Software Life Cycle Assessment (SLCA) in the wild

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Who am I? / Why listen to me?

- Geerd-Dietger Hoffmann / Didi
- Computer Science M.Sc. from University College London
- Low level Linux/ BSD/ Solaris at IBM and CERN
- Startup CTO: DBook, CigarCities, ClimateFarmers, Ecoworks
- NGO work in West Africa: Ebola response and Polio End Game
- Parental leave
- Part time farmer @ RosselHof 👨‍🌾

Who are we? / Why listen to us?

- Green Coding Berlin https://www.green-coding.berlin/
- Developers of:
  - Green Metrics Tool: precise resource measurements
  - Energy ID: measuring resource usage over time
  - Eco CI: cloud measurements through machine learning model
  - Hog: client side resource usage logging
- "Transparency for software and climate impact" @ Bits & Bäume

Software life cycle assessment

- First Google page only software that does life cycle assessment (next to wikipedia explaining Life-cycle assessment)
- Greenhouse Gas Protocol https://ghgprotocol.org/
- ISO 14040 / ISO 14067
- Most of the values are guesses or "guestimates"
- In this case we are only looking at operational "cost".

Previous work

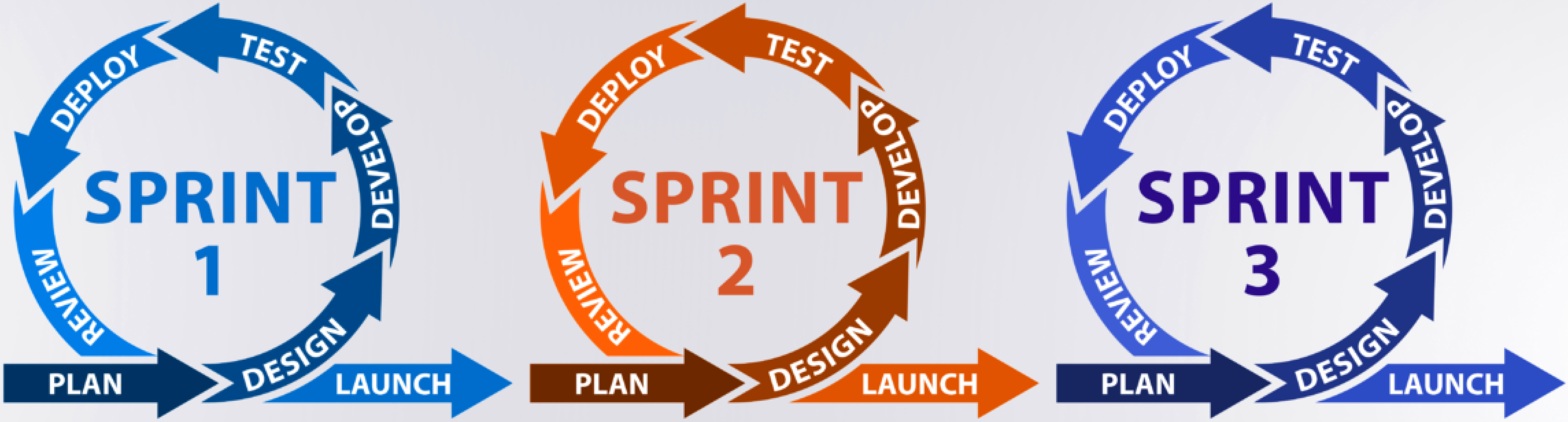
- Green Cloud Computing (Öko Institute, IZM)
- SDIA (Ecocube)
- Umweltcampus Birkenfeld GREENSOFT model
- etc ...

however no devops tooling exists

Five stages of live cycle assessment

1. Material acquisition and preprocessing
2. Production
3. Distribution and storage
4. Use
5. End of life

The problem with software



Software is never finished

The problem / Just Development

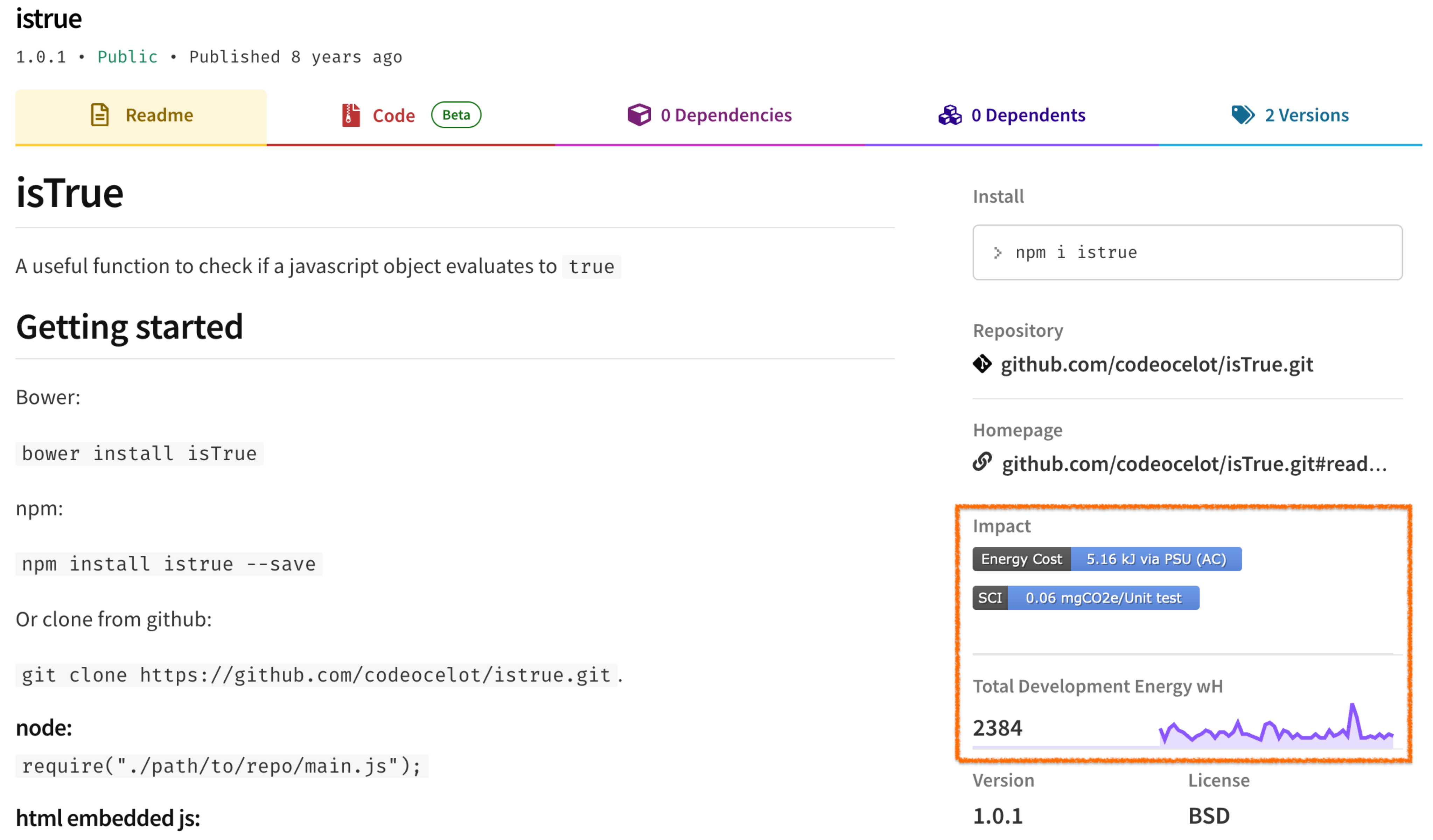
- Local dev environment. Docker, Editors, Linters, Tests
- Code Hosting
- Issues/ Planning
- CI/ CD pipelines
- Dependabot
- Cloud dependencies
- Local compilation of libraries

Solution idea

- Automation ❗
- Simple. Not a lot of overhead. A tool not a burden.
- See each sprint/ iteration as on cycle of of live cycle assessment
- Understand that software is continuously developed
- Set clear boundaries
  - Is the DNS server part of your software?
  - Encoding library development impact

Stages

Classic		New
1	Material acquisition and preprocessing	Libraries/ Software
2	Production	Development
3	Distribution and storage	Deployment
4	Use	Servers/ Cloud/ etc
5	End of life	GOTO 1 or Uninstall



istrue

1.0.1 • Public • Published 8 years ago

isTrue

A useful function to check if a javascript object evaluates to `true`

Getting started

Bower:

```
bower install isTrue
```

npm:

```
npm install istrue --save
```

Or clone from github:

```
git clone https://github.com/codeocelot/istrue.git
```
.

node:

```
require("./path/to/repo/main.js");
```

html embedded js:

Install

```
> npm i istrue
```

Repository

github.com/codeocelot/isTrue.git

Homepage

github.com/codeocelot/isTrue.git#read...

Impact

Energy Cost 5.16 kJ via PSU (AC)

SCI 0.06 mgCO2e/Unit test

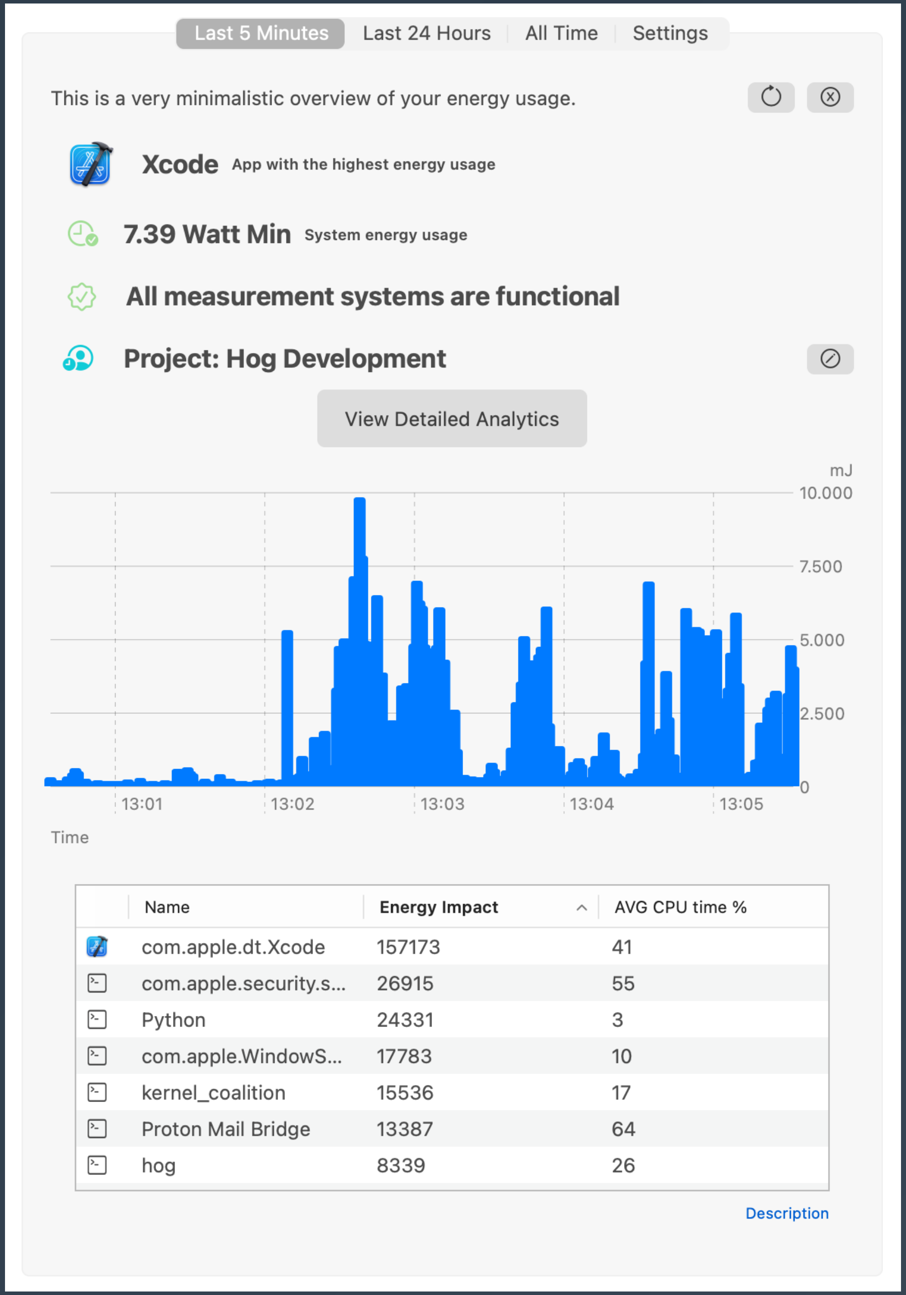
Total Development Energy wH

2384

Version	License
1.0.1	BSD

Development

- Measure the energy while developing
- What about Spotify? *Everything that is happening on the machine counts to the project.*
- Power Hog



This is a very minimalistic overview of your energy usage.

Xcode App with the highest energy usage

7.39 Watt Min System energy usage

All measurement systems are functional

Project: Hog Development

Name	Energy Impact	AVG CPU time %
com.apple.dt.Xcode	157173	41
com.apple.security.s...	26915	55
Python	24331	3
com.apple.WindowS...	17783	10
kernel_coalition	15536	17
Proton Mail Bridge	13387	64
hog	8339	26

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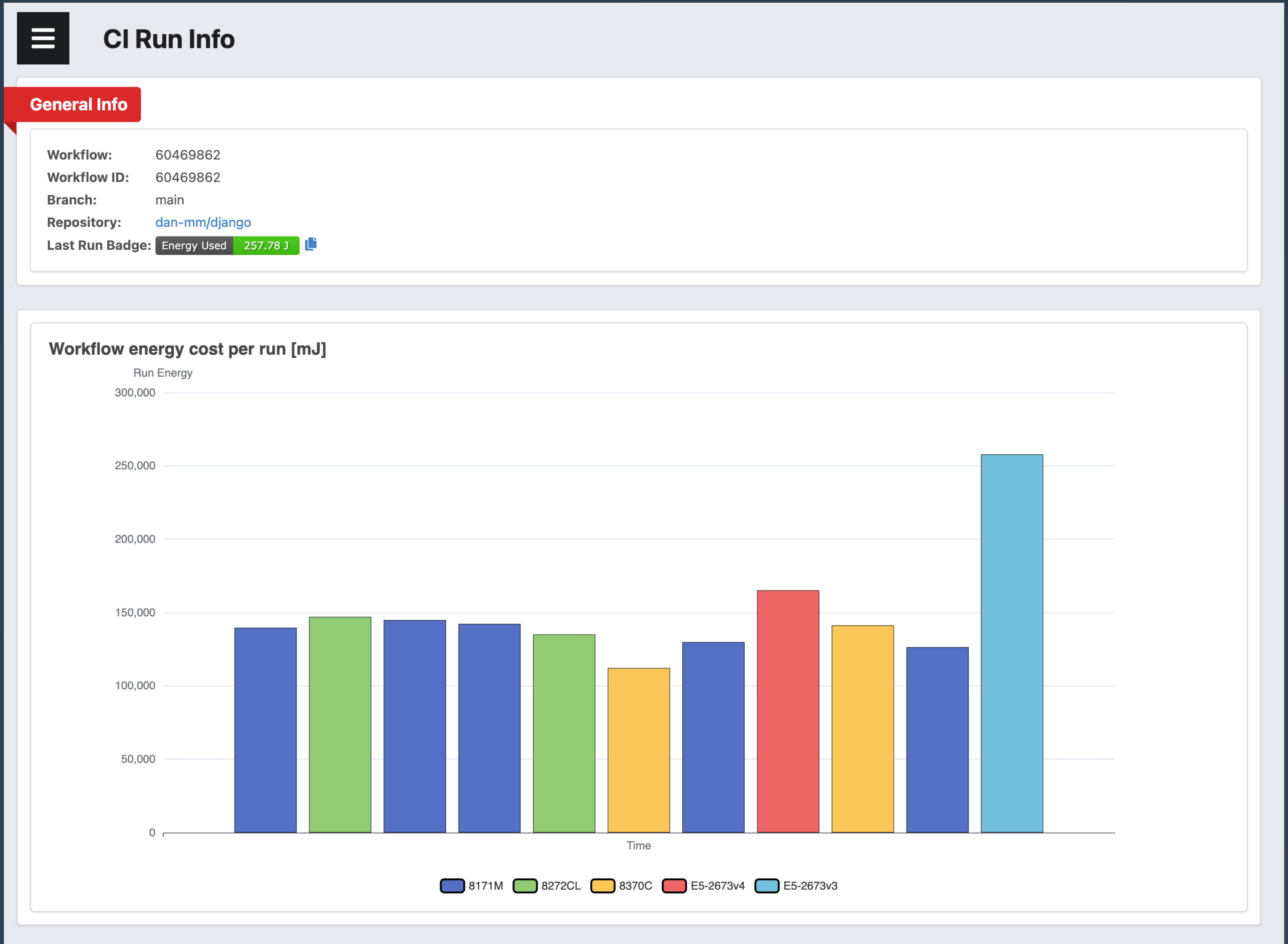
CI/CD



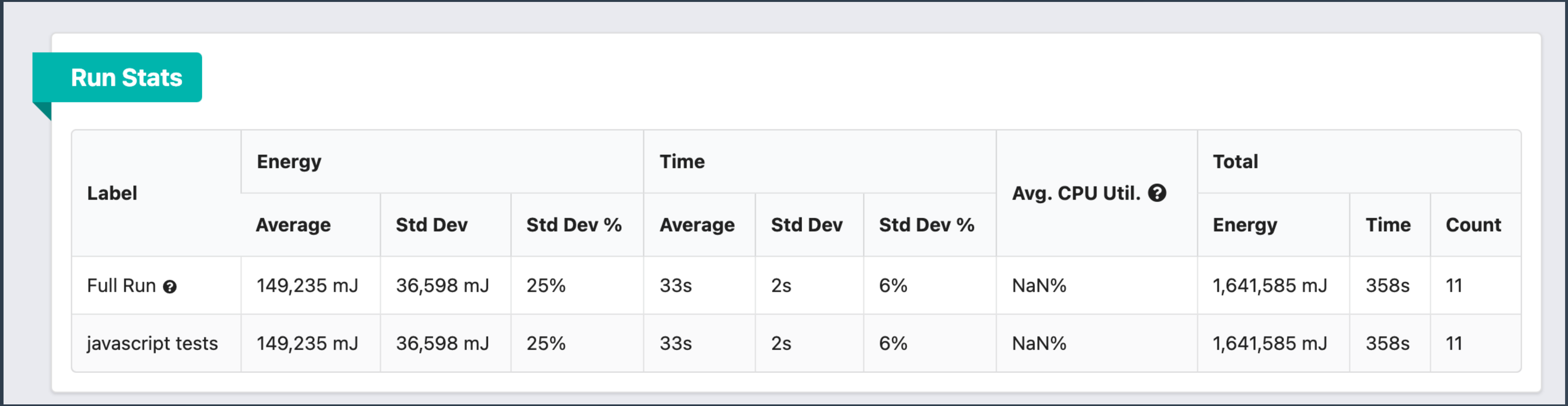
CI Run Info

General Info

Workflow:	60469862
Workflow ID:	60469862
Branch:	main
Repository:	dan-mm/django
Last Run Badge:	Energy Used 257.78 J

Workflow energy cost per run [mJ]

Overall CI/CD



Run Stats

Label	Energy			Time			Avg. CPU Util.	Total		
	Average	Std Dev	Std Dev %	Average	Std Dev	Std Dev %		Energy	Time	Count
Full Run	149,235 mJ	36,598 mJ	25%	33s	2s	6%	NaN%	1,641,585 mJ	358s	11
javascript tests	149,235 mJ	36,598 mJ	25%	33s	2s	6%	NaN%	1,641,585 mJ	358s	11

Development - Open Question

- What about code hosting
- What about tools like Copilot
- What about heating of the office

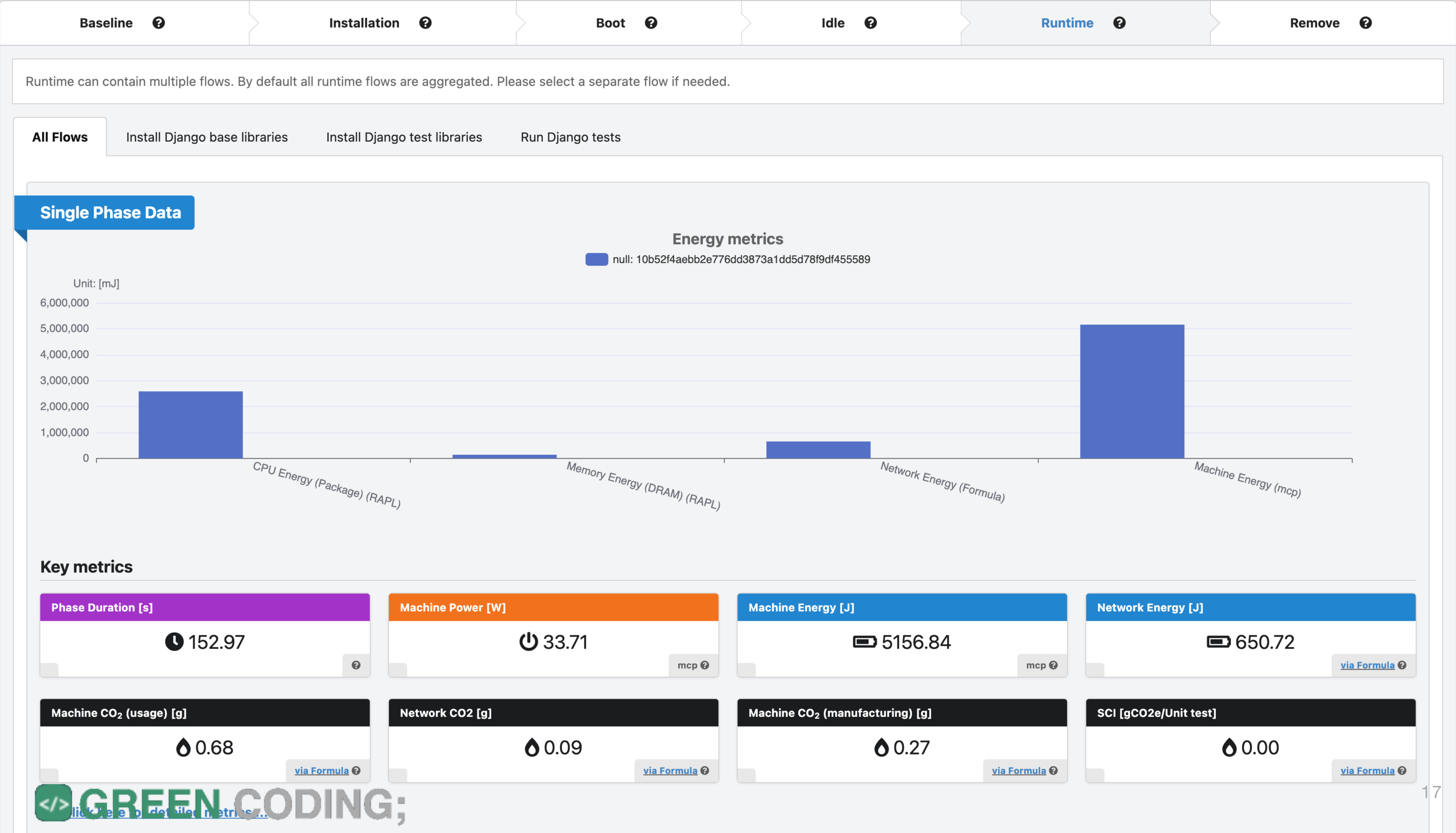
➡️ currently in the works. Green Web Foundation working on IETF Header.

Green Metrics Tool

Our solution of precise usage measurements of containerized applications.

Phases concept from the Blue Angel:

- Baseline
- Idle
- Usage Scenario



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

Single Phase Data

Energy metrics

Key metrics

Phase Duration [s]	Machine Power [W]	Machine Energy [J]	Network Energy [J]
152.97	33.71 mcp	5156.84 mcp	650.72 via Formula
Machine CO$_2$ (usage) [g]	Network CO2 [g]	Machine CO$_2$ (manufacturing) [g]	SCI [gCO2e/Unit test]
0.68 via Formula	0.09 via Formula	0.27 via Formula	0.00 via Formula

lick here for detailed metrics...

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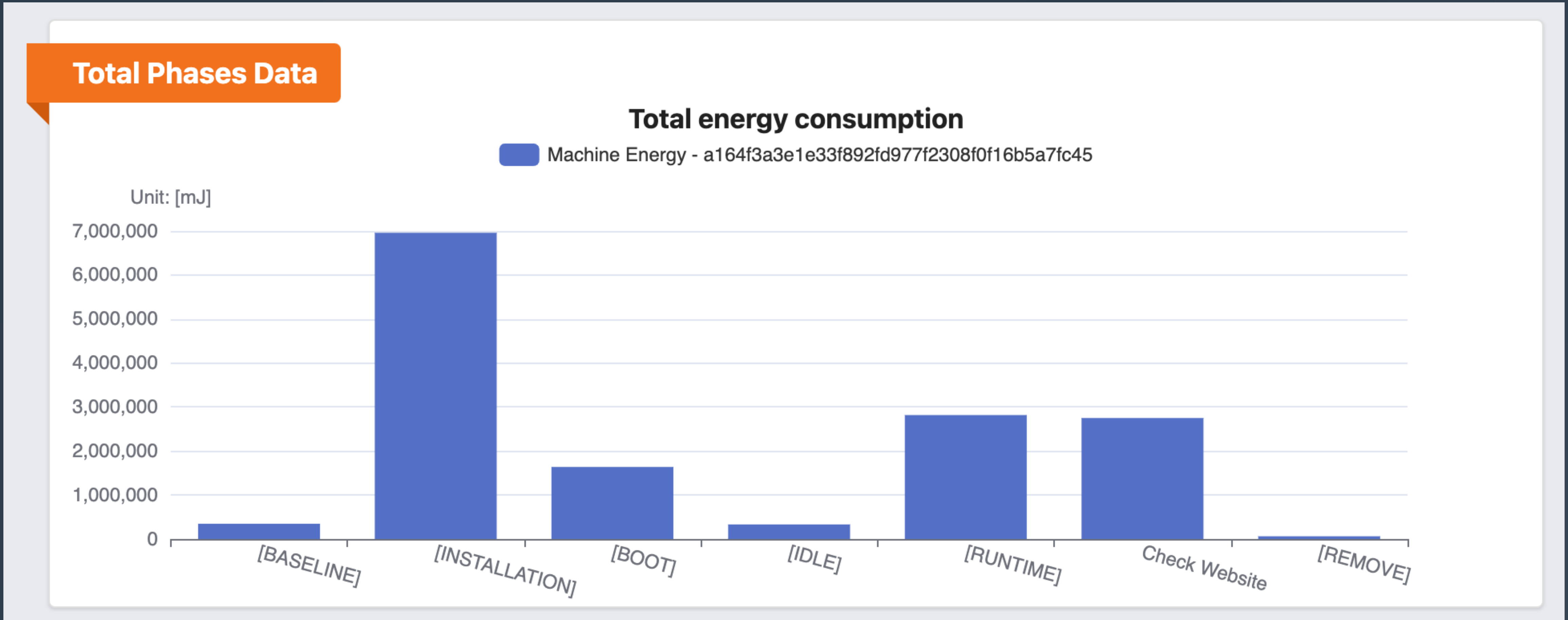
Deployment Stage



Usage Stage

Use the Green Metrics Tool to get actual values

```
/save : 0.0502 J
/last_time: 0.024755 J
/badge: 0.050715 J
```

HTTP Header

```
x-energy-joule:  0.0502
```

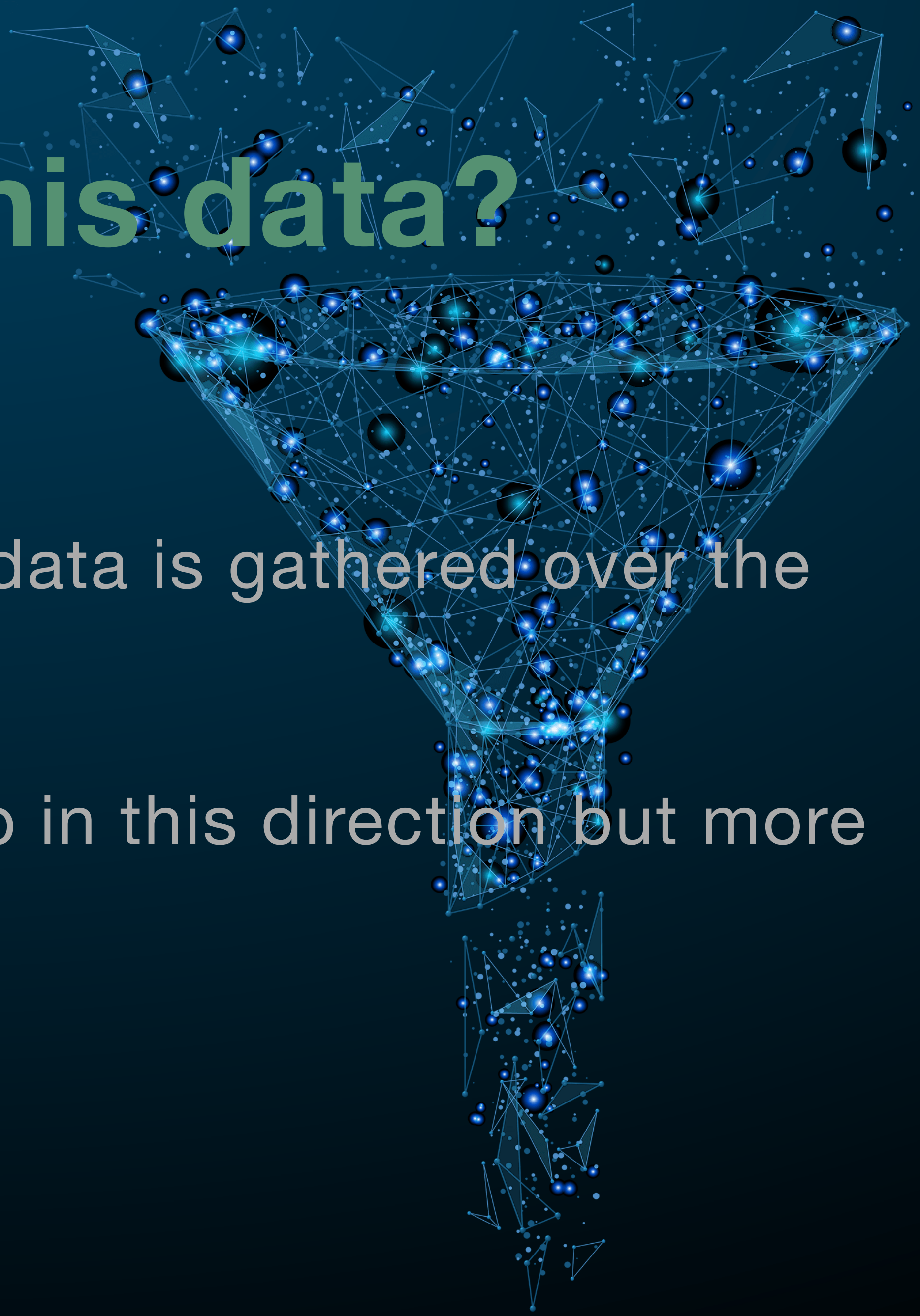
```
x-self-energy-accounting: true
```

GMT Cluster

- In the cloud measurement infrastructure
- Blue Angel Compatible machine, SoftAWERE etc ...
- Can be part of the development workflow

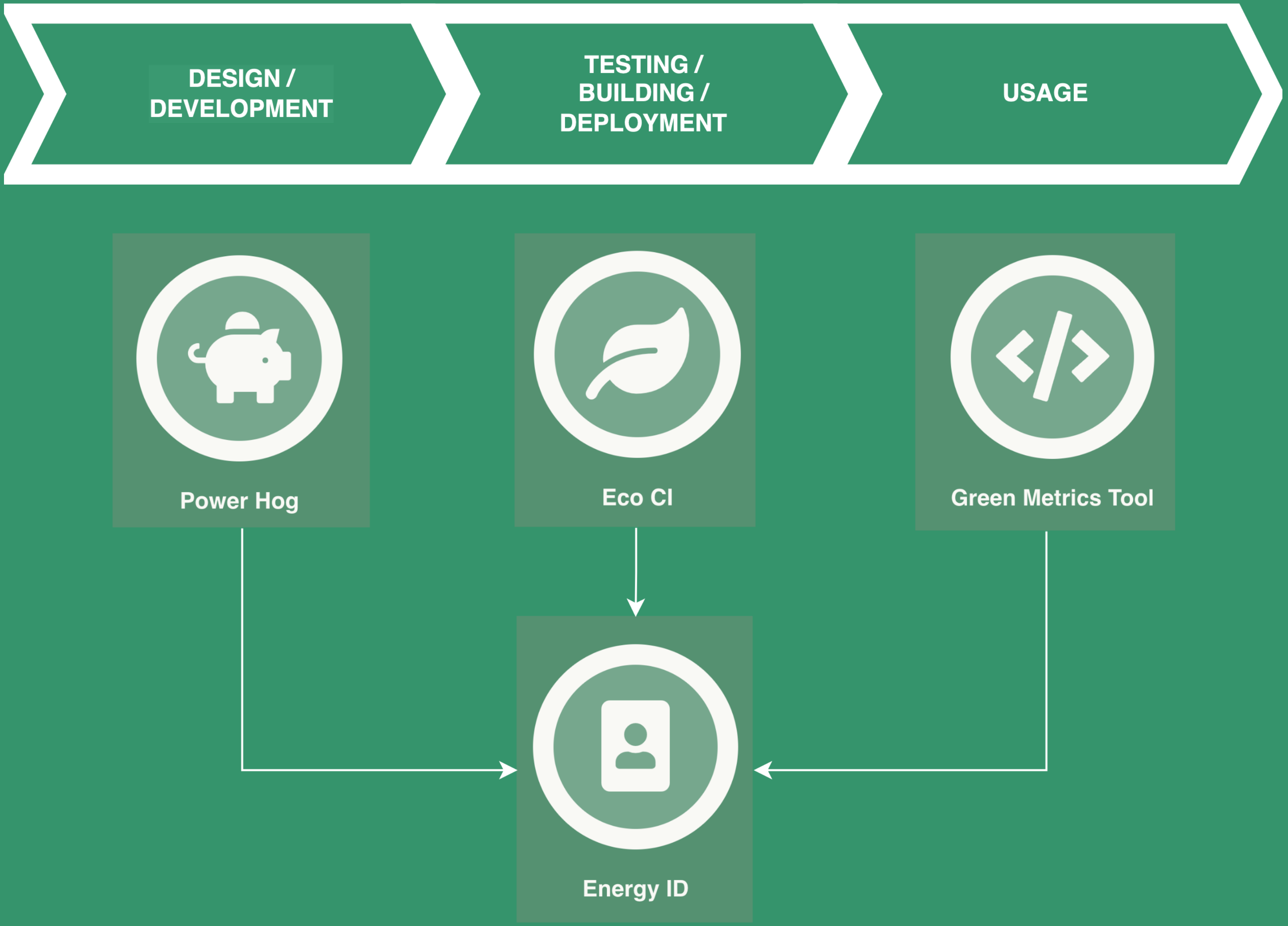
What to do with all this data?

Project Carbon DB



We need a central point where all the data is gathered over the lifetime of the project.

The Green Metrics Tool is the first step in this direction but more work is needed.



DESIGN / DEVELOPMENT

TESTING / BUILDING / DEPLOYMENT

USAGE

Power Hog

Eco CI

Green Metrics Tool

Energy ID

Software Lifecycle Assessment

Conclusion

- Proposed a mapping from Life Cycle Assessment to continuously developed software.
- Introduced initial tooling for all stages.
- We need a central carbon database for software projects in the future!

Questions 🙋‍♀️

Find detailed articles under:
https://www.green-coding.berlin/blog/

Let's work together: didi@green-coding.berlin

References

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