Tools and best practices for Sustainable Software

An overview

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Standard slide for starters

Quick info - Arne Tarara / Green Coding Berlin

- Software-Dev 16+ years
- Founder & CEO **Green Coding Berlin GmbH**
  - We do research and development in open source tools for software resource consumption
  - We help companies assess their digital infrastructure resource consumption

SDIA SUSTAINABLE DIGITAL INFRASTRUCTURE ALLIANCE

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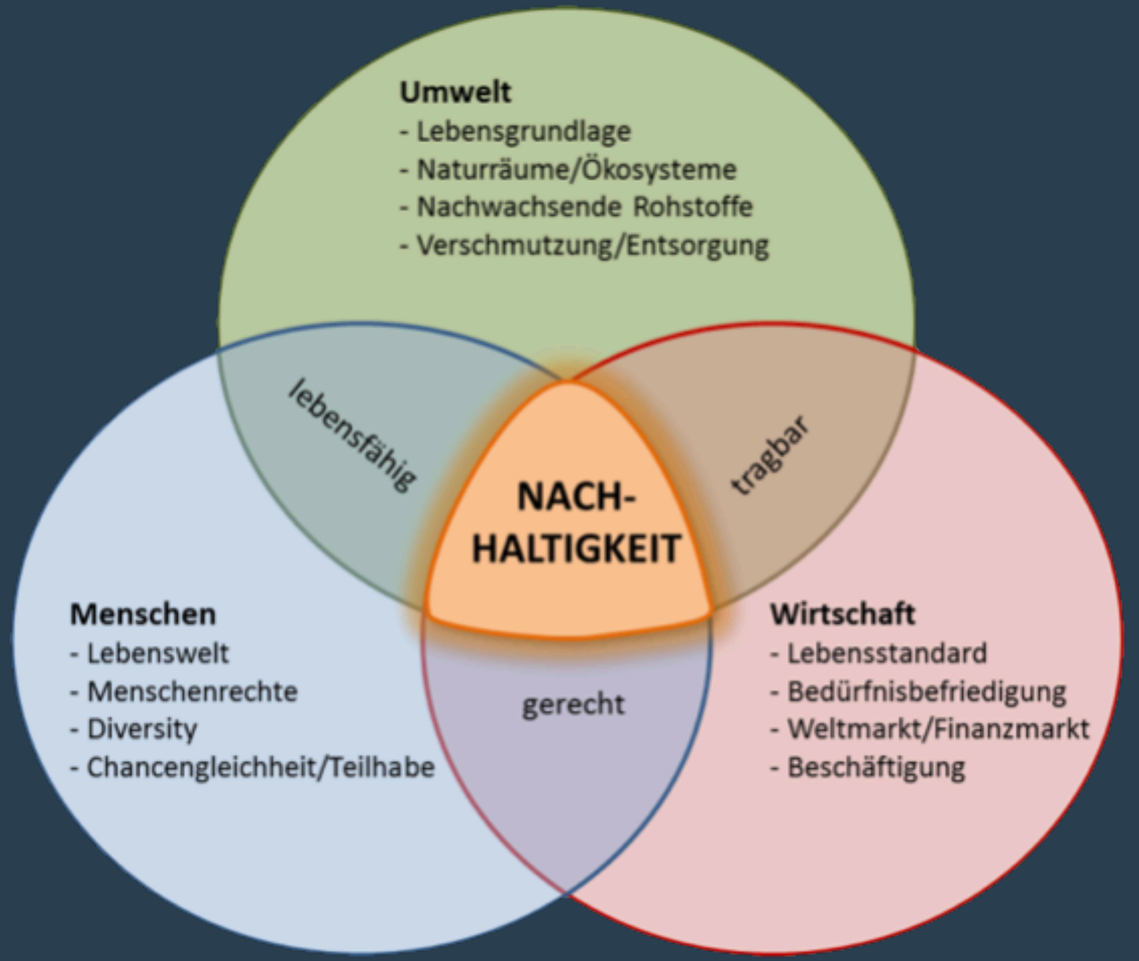
Agenda

25.04.2023

- What is sustainable software engineering?
- Which tools and concepts can I use?
- What are best practices?
- Why is sustainable software hard?

What is the definition of sustainability ...

in the domain of hard- and software



Credit: SDIA

Software uses energy and machines

To make software more sustainable we need to make its consumption visible.

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To make software more sustainable we need to make its consumption visible.

... so what tools do already exist?

Easy starter: Scaphandre - Hubblo

open-source RAPL based command line tool

- Neat feature: Can split by process

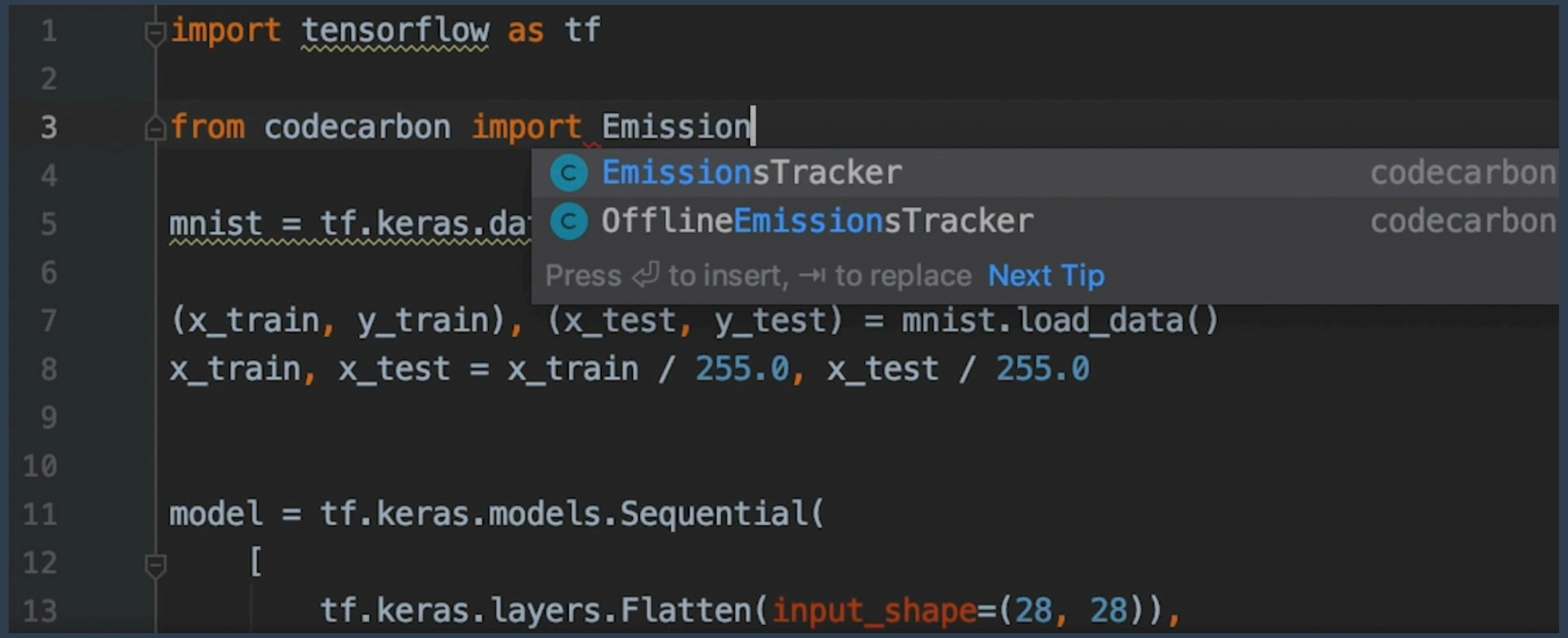
```
Host:   13.1463 W
        package         core            dram            uncore
Socket0 13.1463 W |     10.879847 W     0.748591 W      0.071402 W

Top 5 consumers:
Power           PID     Exe
10.400553 W     16621   "stress"
2.08011 W       16610   "scaphandre"
0.166408 W      2786    "gnome-shell"
0.083204 W      3915    "Xwayland"
0.041602 W      4621    "guake"
----------------------------------------------------------------
```

Ready to use tools

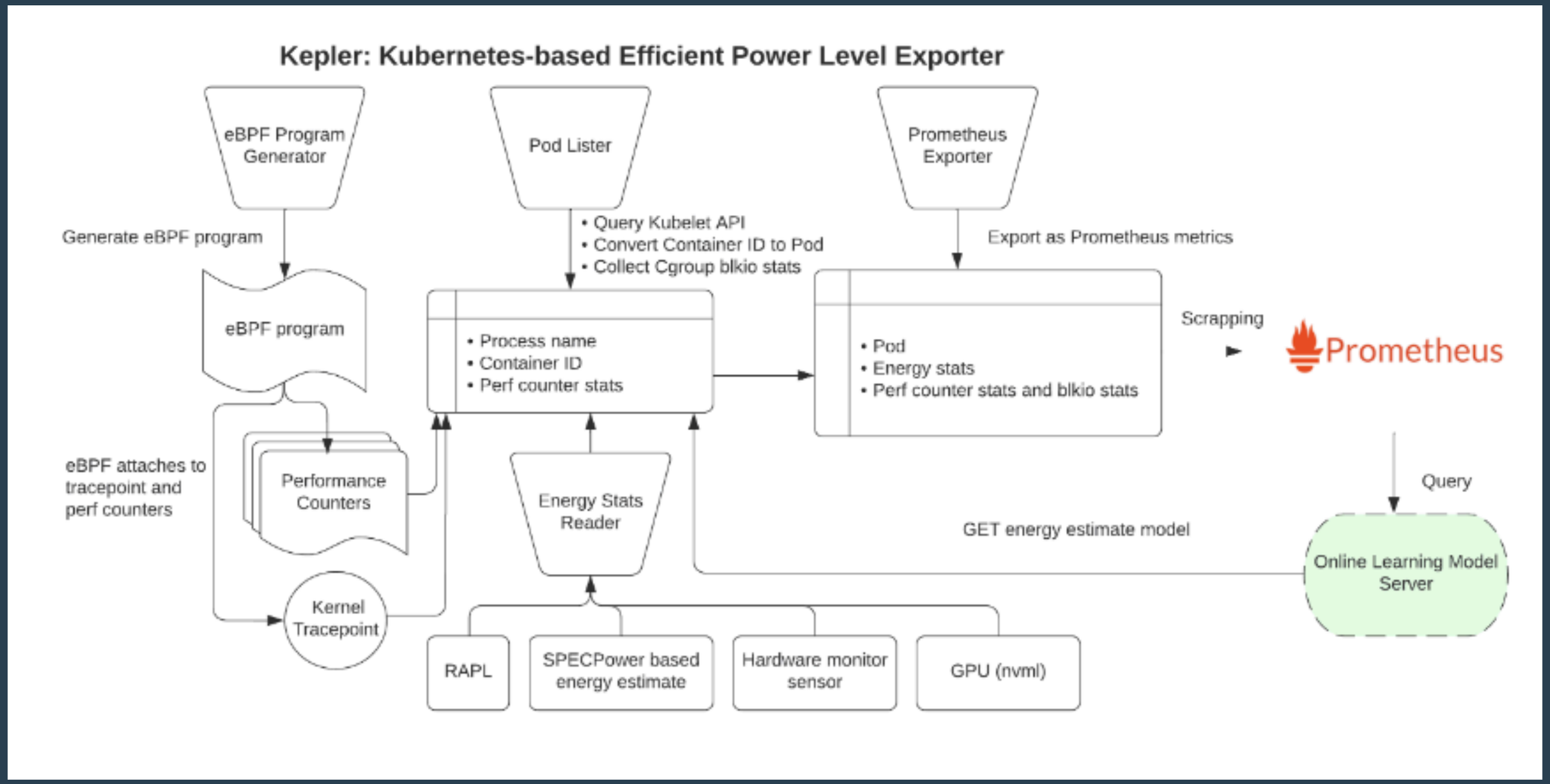
codecarbon.io

- Python
- RAPL-based
- NVIDIA GPU support



Distributed Environments / Clusters

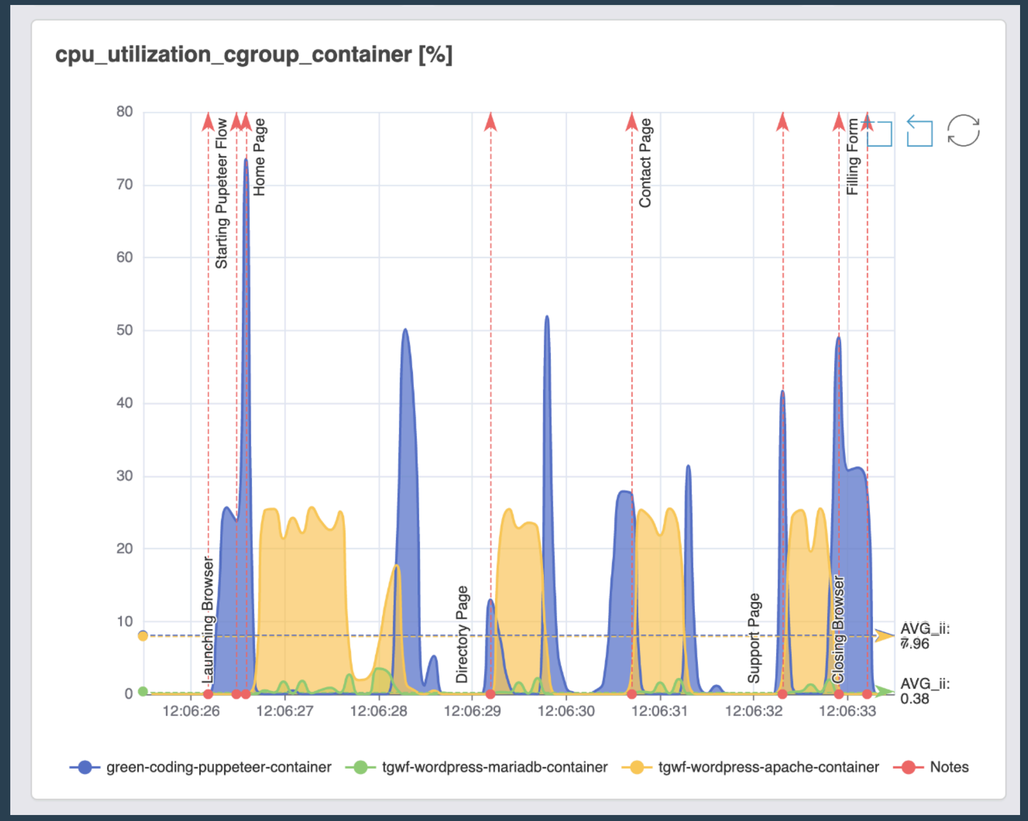
Introducing Kepler

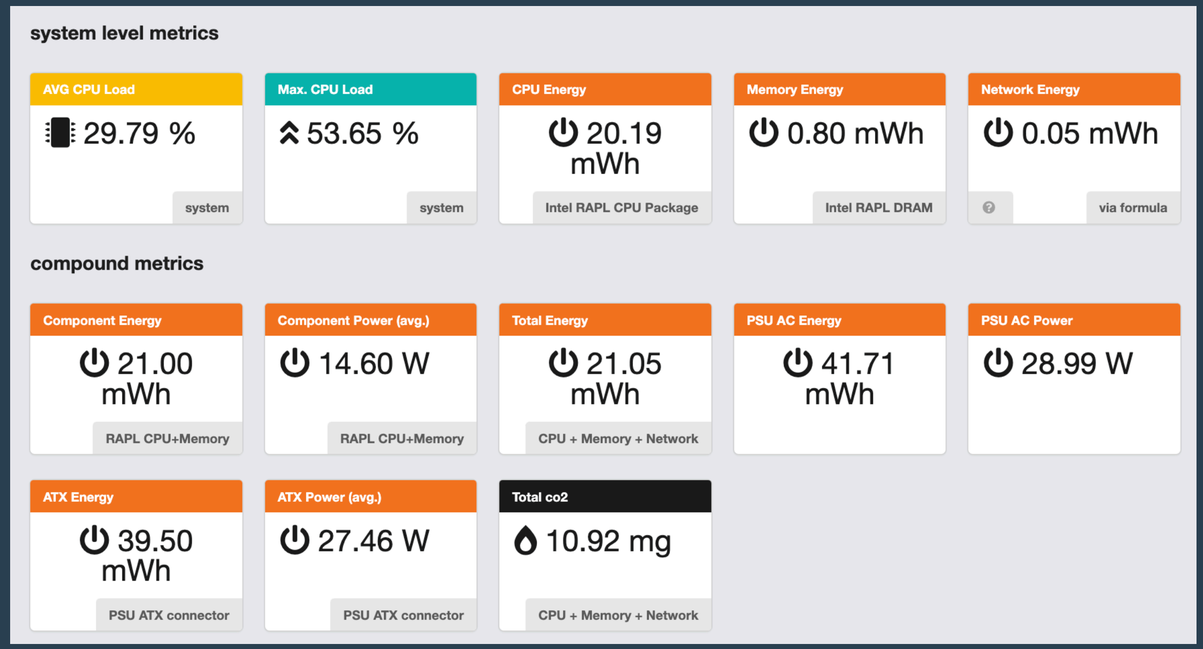


http://sustainable-computing.io

Green Metrics Tool

All-in-One solution for benchmarking, orchestration and transparency





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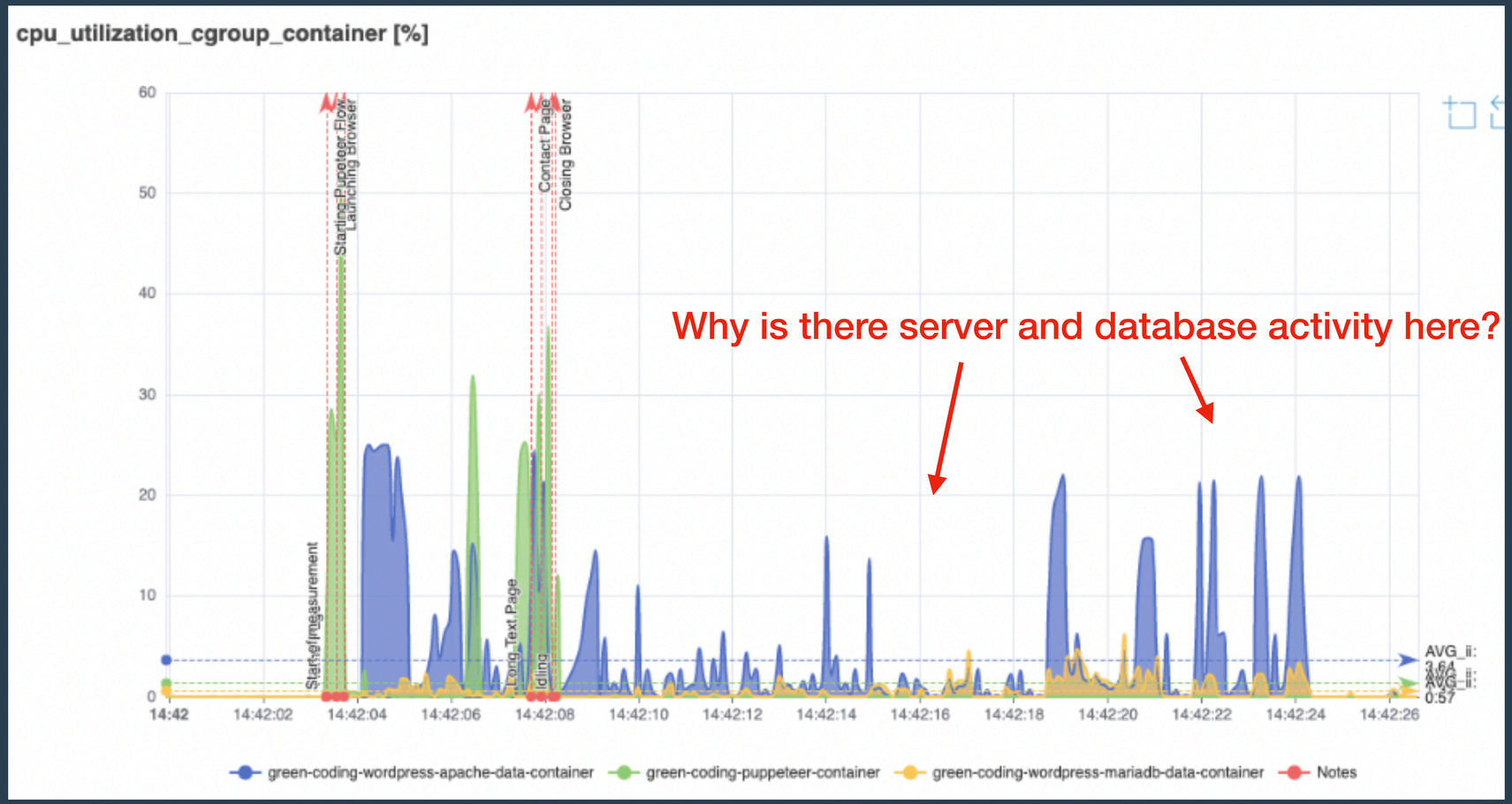
Green Metrics Tool

Container native; For detailed inspection of architecture



Use-Case mit Wordpress / Django Community

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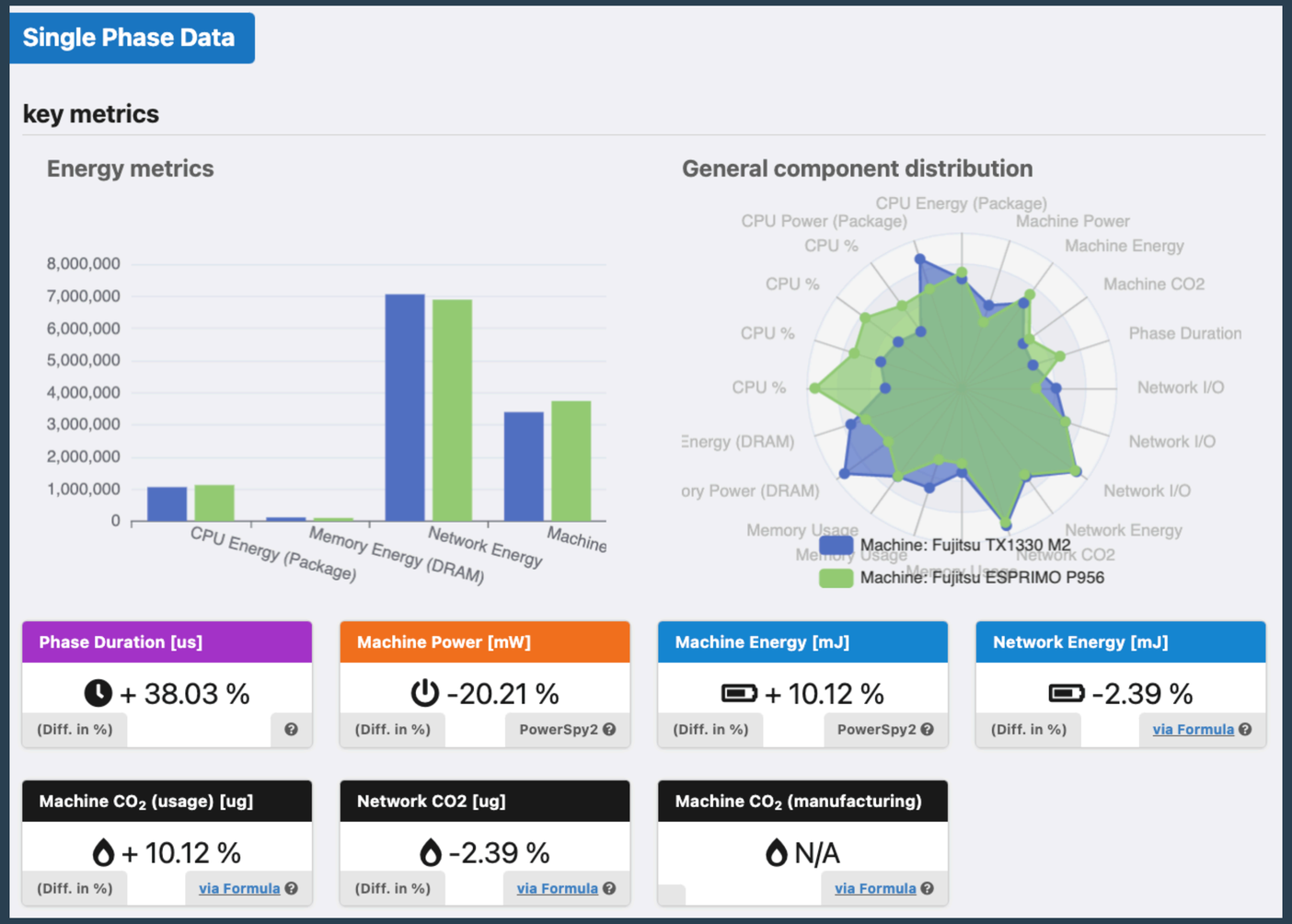
Statistical comparisons and API included



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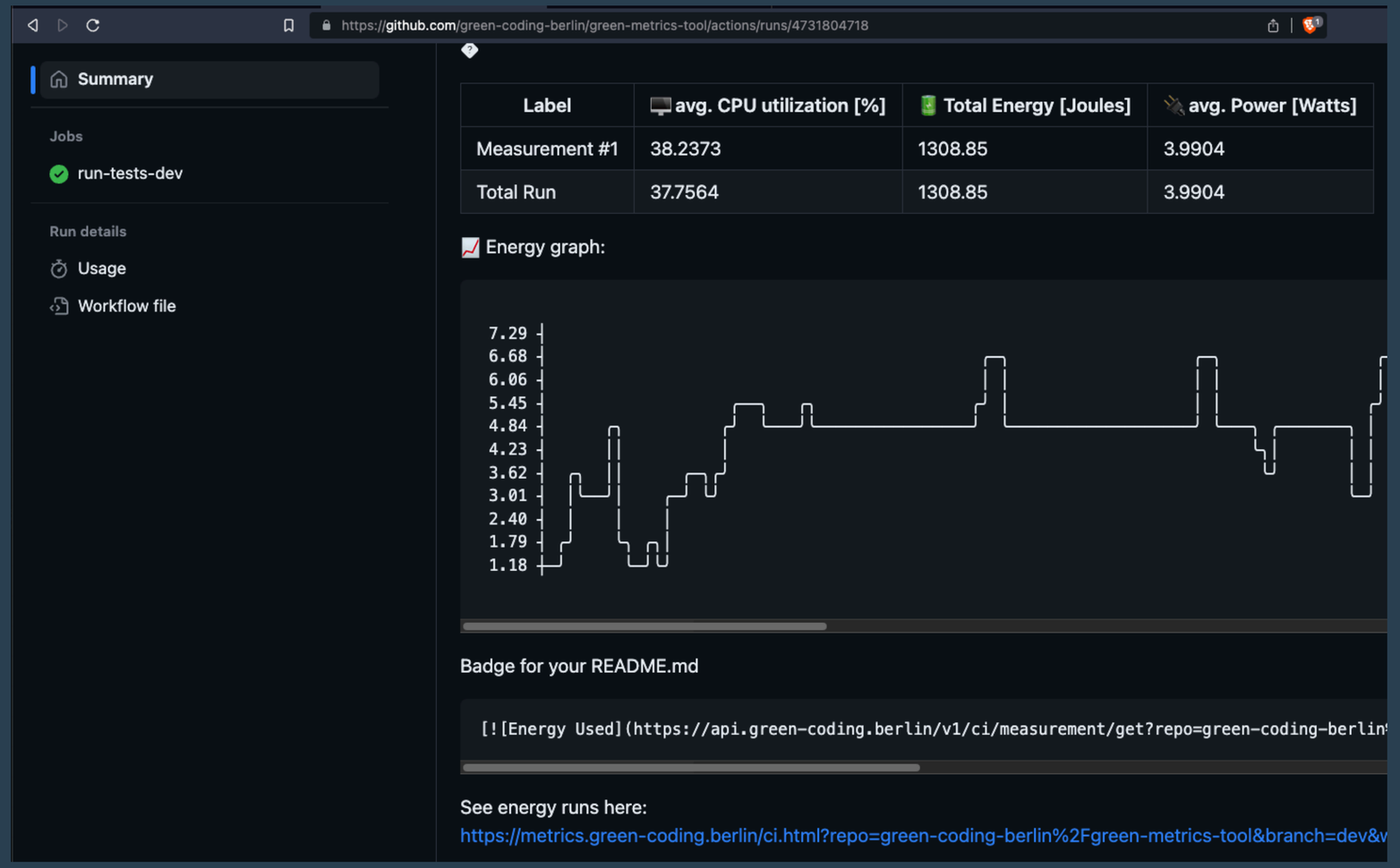
Eco CI Tools - Green Coding Berlin

Energy inside of a CI / CD Pipeline



Eco-CI Tools on Github - Integrated into Actions directly

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Weitere Tools ...

for questions regarding a specific tool, please ask in the Q&A!

- powertop
- powermetrics
- Cloud Carbon Footprint
- turbostat
- powerJoularX
- PAPI
- greenframe.io
- ...

Ok, so know I know some tools

Which should I use? And how do I interpret the data?

Are best practices for sustainable software?

Best Practices

According to the Blue Angel for Software

- **Measure your system**
- **Go for reusability**
- **Go for exportability / interoperability**
- **Code must also run on older hardware**
  - To fight device obsolescence (within reason)

Best Practices

According to the Green Software Foundation - A suprising mix ....

- **Tips that are well known and not really "green software"**
  - Cache Static data
  - Use energy efficient AI models 🤡
  - Minify JS / CSS
  - Right-Size VMs
  - ...
- **Tips that are debatable**
  - Run AI models at the edge
  - Use sustainable regions -> Depends on the network transfer. Hard to wage
  - Stateless design -> On its own no gain
- Source: https://patterns.greensoftware.foundation/catalog/cloud/match-utilization-requirements-of-vm/

Best Practices?

Even simple questions are hard (impossible) to answer

- **Is email more sustainable than paper?**
  - Paper consumes a fixed amount. Email has pot. infinite storage and processing
- **Is Serverless more sustainable than classic VMs?**
  - No solid data on this (Deno / Isolates / Firecracker)
  - Cloudflare / Amazon did decline when asking for sustainability insights
- **Is using AWS Gravitron more sustainable than Intel**
  - What happens to electronic waste?! Life-Cycle ...?
- **Is Python more sustainable than Rust?**
  - Python uses 80-times the Instructions where as Rust uses 1-3. Still people are not changing because of "cost of development" etc. ....

Problems

with current "sustainability" best practices

- **Often they just employ common sense**
  - Like**:** "run less tests"
- **Often generic advice**
  - **"**Use sustainable libraries"
- **Often can be harmful also**
  - Switching machines brings electronic waste
- **Hard to generalize at the moment**
  - Because we have no data
- **Can contain pitfalls**
  Like: "Less runtime is always better" **... no**: TurboBoost, HyperThreading etc. may inverse result

- We plead for a simpler solution ....

Best Practices

But how do we get there

- You just have to measure!
- You have to ask (service providers) for the metrics you don't know.
- And to treat energy and CO2 as a first order metric .... constantly (git-ops)!
- We need a lot of data for general statements
- And we need to include the development and delivery phase of software
  - Isolated benchmarks and claims are helpful for a isolated view, but not for global sustainability

Best Practices

An approach for a framework atm.

1. **Quantify** your system!
   How much am I using for what service (Green Metrics Tool, Scaphandre, Kepler etc.)

2. **Green Energy** (-> Green Web Foundation)
   But not on the moon please!

3. **Idle machines** (Async / Polling / Microservices)
   Only makes sense if you can really turn machines off

4. **Architecture Overhead** (Backups, Logs, Redundancy, Over-Provisioning of Services / Machines)

5. **Language Overhead** (C-Extensions, WebAssembly, Language-Swaps)

6. **Code Changes**
   Even 99% Code runtime reduction is of limited help if the machine then idles

Best Practices

Some general guidance

- **No fancyness until proven helpful**
- **Use less resources -> Yes, common sense!**
  - Services, Machines etc.
- **No off-loading / Backlashes**
  - We are more sustainable, we now use a data provider for that machine!
  - We now use 5 GB less memory (and calculate everything on request :( )
- **General Question: If everybody would do it this way. Would we have enough resources?**
  - Simple chat-bot => ChatGPT
  - Portfolio Website: VPS with Wordpress and database

Thank you! Time for Q&A

Follow green-coding.berlin

- Website / Blog / Newsletter: https://www.green-coding.berlin
- Demo Open Data Repository: https://metrics.green-coding.berlin

- Unsere Projekte: https://www.green-coding.berlin/#projects
- Unsere Case-Studies: https://www.green-coding.berlin/case-studies

- Meetup Gruppe (Berlin): https://www.meetup.com/green-coding

- https://www.linkedin.com/in/arne-tarara / arne@green-coding.berlin

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Backup Slides

Demo

https://preview.green-coding.berlin

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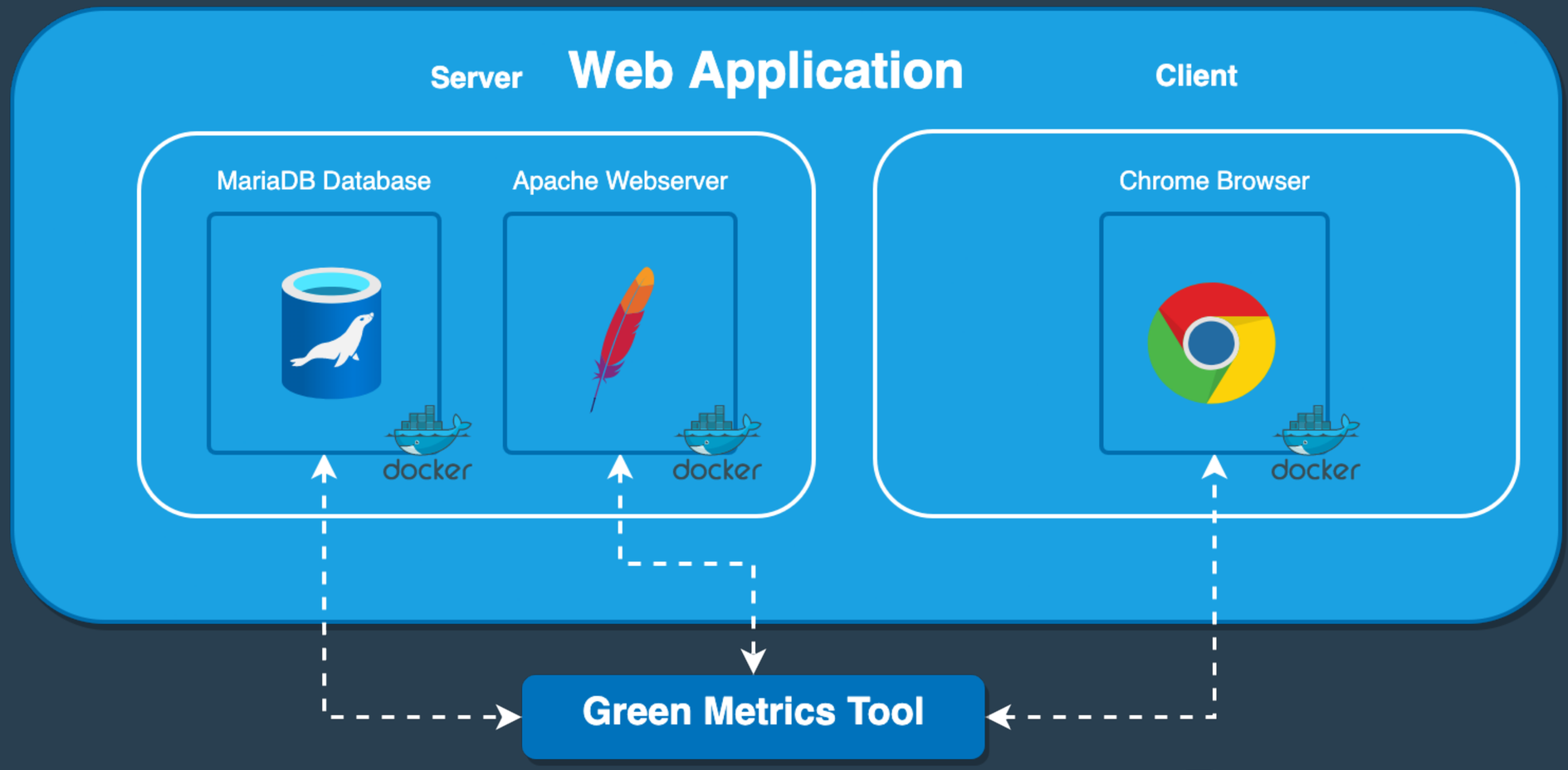
https://github.com/green-coding-berlin/bakerydemo-gold-benchmark

Green Metrics Tool - Schaubild

Container Aufbau für Client-Server Apps



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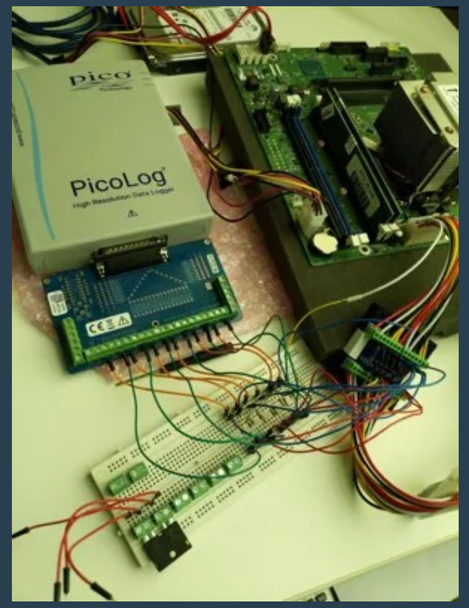
Green Metrics Tool - Hardware Setup

Mess-Sensoren im Green Metrics Tool

- AC / DC Energie
  - IPMI
  - GUDE (Blauer Engel)
  - PowerSpy2 - Consumer Grade Oscilloscope
  - Custom Mainboard Connector for Fujitsu ESPRIMO
- CPU % / CPU-Frequenz
- Temperatur
- CPU / DRAM Energie
  - RAPL
- Netzwerk Datenverkehr / Energie
- Container-Metriken
- ... weitere Reporter als Open-Source Plugin-In möglich



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Green Metrics Tool - Cluster Setup

Aktuelle Rechner im Green Metrics Tool Cluster

- Fujitsu ESPRIMO P956 - Blue Angel compatible (Ubuntu)
- Fujitsu TX1330 M2 - Single-Tenant Server (Ubuntu)
- Quanta Leopard - Multi-Tenant Server - SoftAWERE compatible (Ubuntu)
- Intel Mac 13" Q3-2015
- M1 Mac 13" Q1-2022

Green Metrics Tool - Supported Software

Software Kategorien und OS

- **Server / Client Anwendungen**
  - Beispiele Nextcloud und Django CMS
- **CLI Anwendungen**
  - Beispiele curl oder ML Anwendungen (sklearn, pytorch)
- **Desktop Apps**
  - Beispiele: Google Chrome, Firefox etc.
- **OS**
  - macOS
  - Linux (Ubuntu & Fedora)
  - Windows (nur Gesamtleistung an der Steckdose)