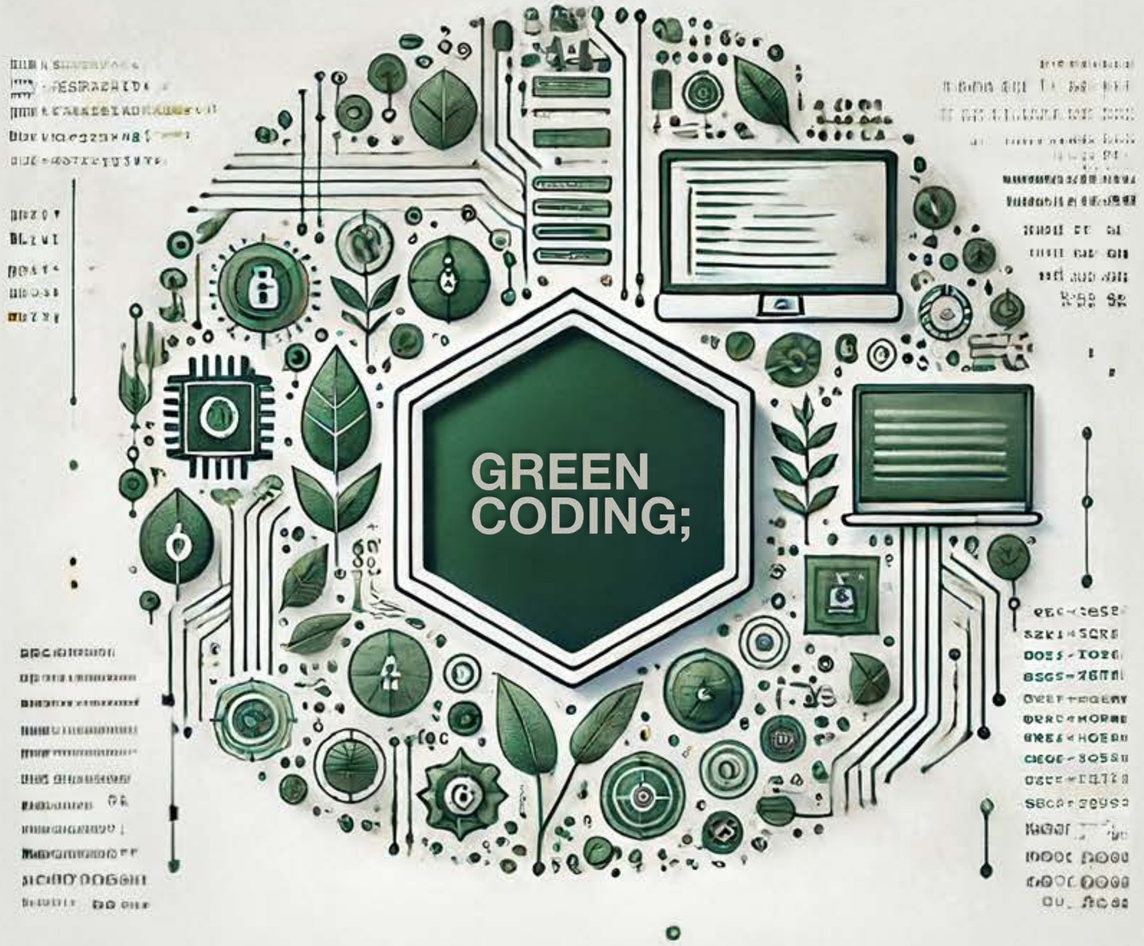
Green Coding Solutions GmbH



Grants and Awards

WSA Winner 2023

Green Screen Coalition

Investitionsbank Berlin

Who am I

Arne Tarara - Green Coding Solutions GmbH (Germany)

- CEO & Founder - Green Coding Solutions
- We are specialized in the reduction of Software-CO_2-Emissions
- Areas: Consulting & Integration, Forschung, Messung, Tools, Infrastruktur
- We love open source - all our tools are open source and free to use

Lufthansa Industry Solutions

Green Software Foundation

Umwelt Bundesamt

wagtail

GREEN CODING;

ecoCompute

ABOUT CALL FOR SPEAKERS BECOME A SPONSOR COMMUNITY MORE GET YOUR TICKET

ecoCompute conference

13 & 14 November 2025

📍 bUm - Berlin, Germany

https://www.eco-compute.io/

GREEN CODING;

Agenda

- **Introduction**: What is the Blue Angel label and why apply it to software?
- **Certification Process**: Steps to certify software under DE-UZ 215
- **Technical Requirements**: Detailed criteria (efficiency, hardware longevity, transparency, etc.)
- **Measurement & Tooling:** How to measure software efficiency (idle vs. active, scenarios) and tools
- **Case Study – Nextcloud**: Experience of a real-world software project getting certified
- **Benefits**: Advantages for developers, companies, and users

Why Measuring Software Is Important

For climate conscious people and organisations

- **Problem**: Software and ICT is a relevant CO2 emitter in modern digitalized companies (15 - 30%)
- **Solutions:**
  - Measuring software is the foundation of every optimization
  - We already have many good and open source solutions off-the-shelf to use
  - The community is so mature that even ChatGPT can unearth many good recommendations nowadays :)

The only thing lacking so far: Strong business incentives and customer visibility

What is the Blue Angel?

Some history and ambitions

- **Germany's Environmental Label:** Established over 40 years ago by the German government
- **Expansion to Software in 2020:** Software was/is largely unregulated in terms of energy efficiency .
- **Why software matters?**
  - "A computer can only be as energy efficient as the software allows."
  - Environmental Impact: ICT software is estimated to cause 2–4% of global CO_2 emissions, same as aviation

Blue Angel for Software

Scope

- **Scope**: Initially limited to desktop applications, it now covers:
  - Desktop software (PC),
  - Mobile apps (smartphones/tablets),
  - Server software or combined client-server systems (e.g. web services with clients) .

Blue Angel Software Label

Measurement approaches

- **Standard Usage Scenario** (Scenario Test)
  - Run the scenario at least 10 times on the test system
  - The scenario should cover a few minutes of typical use (enough to exercise main functionality)
- **Long-Term Use** (Long-Term Test)
- => Document

Blue Angel Software Label

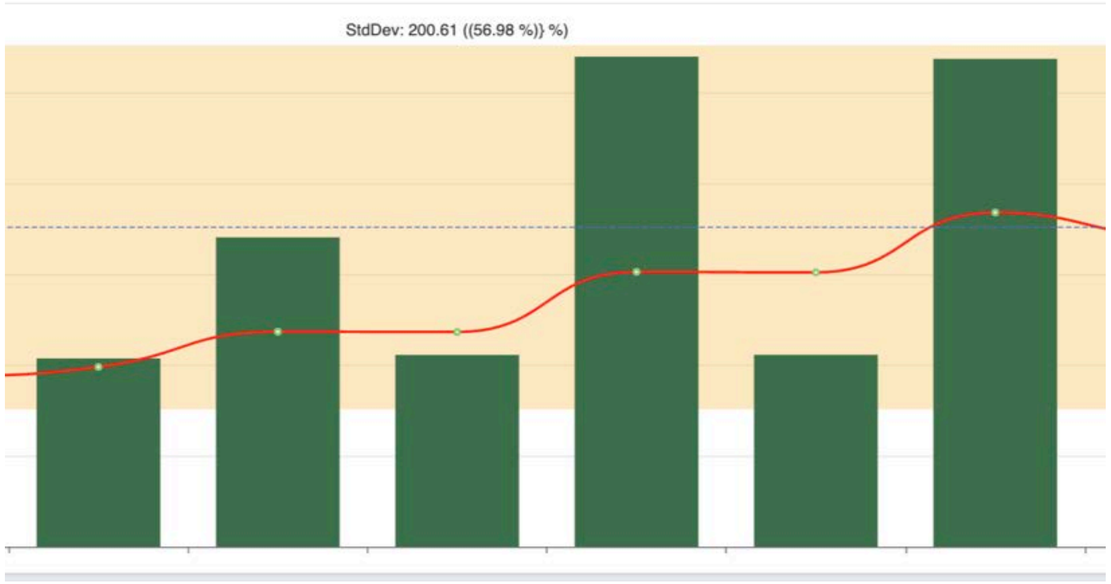
Key objectives

- **Energy & Resource Efficiency:** Improve resource efficiency by requiring developers to be measure and report software energy and resource consumption
- **Extended Hardware Lifespan:** The software must not force users into frequent hardware upgrades. It should run on hardware that's at least 5 years old and refrain from unnecessary bloat that causes "planned obsolescence".
- **Transparency & Open Standards**: High transparency in how the software operates. This includes clear documentation of interfaces (APIs), use of open or standard data formats (to avoid lock-in), and ideally making source code available, especially after end-of-life.
- **User Autonomy & Privacy:** Users remain in control. No forced updates without consent, no hidden data collection or tracking, and no embedded advertising that wastes resources. The software should be modular (users can disable unwanted features) and fully uninstallable.
- **Verification & Accountability**: All claims are measured and verified. Energy usage and resource consumption must be documented with standardized tests, and the results are made public for accountability. An independent audit ensures the data and criteria compliance are credible.

Blue Angel for Software

Some notable technical requirements

- Sampling rate must be 1 Hz at least
- Energy consumption (Wh) may only deviate 5% between runs.
  - Reproducability is very important!



Who Has Earned the Blue Angel (Software)?

Current certificate holders

Green Metrics Tool

Green Coding Solutions GmbH

KDE Okular

KDE e.V.

Nextcloud Server

nextcloud GmbH

GREEN CODING;

Comparing standards

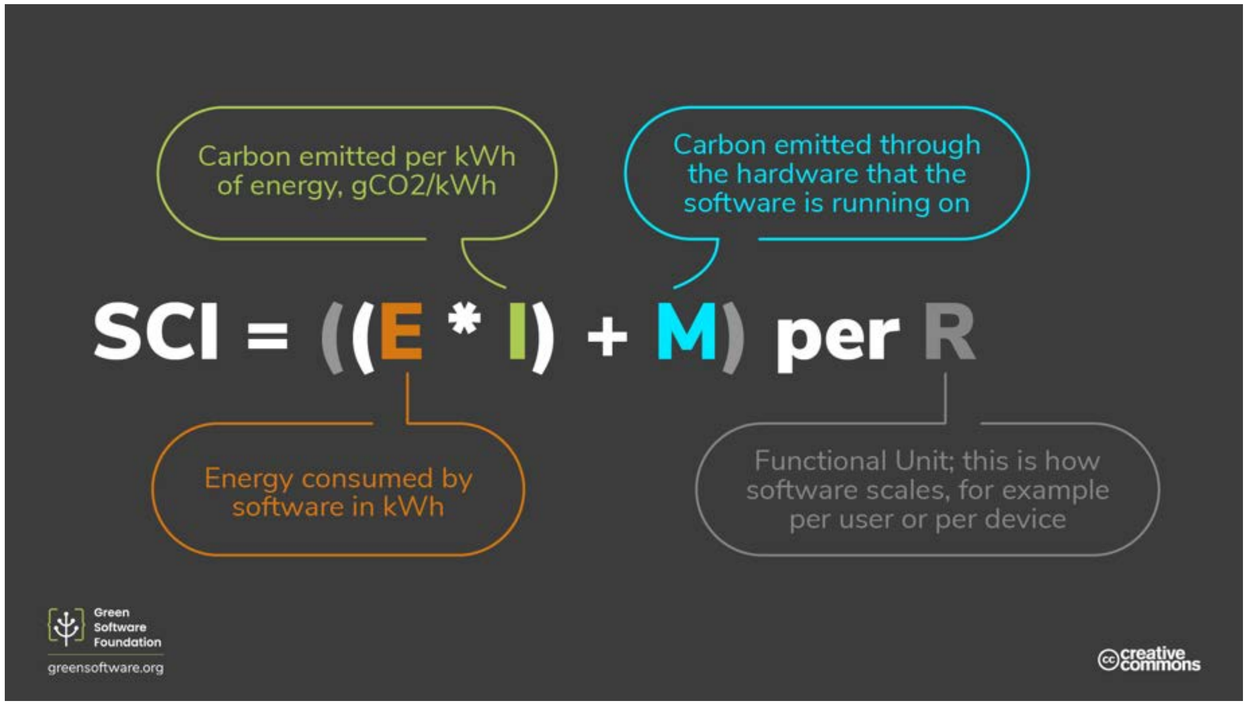
Blue Angel vs. SCI

GREEN CODING;

Comparison of technical requirements

SCI vs Blue Angel: SCI

What



SCI by Green Software Foundation

How

- System boundaries can be defined freely
- Measurement protocol not defined
- Use Case freely selectable
- No verification or validation

Comparison of technical requirements

SCI vs Blue Angel: Blue Angel

What

- Energy consumption of **ALL hardware components** needed to run application
- **No carbon** required
- Performance metrics (CPU%, Memory use etc.)
- **Network connections** and traffic
- Documentation, API specs, Uninstallabilty, Export-Formats etc.

How

- **Measurement protocol** must follow software life cycle (baseline, idle, use)
- **Hard requirements** for resolution and StdDev
- Must run on 5 year old hardware
- **Use Case must be typical** for software and match with with vendor claims
- **Verified by auditor**

Blue Angel thinks in phases

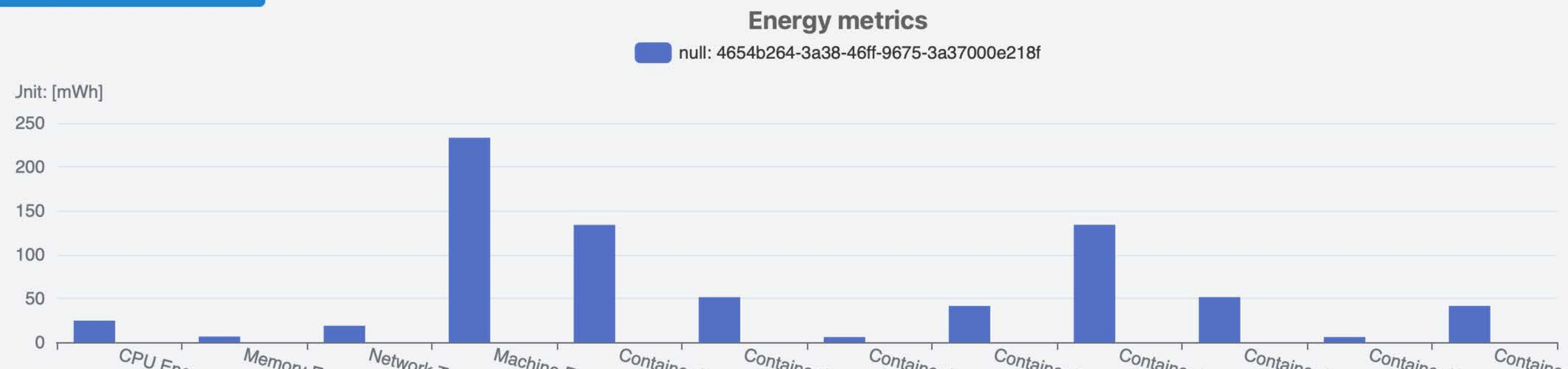
Different paradigm then plain "performance engineering" of code blocks

Baseline | Installation | Boot | Idle | Runtime | Remove

Runtime can contain multiple flows. By default all runtime flows are aggregated. Please select a separate flow if needed.

All Flows | Check Website

Single Phase Data

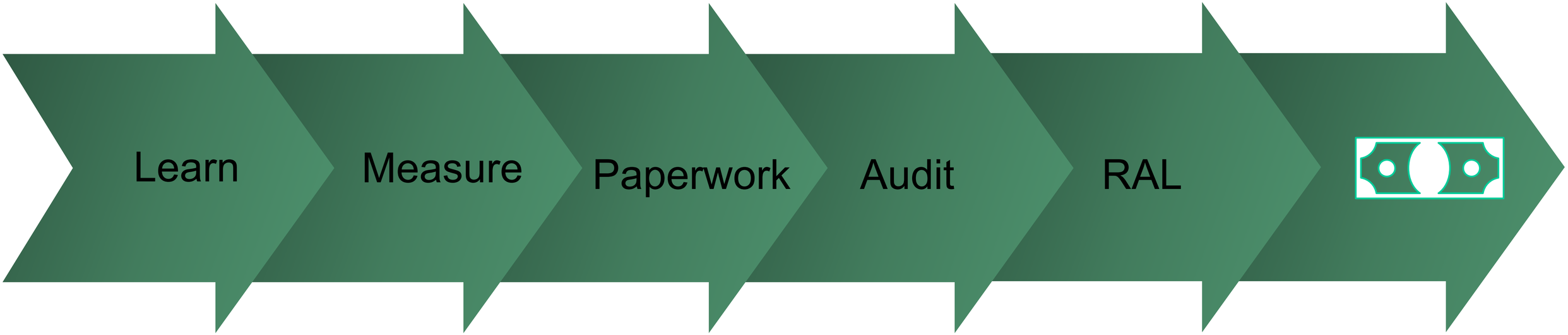


Formal process

For Blue Angel application

GREEN CODING;

How to get the Blue Angel



Blue Angel in a list

Full overview of all documents needed

- Annex 1 - Software overview
- Annex 2 - Overview of the measurement data (complete document created by the exporter)
- Annex 3 - Measurement data series and description of the measurement setup
- Annex 4 - Declaration on the data formats used in your software
- Annex 5 - Declaration on API documentation, source code and licenses of your software
- Annex 6 - Declaration on the freedom from advertising, uninstallation and continuity of your software
- Annex 7 - The publicly downloadable document with an overview of the minimum system requirements, the measurement setup and the measurement results
- Example: https://produktinfo.blauer-engel.de/uploads/pdf_uploads/Anlage_7-1.pdf

Use Case Example

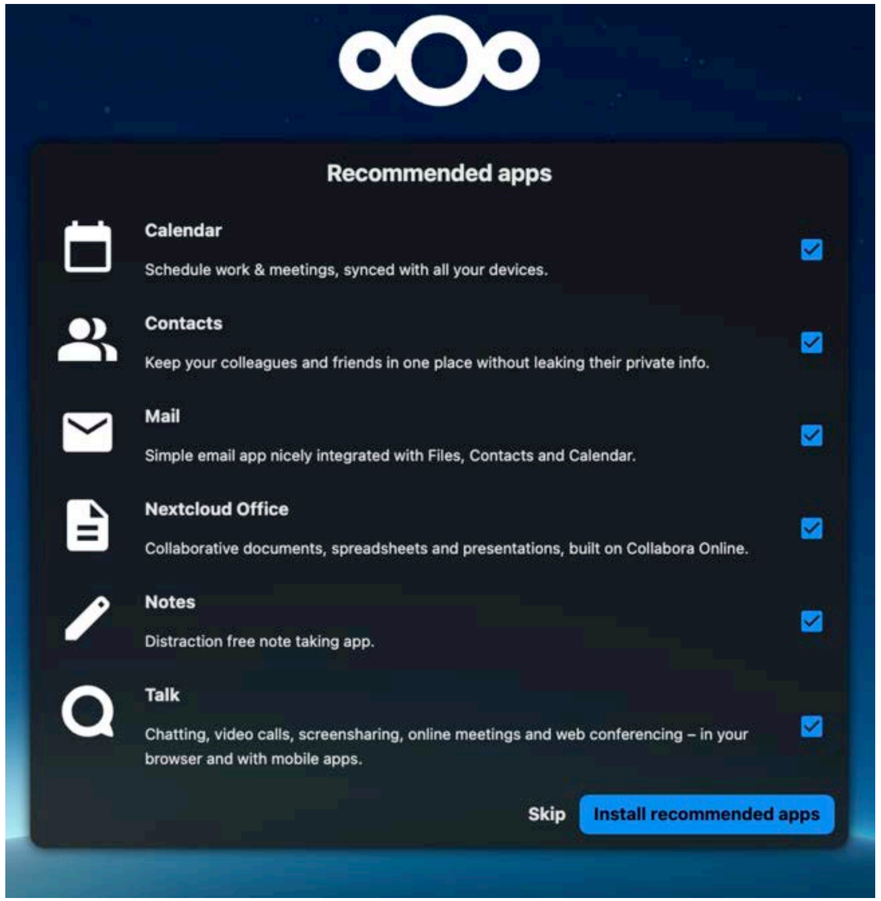
Nextcloud - Blue Angel and SCI

GREEN CODING;

Selection of "Usage Scenarios"

Example Nextcloud

- Scenarios should be representative
- Scenarios should be what vendor advertises / features
- Scenarios should capture "80%" of all the use cases
- Scenarios should be done like a real user (waiting times, idle etc.)



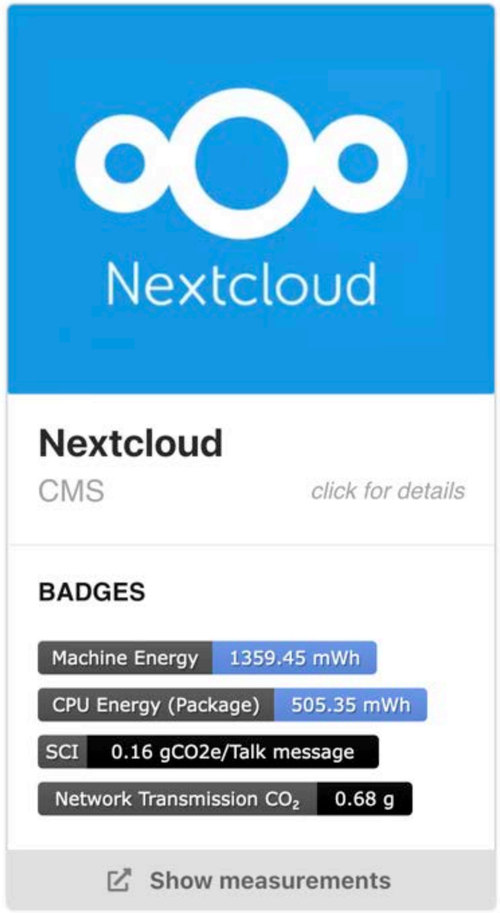
Designing a Standard Usage Scenario

- Representative Use-Case
- Not Every Edge Case
- Automate if Possible
- Document the Scenario

```
log_note("Opening login page")
page.goto(f"{DOMAIN}/")

log_note("Logging in")
login(page, domain=DOMAIN, username=USER2['username'], password=USER2['password'])
user_sleep()

log_note("- Nutzen der Suchfunktion im Text der Dateien durch User #2 mit Begriff Carpe
search_input_selector = 'div#files-global-search-bar input.oc-search-input'
search_term = 'Carpet'

user_sleep()

page.wait_for_selector(search_input_selector, state='visible')
page.fill(search_input_selector, search_term)

user_sleep()

page.press(search_input_selector, 'Enter')

log_note("- Sicherstellung das Dokument gefunden wurde")
page.wait_for_selector('.oc-resource-details ', state='visible')
```

Example outputs

For SCI and Blue Angel data



Source: https://www.green-coding.io/products/energy-id/

- **Szenario Calendar** - Nextcloud login über das Web Interface. Erstellen eines neuen Kalender-Eintrag. Ändern des Kalender Eintrag. Löschen des Kalender Eintrag.

Messung des Softwareprodukts während der Nutzung - Für virtualisierte Systeme - Server (Datenbank (db) + Apache Webserver mit Nextcloud & PHP (nc) + HTTPS Reverse Proxy (ncs))				
ID	**Bezeichnung**	**Hinweis**	**Ergebnis**	**Einheit**
3.1.1.4 a)	Prozessorarbeit		165	%*s
3.1.1.4 b)	Arbeitsspeicherarbeit		23.670	MByte*s
3.1.1.4 c)	Permanentspeicherarbeit (Lesen und Schreiben)		277.613	MByte*s
3.1.1.4 d)	Übertragene Datenmenge für Netzzugang		160	Mbit/s*s
3.1.1.4 e)	Energiebedarf	netto beim Szenario-Test; brutto beim Langzeit-Test	0,01	Wh
Messung des Softwareprodukts während der Nutzung - Für virtualisierte Systeme - Client (Firefox Web-Browser)				

Source: https://produktinfo.blauer-engel.de/uploads/pdf_uploads/Anlage_7-1.pdf

GREEN CODING;

Insights from energy measurements

For Nextcloud

- Idle energy close to native server idle - Good for Nextcloud 24h operation model
- Browser to access interface was **5x more energy consuming** than Backend application
- Cron-Jobs for maintenance of database are equally good optimization target as multi-user document editing
- Video-Calling very efficient and low value target
- Energy regression in frontend found by making energy and idle time first class citizen - Classic regression test has missed this

Values for developers and companies

Blue Angel standards derive values to your software

GREEN CODING;

Benefits of sustainable software

For developers

- Making sustainable software is a **quality statement**
  - Better insight into application increases **resilience**
  - Code efficiency **decreases technical debt**
  - **Skill-Growth** through code efficiency techniques
  - Idle times are rarely considered in application development so far
  - Phases approach looks at whole life cycle and sees software as a whole
- Energy and Carbon will be come a key metric in a **renewable powered world**
- Sustainable software stands out
  - Recognition and Peer Respect
- Real world impact through **energy and carbon savings**

GREEN CODING;

Expanding the view even more

Looking at the software "life cycle"

Benefits of sustainable software

For companies

- Market Differentiation
- Compliance with Green Procurement
- Alignment with Corporate Sustainability Goals
- Brand Image and PR
- **Talent Attraction and Retention**
- Efficiency ≈ Cost Savings
- Sales increase with climate conscious buyers

Benefits of sustainable software

For users and customers

- Energy Savings
- Better Performance on Older Devices
- Reliability and Longevity
- Transparency and Trust
- User Autonomy and Flexibility
- Less Annoyances

GOOD FOR ME, GOOD FOR THE ENVIRONMENT

Green Metrics Tool

An open source tool to create SCI and Blue Angel

GREEN CODING;

Our contribution to open source measurement

Develop an open source tool that is SCI and Blue Angel conformant

Green Metrics Tool

Blue Angel for Software

Green Software Foundation SCI

GREEN CODING;

Our contribution to open source measurement

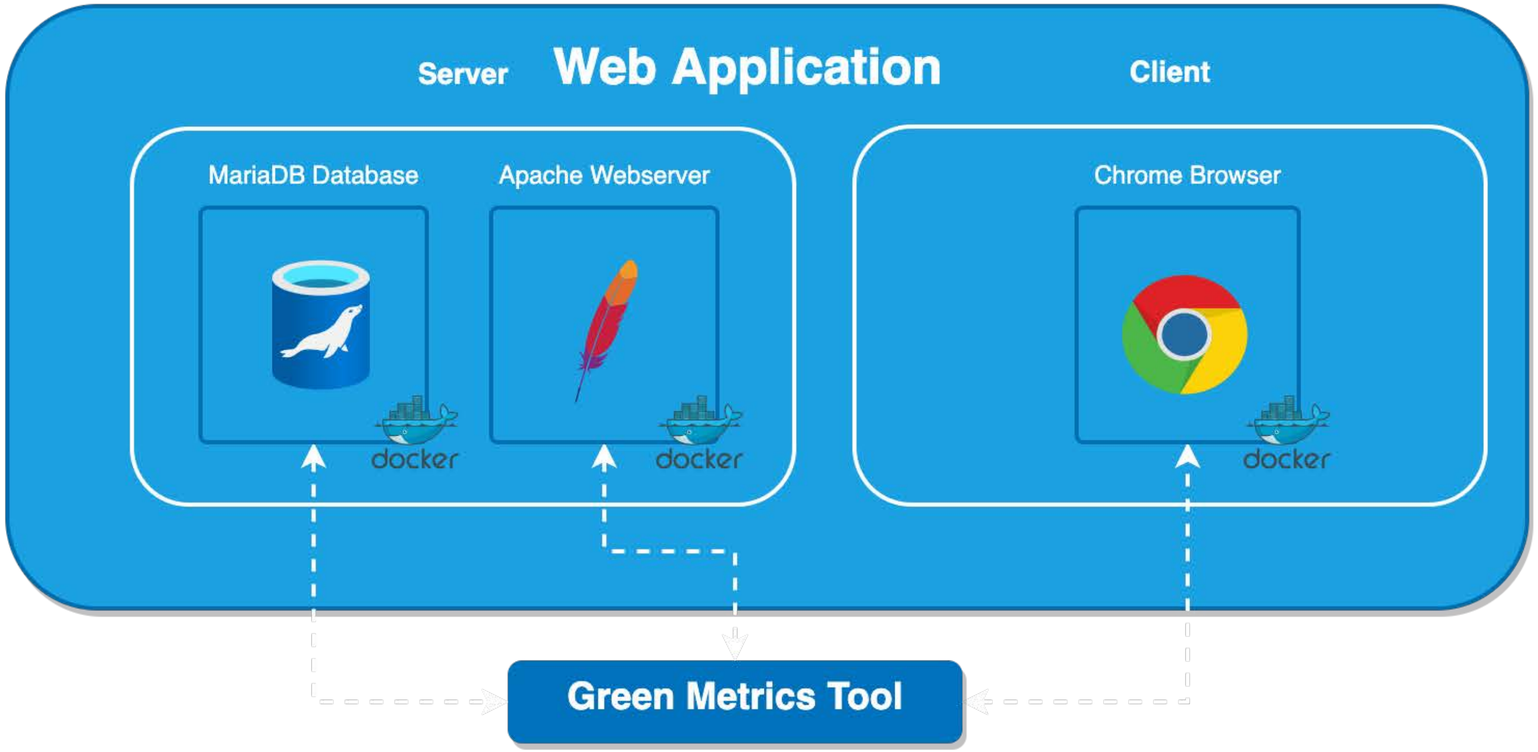
Develop an open source tool that is SCI and Blue Angel conformant

BLUE ANGEL CERTIFICATION

Our Tool is Blue Angel for Software certified!

How the GMT is set up

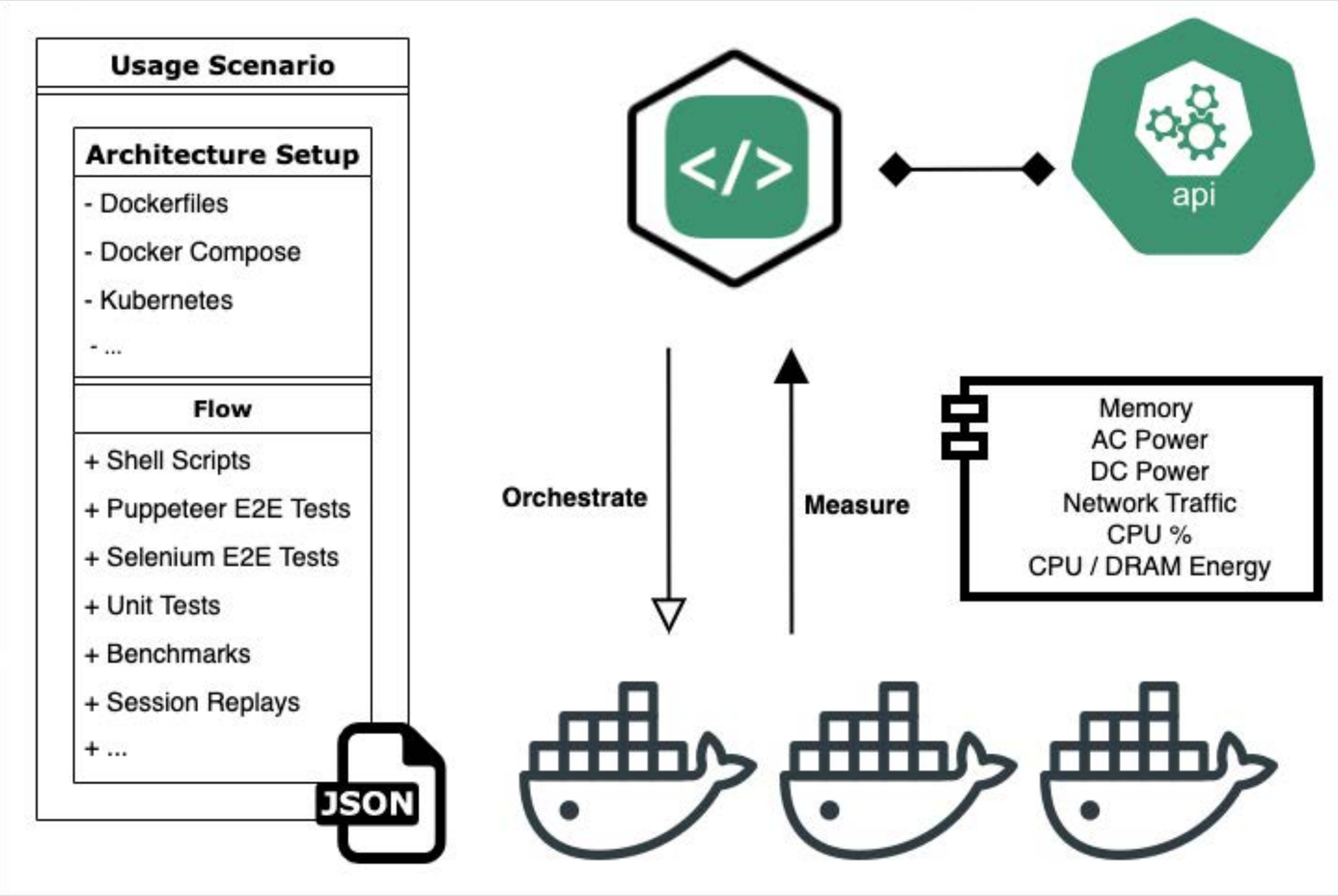
Native understanding of separation of software components for drill-downs



Native Understanding of modularity of applications and separate measurements

Overview

Re-Use of existing infrastructure as code (IaC) for easy setup and integration



Re-Use of existing infrastructure as Code (IaC)

https://metrics.green-coding.io/index.html?uri=https://github.com/green-coding-solutions/nextcloud-docker

- Home
- ScenarioRunner
- Runs / Repos
- Watchlist
- Submit Software
- Cluster Status
- Eco CI
- Power HOG
- CarbonDB
- Data Analysis
- Authentication
- Settings

Green Metrics Tool - Home

Welcome to the home page

The Green Metrics Tool is a modular suite of different tools that capture energy and carbon data for different stages of the software lifecycle.

The home page shows you all available and connected tools.

Click on any of them to get to a detailed view of the energy and carbon data.

Through settings you can also adjust the default sorting, default fetching of detailed metrics etc..

ScenarioRunner

Measure software for energy and CO_2

Visible for your user:

Current Runs in DB: **15431**

Oldest Run in DB: **2023-01-01**

Eco CI

CI/CD plug-in for energy and CO_2

Visible for your user:

Current CI/CD runs in DB: **184143**

Oldest Run in DB: **2023-03-04**

CarbonDB

View your total CO_2 by project, tool and source

Visible for your user:

Current data points DB: **4985**

Oldest data in DB: **2023-01-01**

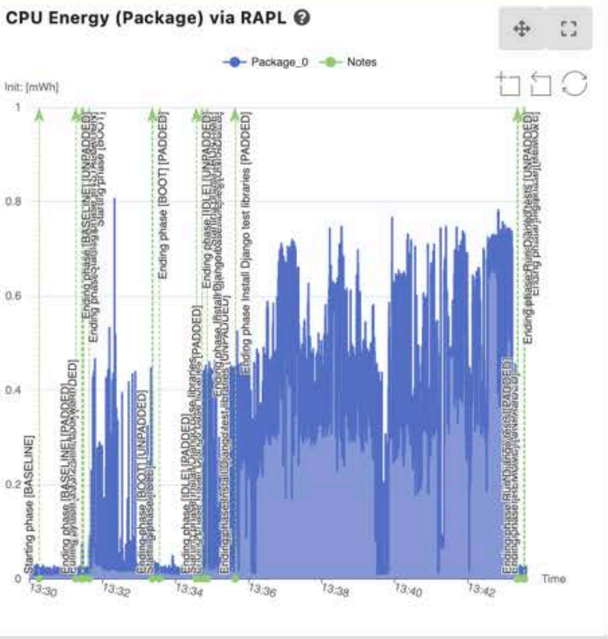
PowerHOG

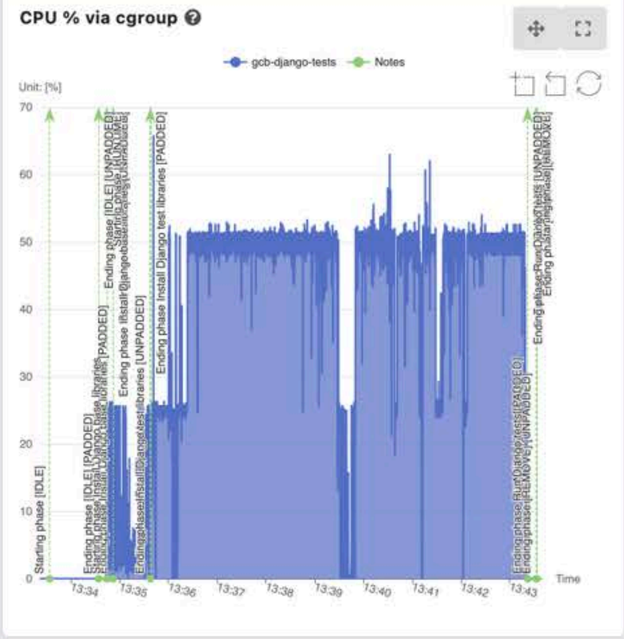
Measure the development of software for energy and CO_2

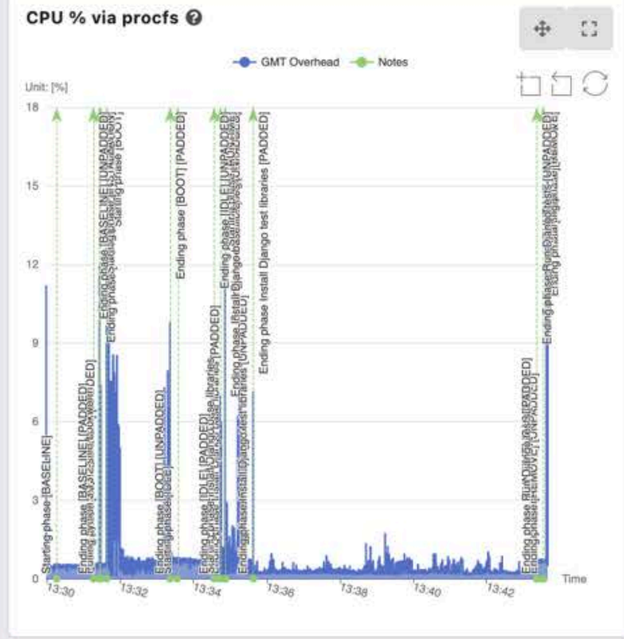
Visible for your user:

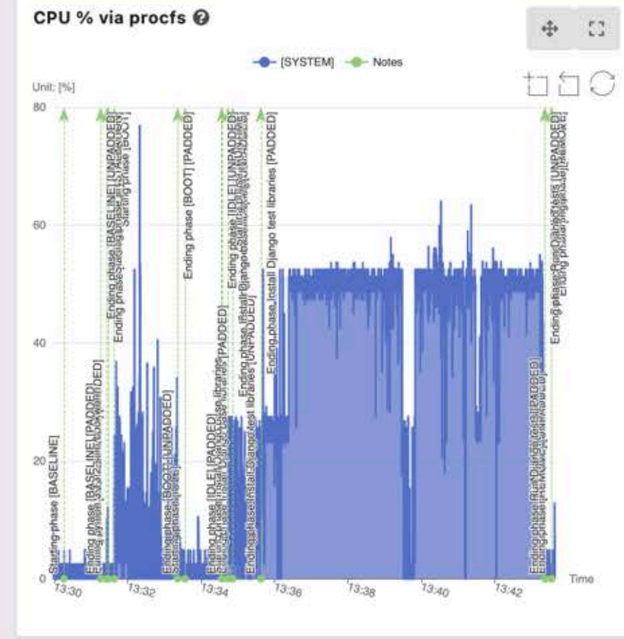
Current data points in DB: **581087**

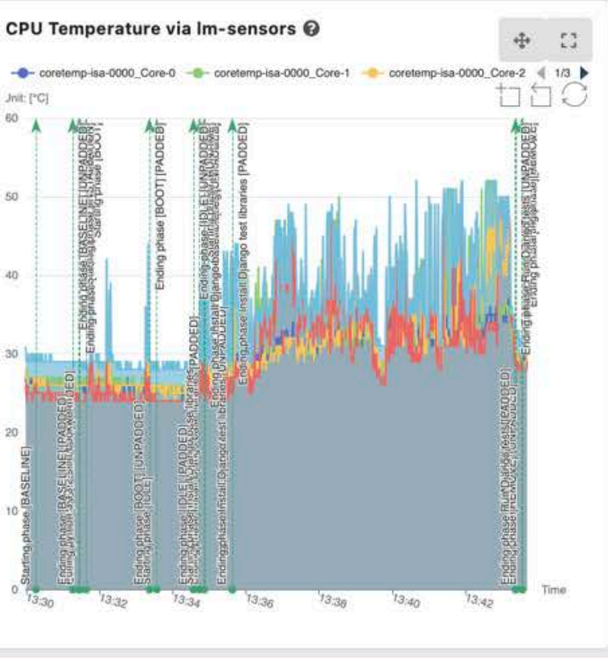
Oldest data in DB: **2025-03-22**

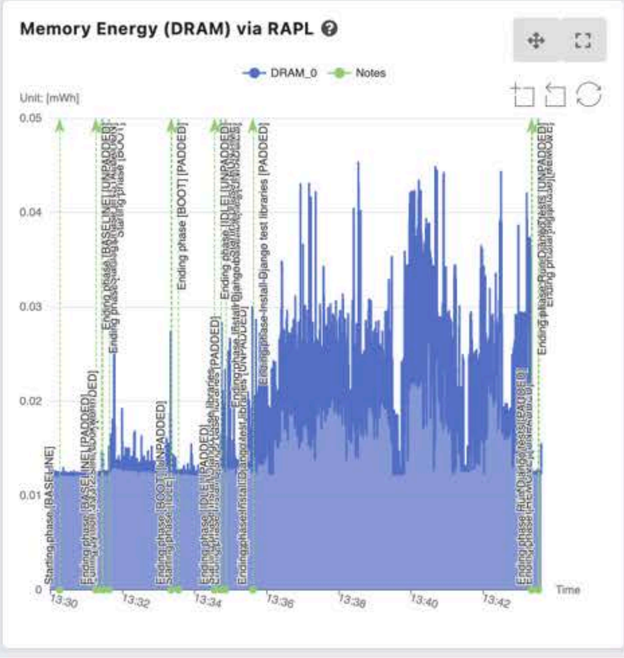

CPU Energy (Package) via RAPL
Package_0
Notes
Unit: [mWh]
Time

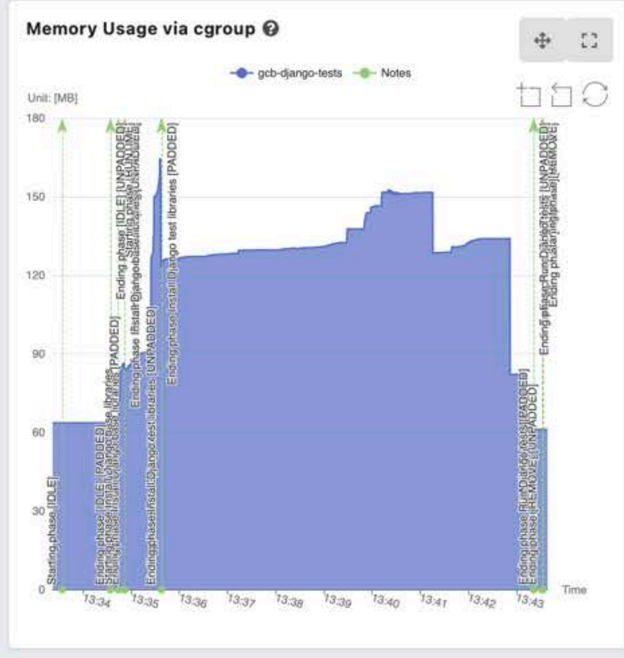

CPU % via cgroup
gcb-django-tests
Notes
Unit: [%]
Time

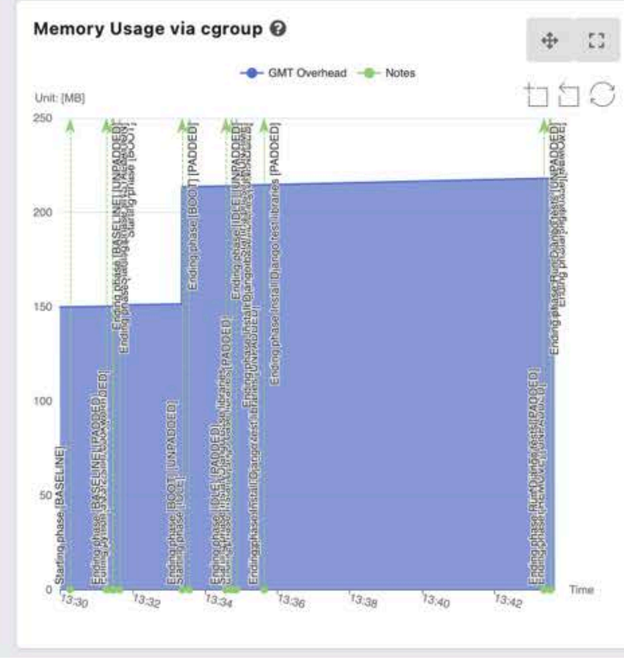

CPU % via procfs
GMT Overhead
Notes
Unit: [%]
Time


CPU % via procfs
[SYSTEM]
Notes
Unit: [%]
Time


CPU Temperature via lm-sensors
coretemp-isa-0000_Core-0
coretemp-isa-0000_Core-1
coretemp-isa-0000_Core-2
Unit: [°C]
Time

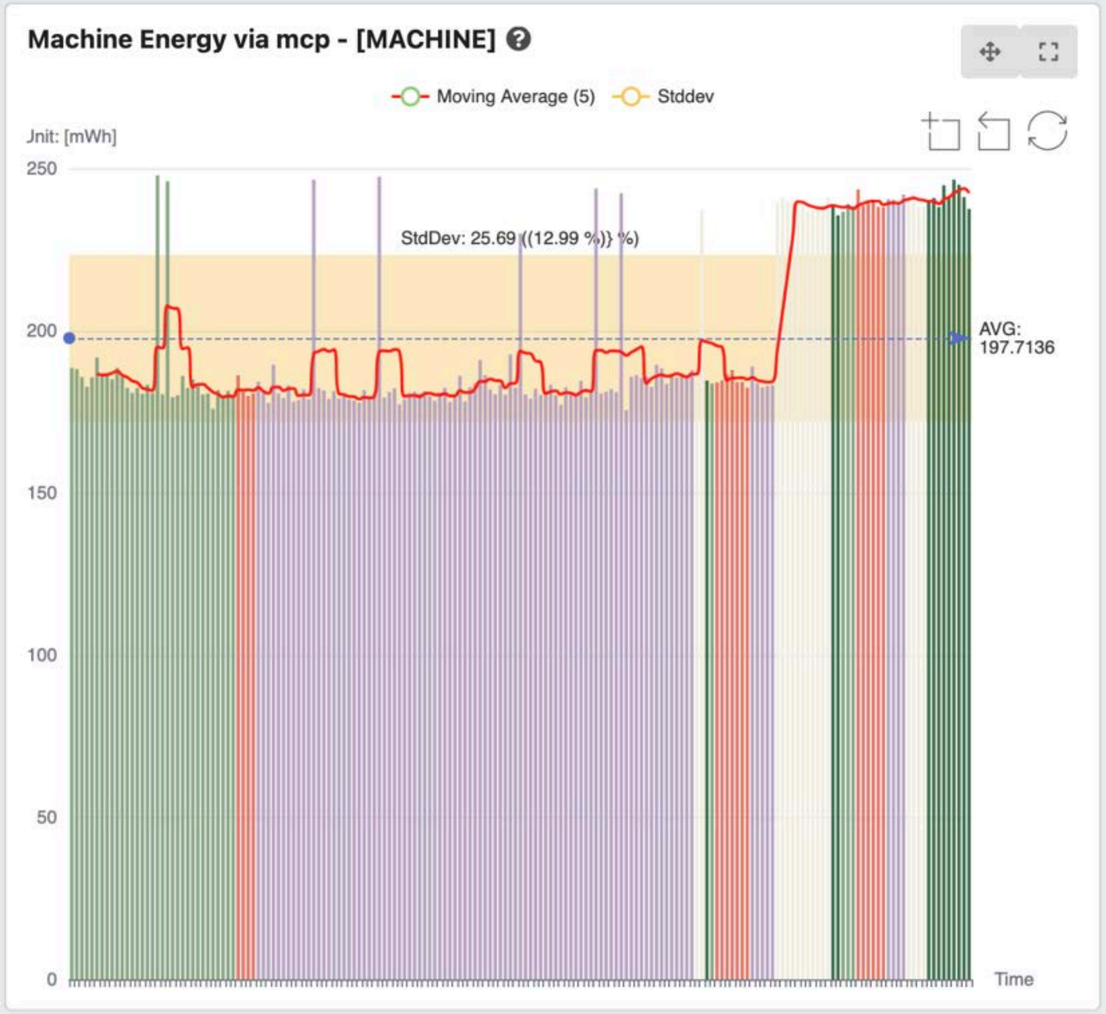

Memory Energy (DRAM) via RAPL
DRAM_0
Notes
Unit: [mWh]
Time

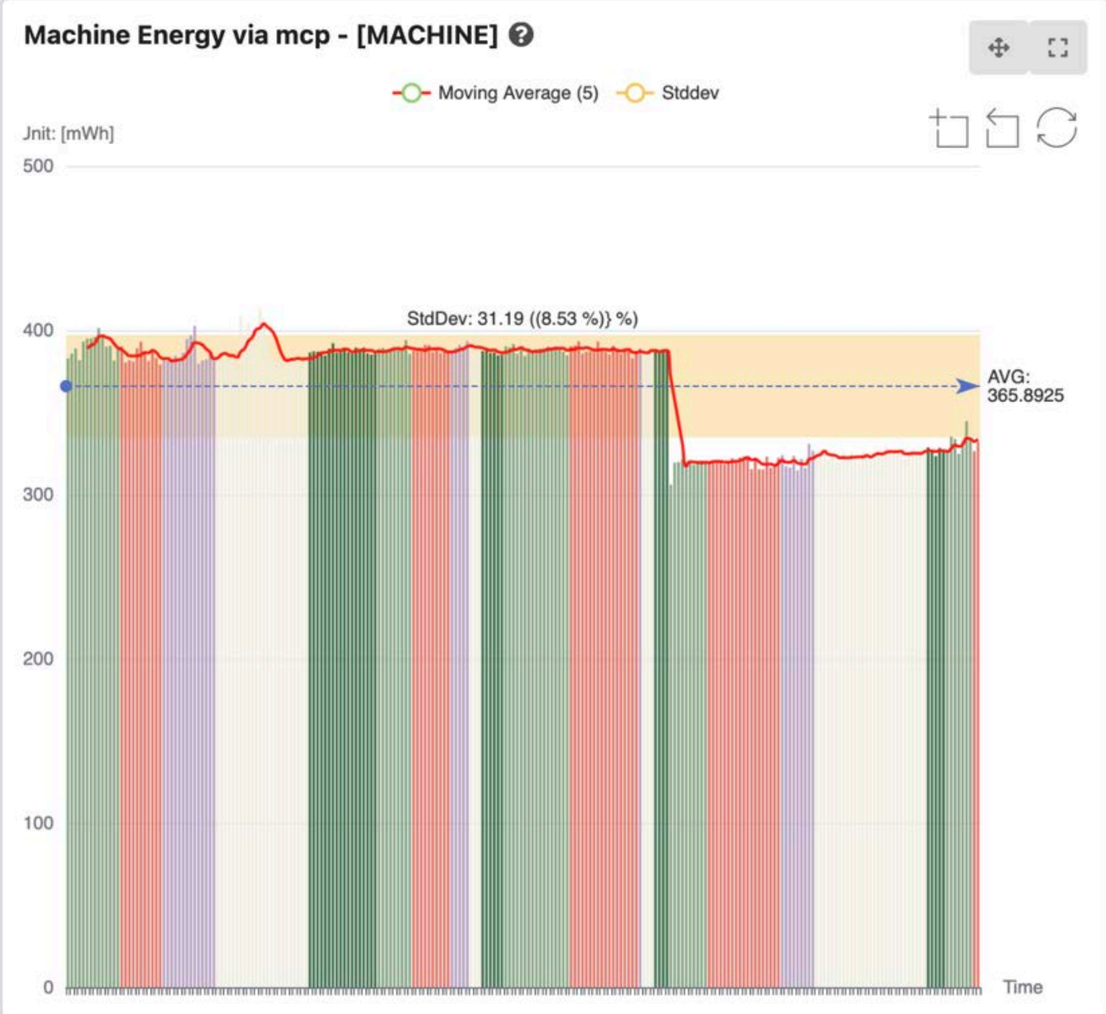

Memory Usage via cgroup
gcb-django-tests
Notes
Unit: [MB]
Time


Memory Usage via cgroup
GMT Overhead
Notes
Unit: [MB]
Time

Monitoring over time

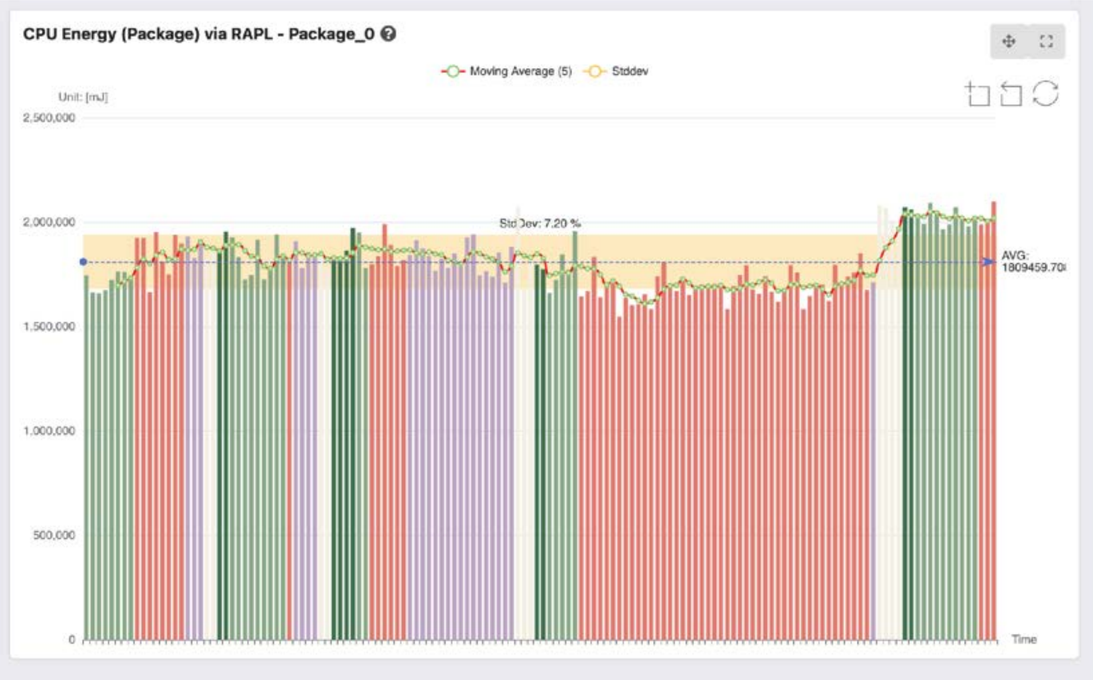
Nextcloud vs. Wordpress

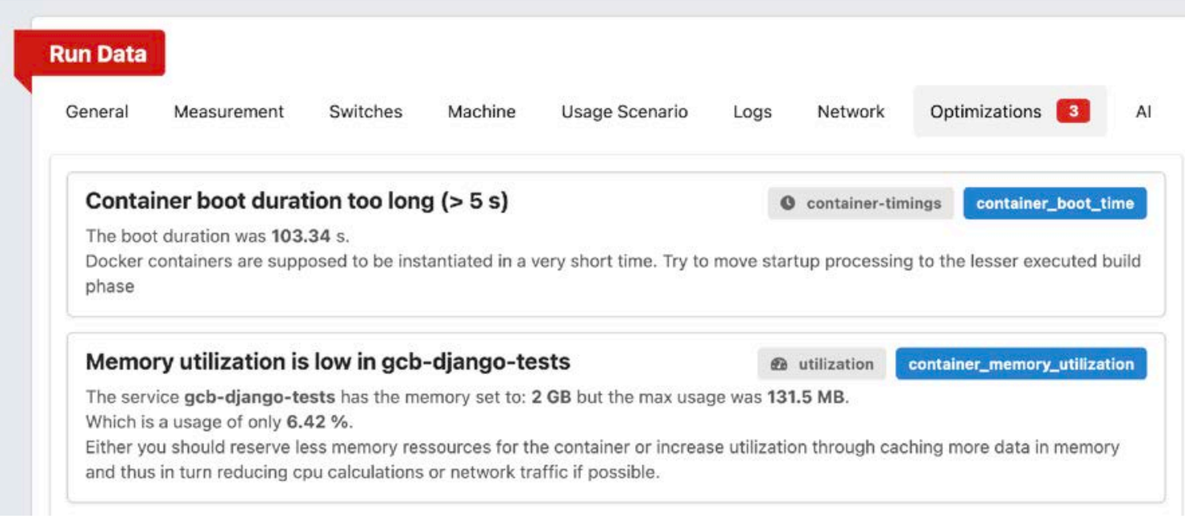




Green Metrics Tool

Integration of Green Gates either in included Dashboard or via git-ops workflows





Long-term analysis and “Green Quality Gates” optimizations ensure sustainable green software developments

GREEN CODING;

Green Metrics Tool

What does our company offer

Measurement-Cluster

- No need to set up own infrastructure for measurement
- Guaranteed hourly deviation of energy < 1%

Virtualized test method

- Easier measurement of highly containerized applications

Exporter

- Exporter for required equipment for the certification process

Automation

- Automatic validation of all Blue Angel requirement criteria
- Tips and recommendations for reducing energy consumption

GREEN CODING;

You can do something

It’s really easy to start measuring.

Submit software for measurement

Name

E-Mail (optional - get ping on measurement complete)

Image URL (optional - used in Watchlist for repeated measurements)

Github-/Gitlab-/Bitbucket-URL

Filename (optional - default: usage_scenario.yml)

Branch (optional - default: main)

-- Select hardware for testing --

Find the specifications of the machines in our documentation

-- Select measurement interval --

Submit software

GREEN CODING;

main 10 Branches 0 Tags Go to file Code

ArneTR Integrating healthcheck to prevent connection_refused fails 36687d9 · 2 months ago 266 Commits

.github/workflows	Adding verbosity to pytest	7 months ago
ai-model	Adding CPU and GPU variant	3 months ago
apache-mariadb-php	Refactoring of container names (#23)	3 years ago
blauer-engel-okular-xdotool	Added log-stdout so that notes can actually be read	2 years ago
detach-test	Notes are logged now correctly	2 years ago
drupal	Ignoring unsupported keys	3 months ago
firefox-X11	moved all setup-commands to new object syntax	3 months ago
green-software-foundation-sci	moved all setup-commands to new object syntax	3 months ago
idle	Moving from cmd to command	2 years ago
jmeter	moved all setup-commands to new object syntax	3 months ago
linting	REmoved versions	2 years ago
long-test	Removed longtest from example application tests	last year
ml-model	Added log-stdout so that notes can actually be read	2 years ago

About

Example applications to be measured with the Green Metrics Tool

Readme
CC0-1.0 license
Activity
Custom properties
1 star
3 watching
2 forks
Report repository

Releases

No releases published

Packages

No packages published

Contributors 7

Benefits for developers

How can the GMT make your life easier?

- **Focused carbon savings made easy**: GMT recommends exactly what you can do to decrease energy usage, removes guesswork so you can take quick action.
- **Dependency impact visibility**: Spot "low efficiency" packages in your depencies - Increase performance and resilience.
- **Painless measurement**: Integrated with GMT eco-system can hook into git-ops workflows, CI/CD pipelines and more. Re-Use existing infrastructure
- **Transform your coding to green**: Looking at software over the whole life cycle, Include important idle teams, Make Energy a first class citizen
- **Future Proof Code**: By having "green gates" in your CI/CD to keep software green

What is missing?

- How are you currently managing the sustainability of your applications?
- What hurdles are you facing in your teams?
- What do you need to bring your software ready for the upcoming sustainability age?
- Tell us your pain points!

Thank you

Want to know more?

- Our projects: https://www.green-coding.io/#projects
- Our resarch: https://www.green-coding.io/#research
- **Nextcloud Case Study:** https://www.green-coding.io/files/case-studies/case-study-nextcloud-blue-angel.pdf
- AI Energy Measurements: https://www.green-coding.ai
- Didi: didi@green-coding.io

GREEN CODING;

ecoCompute

ABOUT CALL FOR SPEAKERS BECOME A SPONSOR COMMUNITY MORE GET YOUR TICKET

ecoCompute conference

13 & 14 November 2025

📍 bUm - Berlin, Germany

https://www.eco-compute.io/

GREEN CODING;