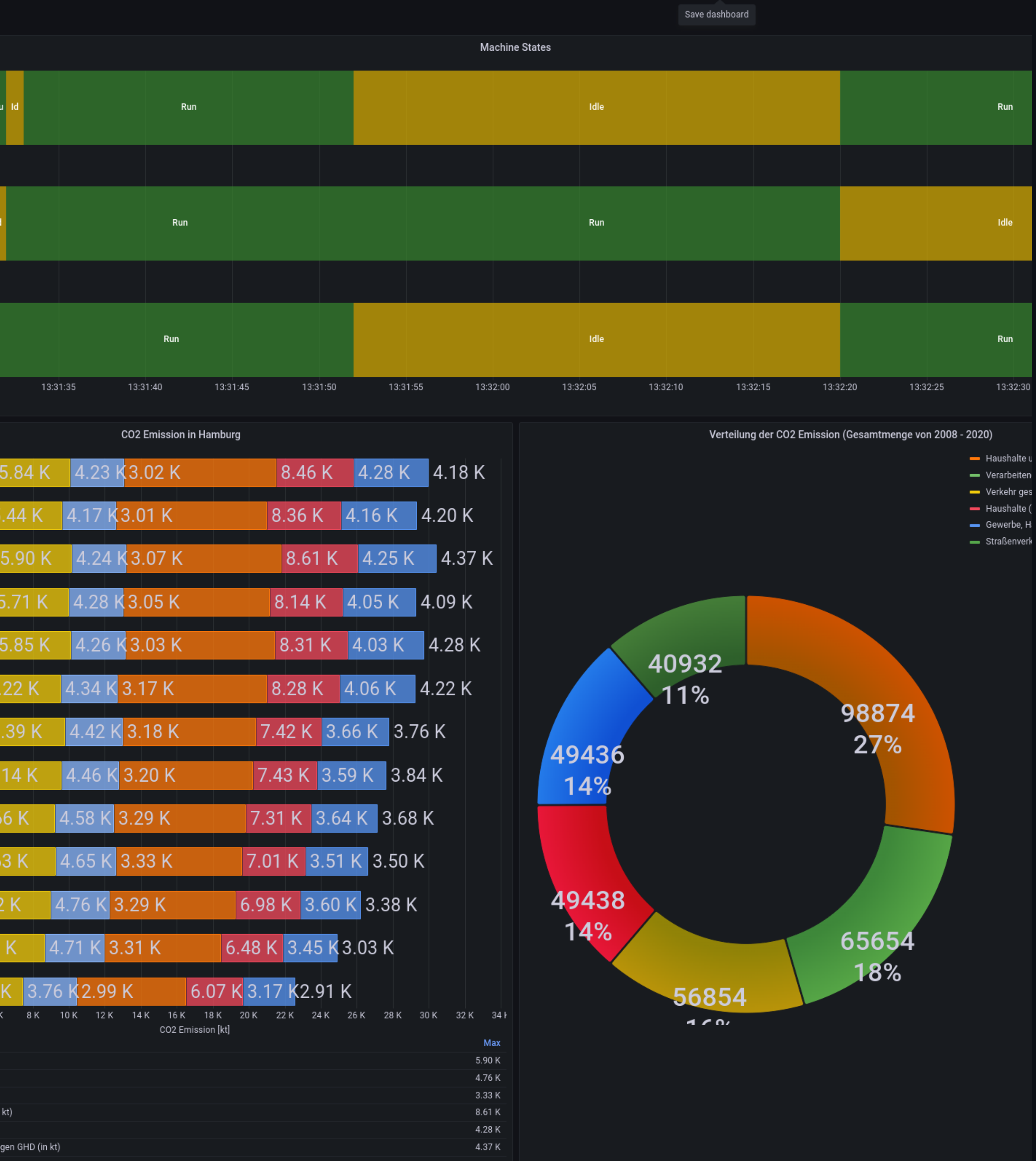


Dashboard - Grafana

Grafana is an open source analytics and interactive visualization tool.

- charts
- graphs
- alerts for the web when connected to supported data sources.

As a visualization tool, Grafana is a popular component in monitoring stacks, often used in combination with time series databases such as InfluxDB.


Save dashboard
Machine States
Id
Run
Idle
Run
Run
Run
Idle
Run
Idle
Run
13:31:35
13:31:40
13:31:45
13:31:50
13:31:55
13:32:00
13:32:05
13:32:10
13:32:15
13:32:20
13:32:25
13:32:30
CO2 Emission in Hamburg
5.84 K 4.23 K 3.02 K 8.46 K 4.28 K 4.18 K
.44 K 4.17 K 3.01 K 8.36 K 4.16 K 4.20 K
5.90 K 4.24 K 3.07 K 8.61 K 4.25 K 4.37 K
5.71 K 4.28 K 3.05 K 8.14 K 4.05 K 4.09 K
5.85 K 4.26 K 3.03 K 8.31 K 4.03 K 4.28 K
.22 K 4.34 K 3.17 K 8.28 K 4.06 K 4.22 K
.39 K 4.42 K 3.18 K 7.42 K 3.66 K 3.76 K
14 K 4.46 K 3.20 K 7.43 K 3.59 K 3.84 K
6 K 4.58 K 3.29 K 7.31 K 3.64 K 3.68 K
3 K 4.65 K 3.33 K 7.01 K 3.51 K 3.50 K
2 K 4.76 K 3.29 K 6.98 K 3.60 K 3.38 K
K 4.71 K 3.31 K 6.48 K 3.45 K 3.03 K
K 3.76 K 2.99 K 6.07 K 3.17 K 2.91 K
8 K
10 K
12 K
14 K
16 K
18 K
20 K
22 K
24 K
26 K
28 K
30 K
32 K
34 K
CO2 Emission [kt]
Verteilung der CO2 Emission (Gesamtmenge von 2008 - 2020)
Haushalte u
Verarbeiten
Verkehr ges
Haushalte (
Gewerbe, H
Straßenverk
98874
27%
65654
18%
56854
49438
14%
49436
14%
40932
11%

	Max
	5.90 K
	4.76 K
	3.33 K
kt)	8.61 K
	4.28 K
gen GHD (in kt)	4.37 K

Dashboard - Example

Let's start

- Check installation requirements
  - 64bit environment (AMD64, ARM64)
  - Docker
  - Docker-Compose
- Checkout the repository:
  - https://code.curious.bio/curious.bio/iot-backend
  - https://code.curious.bio/curious.bio/smart-energy-monitor
- Let's follow the README, together!

🫵 Hands on

Where can I find this presentation?

https://code.curious.bio/curious.bio/iot-backend/src/branch/main/docs/workshop