

Green Frontend

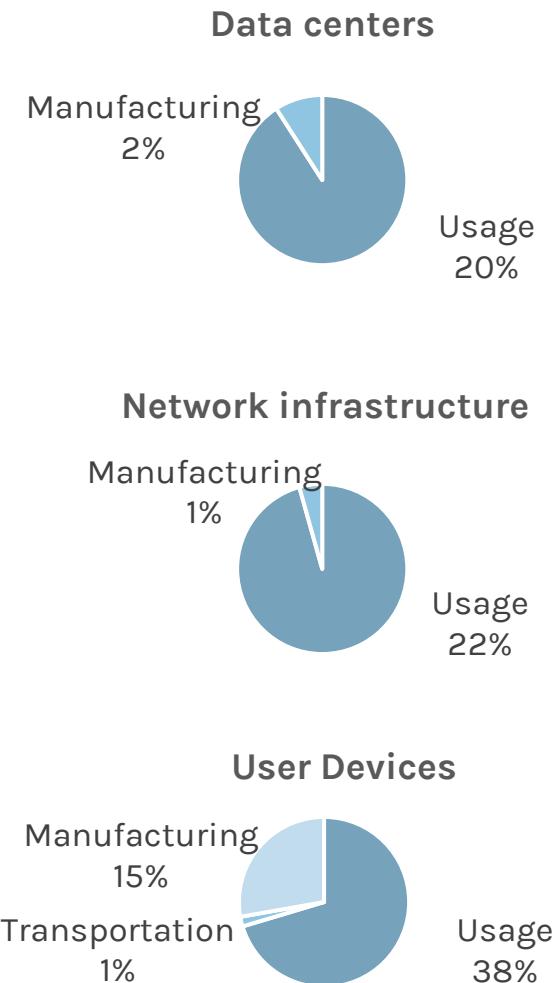
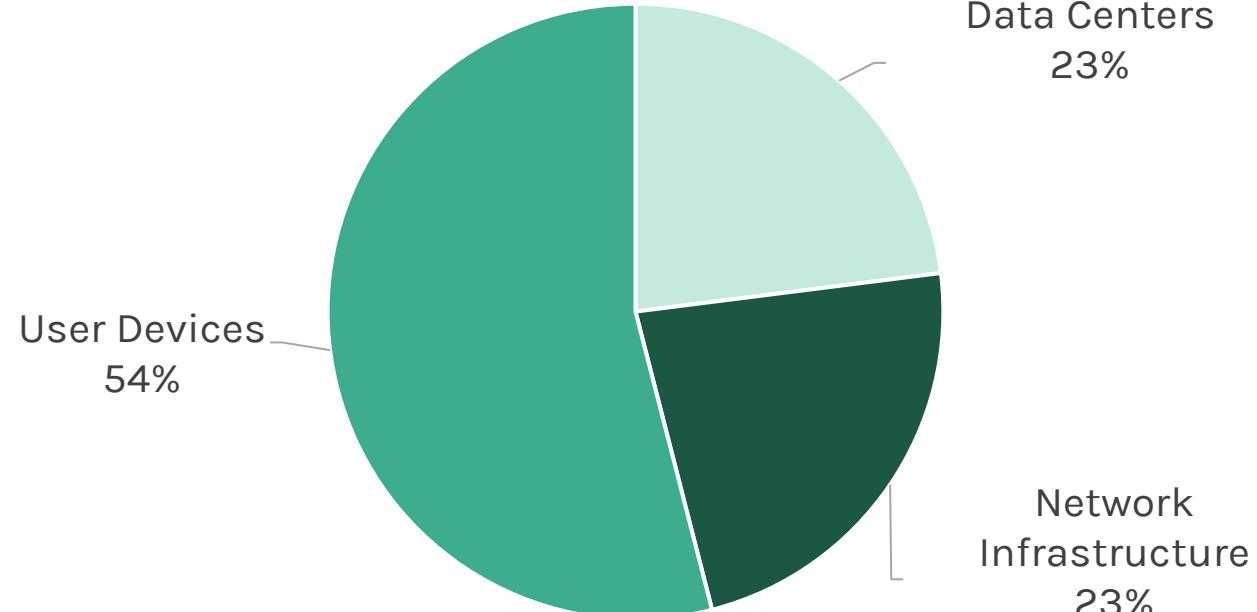
Measuring and understanding the environmental impact of web applications

David Kopp, Jan Kirchner

envite >*

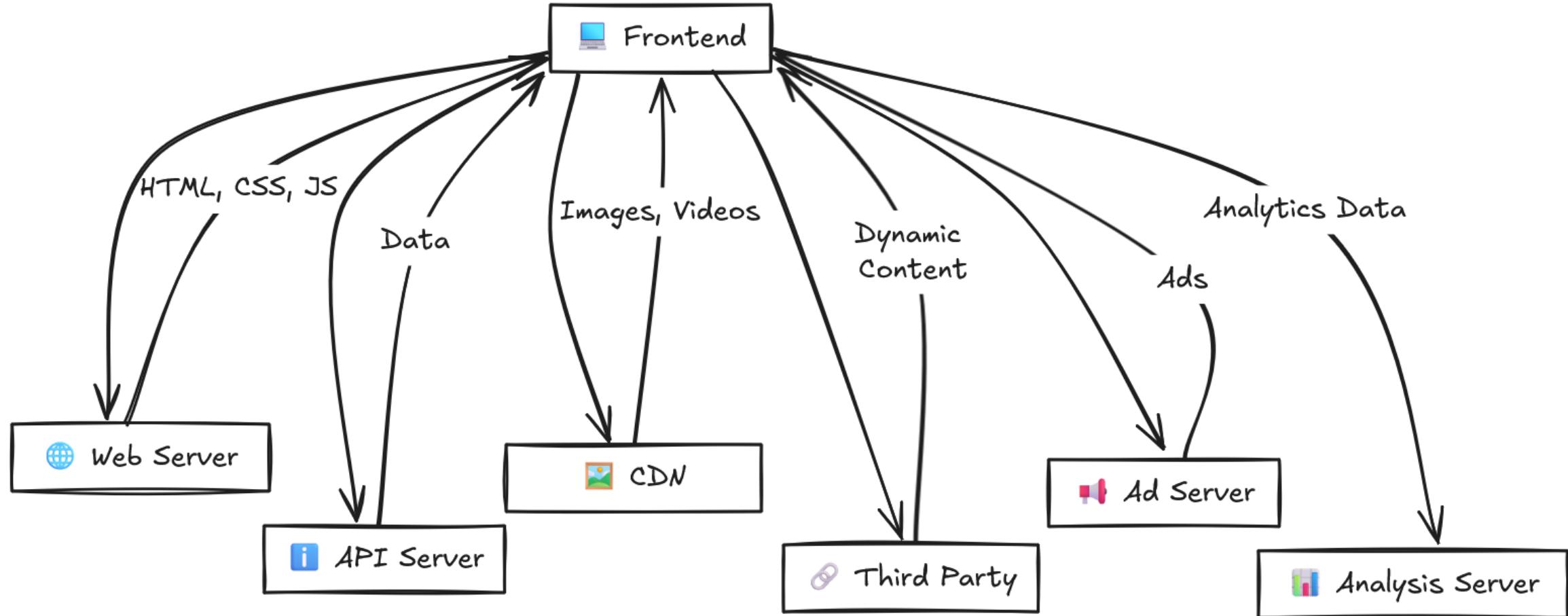
User devices: the biggest source of ICT's global CO₂ emissions

Relative carbon footprint per segment

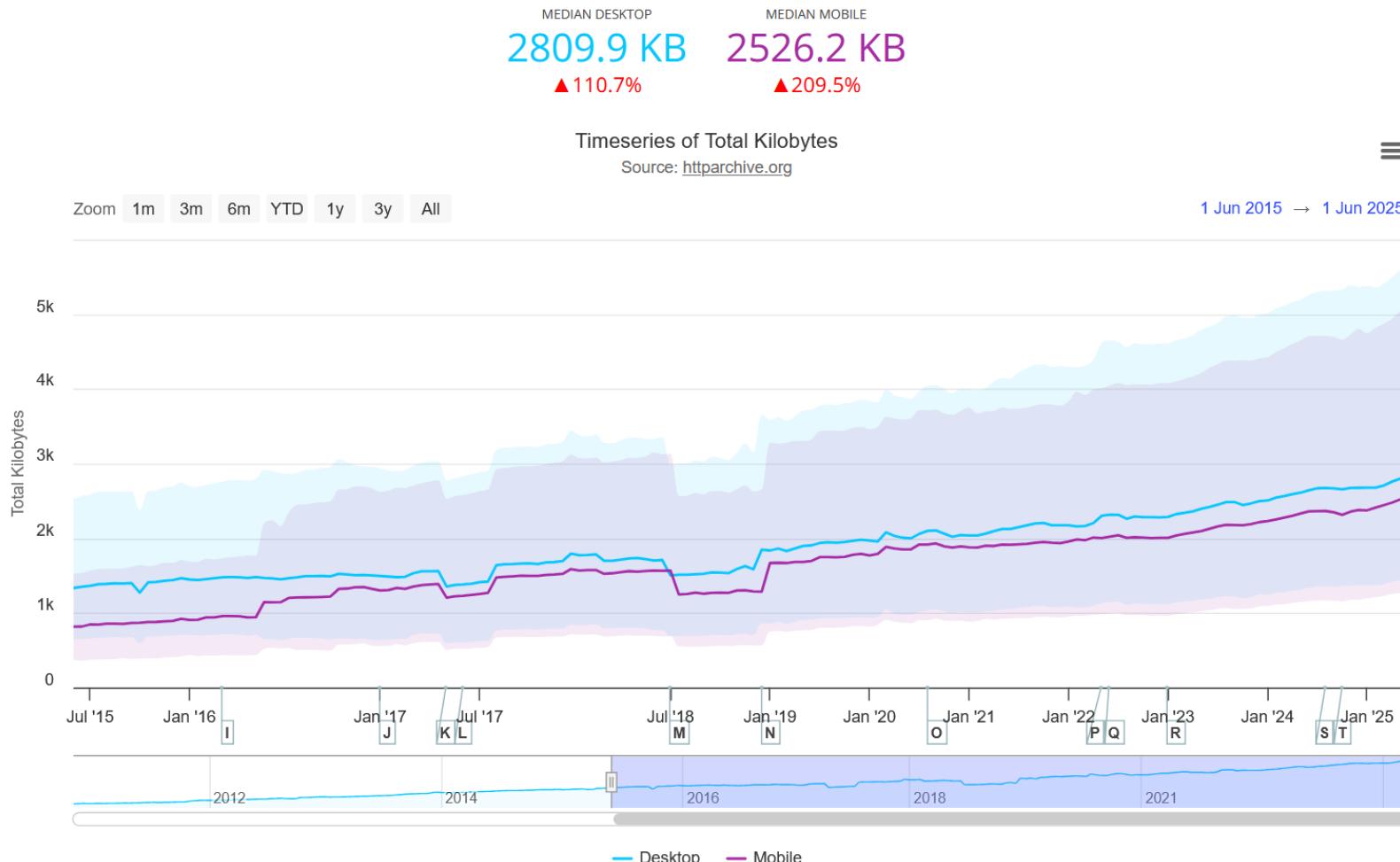


Environmental impacts of digital technology in the world, third edition, Green IT Association, 2025 (IENM 2025), <https://t.ly/greeniteco.IENM2025>

Frontends drive network and server load



Web pages become heavier



In the last 10 years,
average web page size:

- has doubled
(desktop)
- has tripled
(mobile)

How to determine the environmental impact of a web application?

Measure!

Who are we?



- Founded in 2022
- IT Consulting focuses on Sustainability IN IT & Sustainability BY IT



- Jan Kirchner
- Green IT Consultant
- Focus: Frontend/Fullstack development



- David Kopp
- Green IT Consultant
- Focus: Backend development, DevOps, ecological assessment of IT systems

Agenda

↗ Introduction

Methodologies & Tools

User Interactions

Good & Bad Websites

Conclusion

Agenda

Introduction

➤ Methodologies & Tools

User Interactions

Good & Bad Websites

Conclusion

From energy to carbon

energy consumption [Wh]

×

carbon intensity [g CO₂/Wh]

+

embodied carbon [g CO₂]

=

carbon emissions [g CO₂]

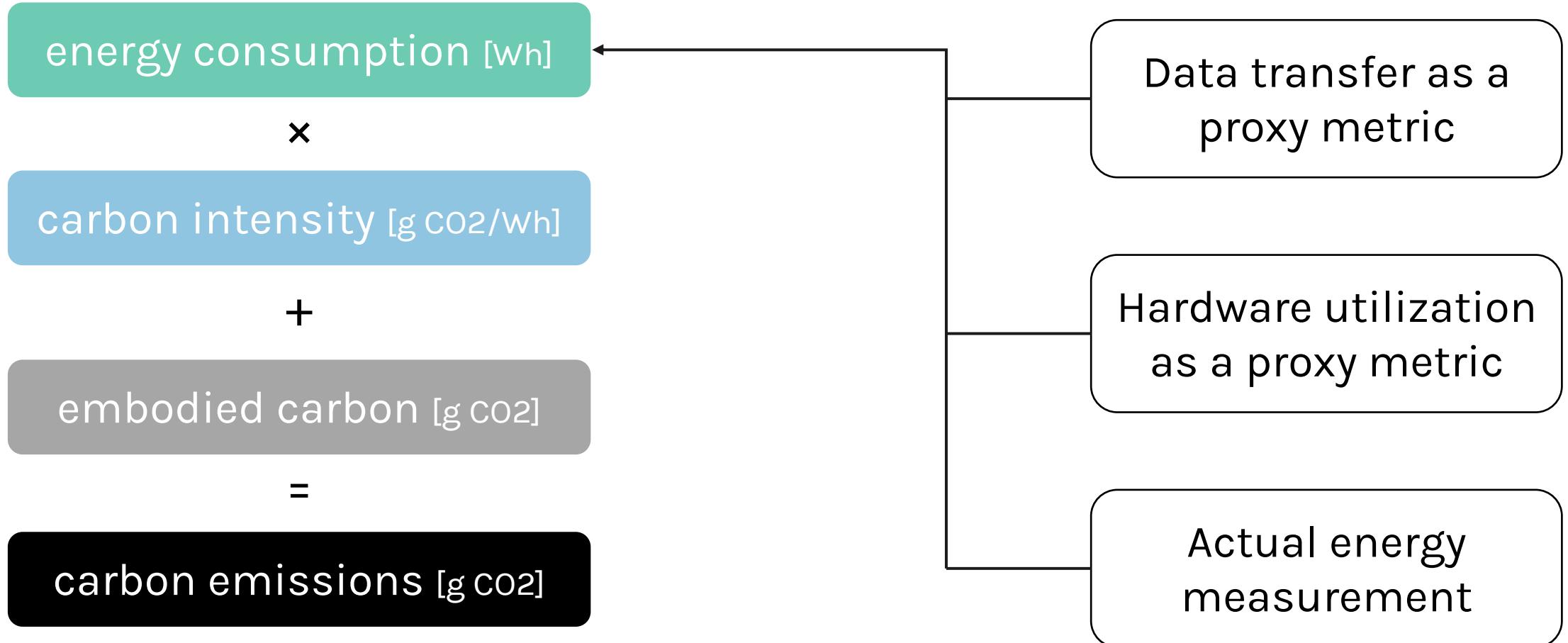
measured / estimated

static: global or regional average

dynamic: live, regional

LCA database

Capturing the energy consumption



Server-side vs. client-side measurements

New challenges:

- Diverse hardware (from smartphones to desktops)
- No direct control over the runtime environment
- Devices' energy consumption depends on other factors
 - display brightness, network connection, background apps, energy-saving mode ...

Green Software Tool Landscape



EXPLORE GUIDE STATS

Type to search items 🔍 ↻ ⌂

Filters GROUP: Measurement Optimization VIEW MODE: Grid Card ZOOM: [- +]

Category	Tool	Description
Infrastructure & Cluster Level	Li10	Infrastructure Provider Level
	Ovhcloud	
	Tailpipe	
	Cloud Assess	
	SPRUCE	
	greenpixie	
	ttexture	
	ecoinfra	
	CloudScanner	
	aws	
Device or Process Level	powerstat	Agent
	Perf	Planning & Calculation
	Turbostat	Kubernetes
	powerTOP	
	EnergiBridge	
	CPU Energy Meter	
	KEPLER	
	procpower	
	powermetrics	
	EnergAt	
Data Aggregation	fruggr	Process Metrics Exporter
	sopht	
	tech.	
	laguado	
	Antarctica	
	KEPLER	
	Carbon Footprint Modeling Tool	
	e-footprint model	
Component	LIMO	Containerized Application
	cardamon	
		Mobile App
		Desktop Application
Website	CO2.js	Website Carbon Estimation
	EcoGrader	
	cardamon	Website Analysis
	Website Carbon Meter	
	Cleaner Web	
	Ecoping	
	EcoGrader	
	Ecoping	
	Cleaner Web	
	#G	
AI	WebNRG	Website Energy Measurement

<https://landscape.bundesverband-green-software.de>

Green Software Tool Landscape

Category "Website"



Website Carbon Estimation

CO2.js

IN ACTIVE USE BY BVGS MEMBERS

Ecograder

IN ACTIVE USE BY BVGS MEMBERS

Website Carbon Meter

cardamon

eco Index

Ecoping

Cleaner Web

Website Analysis

Ecograder

IN ACTIVE USE BY BVGS MEMBERS

Website Energy Measurement

WebNRG

<https://landscape.bundesverband-green-software.de>

Proxy Metric: Data Transfer

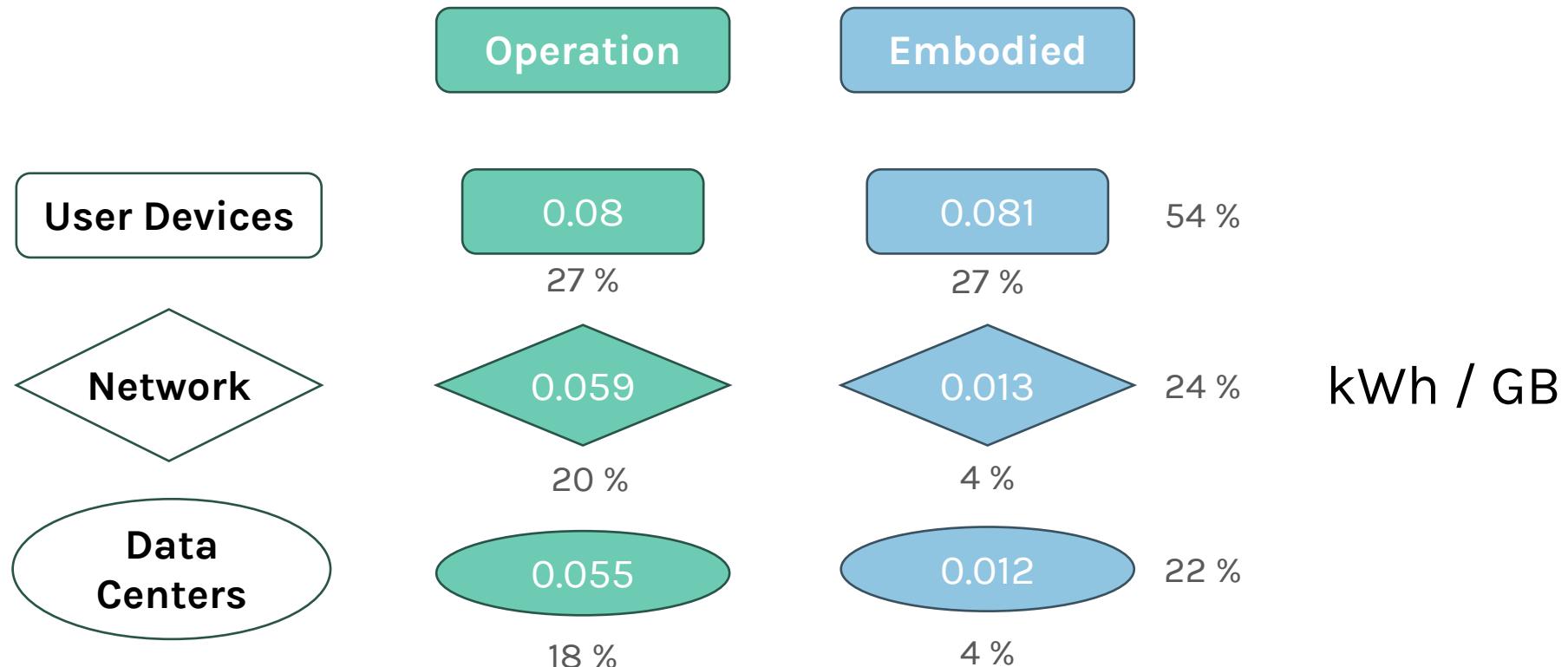
- Data transfer can be easily captured
- Used as proxy metric for energy consumption
- A conversion factor is needed (kWh / GB)
- Top-down approach based on global averages
 - Segments: user devices, network, data centers
 - Operational and embodied emissions
- Most widely used: Sustainable Web Design Model

Sustainable Web Design Model

- Input: amount of transferred data
- Additional variables:
 - carbon intensity of the grid (e. g. global: 494 g CO₂e / kWh)
 - Green hosting factor
 - Percentage of recurring visits + percentage of resources in cache
- Popular implementation: CO2.js
 - JavaScript library created by the Green Web Foundation

<https://sustainablewebdesign.org/estimating-digital-emissions/>

Sustainable Web Design Model – Coefficients

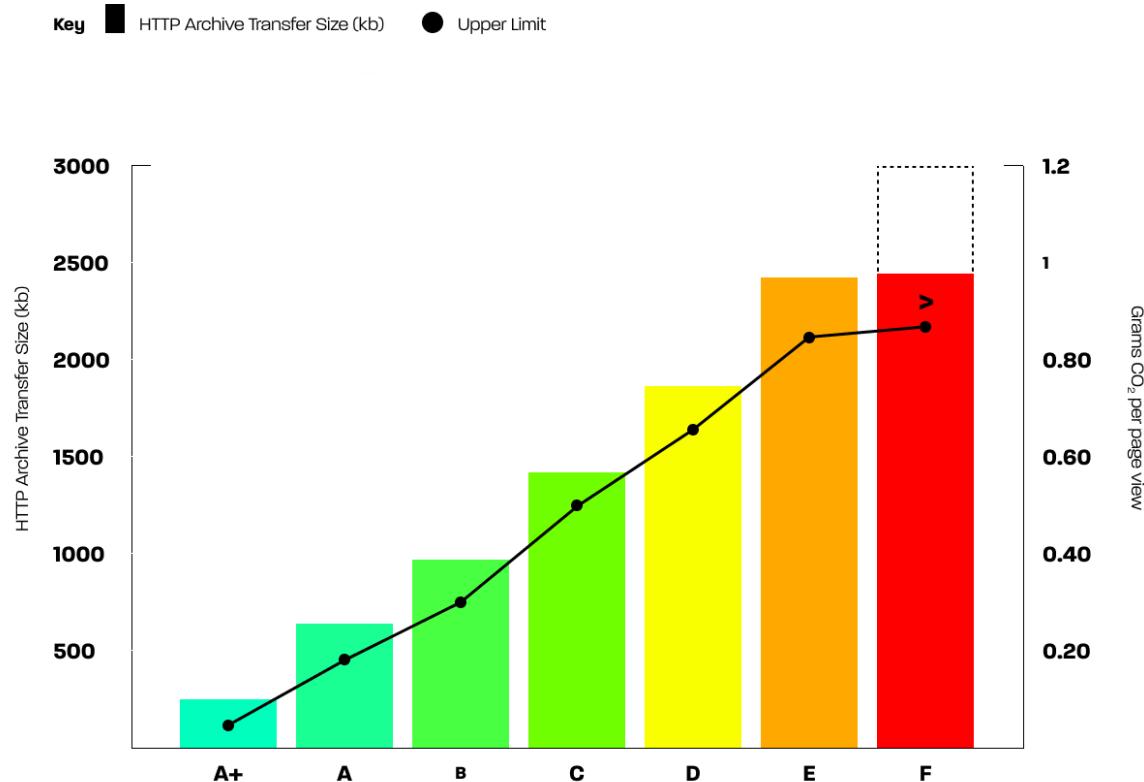


<https://sustainablewebdesign.org/estimating-digital-emissions/>

Digital Carbon Rating

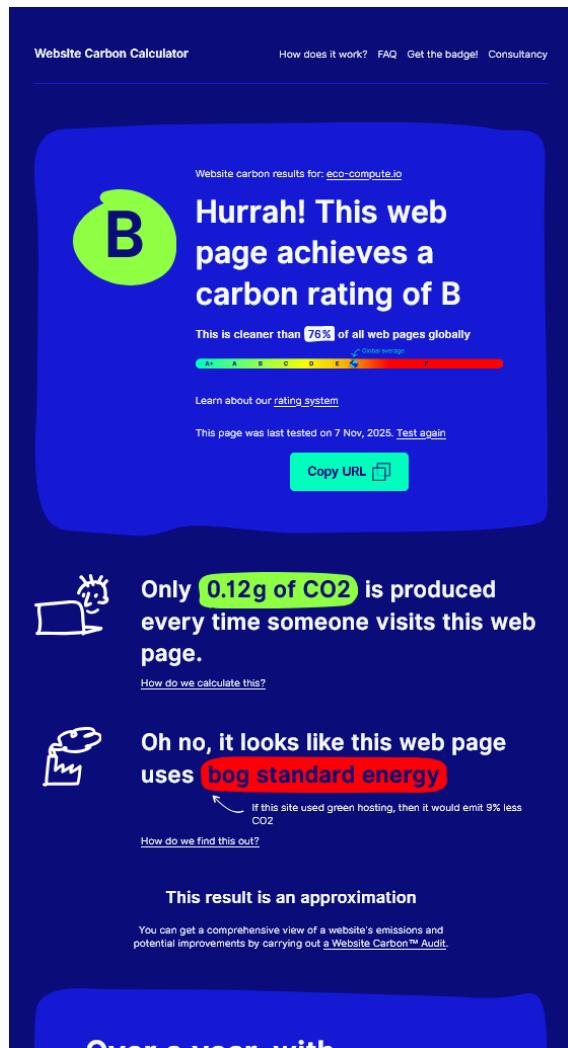
Converts estimated carbon emissions into an intuitive rating from A+ to F

Rating	Data Transfer (kB)	g CO ₂ e per Page View
A+	272	0.040
A	531	0.079
B	975	0.145
C	1410	0.209
D	1875	0.278
E	2419	0.359
F	≥ 2419	≥ 0.360



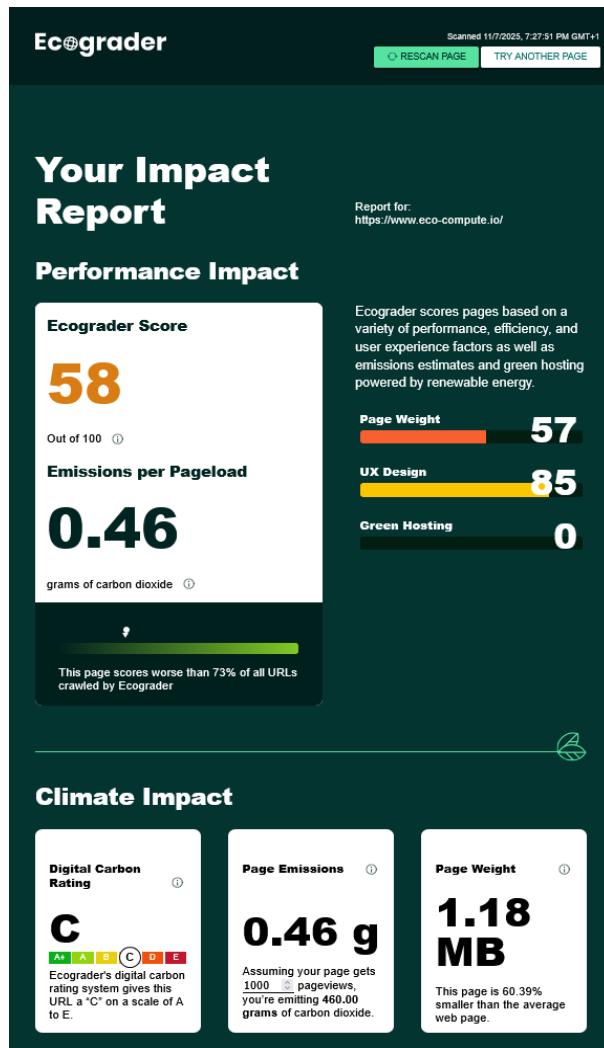
<https://sustainablewebdesign.org/digital-carbon-ratings/>

WebsiteCarbon.com



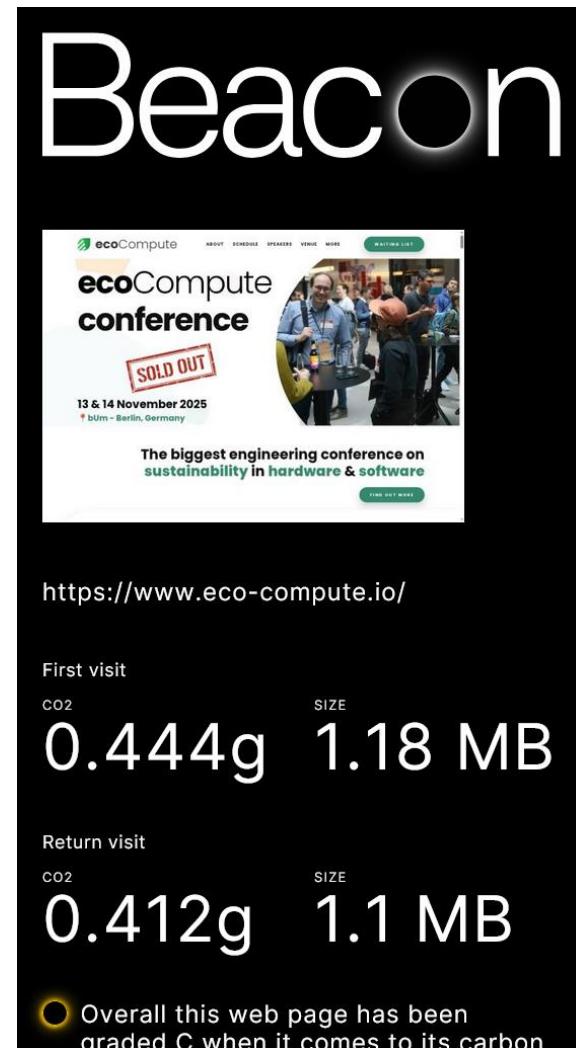
<https://www.websitecarbon.com/website/eco-compute-io/>

Ecograder



<https://ecograder.com/report/0D7go8uhRsXltVWwJx9PFFfYR>

Beacon



<https://digitalbeacon.co/report/eco-compute-io>

Optimization Recommendations



65 Ecodesign score [?](#)

Kastor advises you to prioritize



- ✖ Do not download images if they are not visible
- ✖ Avoids an excessive DOM size
- ✖ Prefer standard fonts

Frontend

Reduce the impact of third-party code - **Third-party code blocked the main thread for 1,200 ms**
0% of compliance

✖ Defer off-screen images - **Potential savings of 494 KiB**
0% of compliance

✖ Avoid serving legacy JavaScript to modern browsers
0% of compliance

✖ You should include specials print fonts in your print css
5% of compliance

✖ Do not download images if they are not visible - **11 images**
6% of compliance



87
out of 100

Page Weight

1

By compressing image file size and removing unused items from a page you'll not only reduce emissions but faster-downloading pages make users happier as well. Below are some things you can do to reduce the size of this page.



Optimize Media

97 OUT OF 100



Reduce Overall Page Weight

73 OUT OF 100



Remove Unused Code

75 OUT OF 100



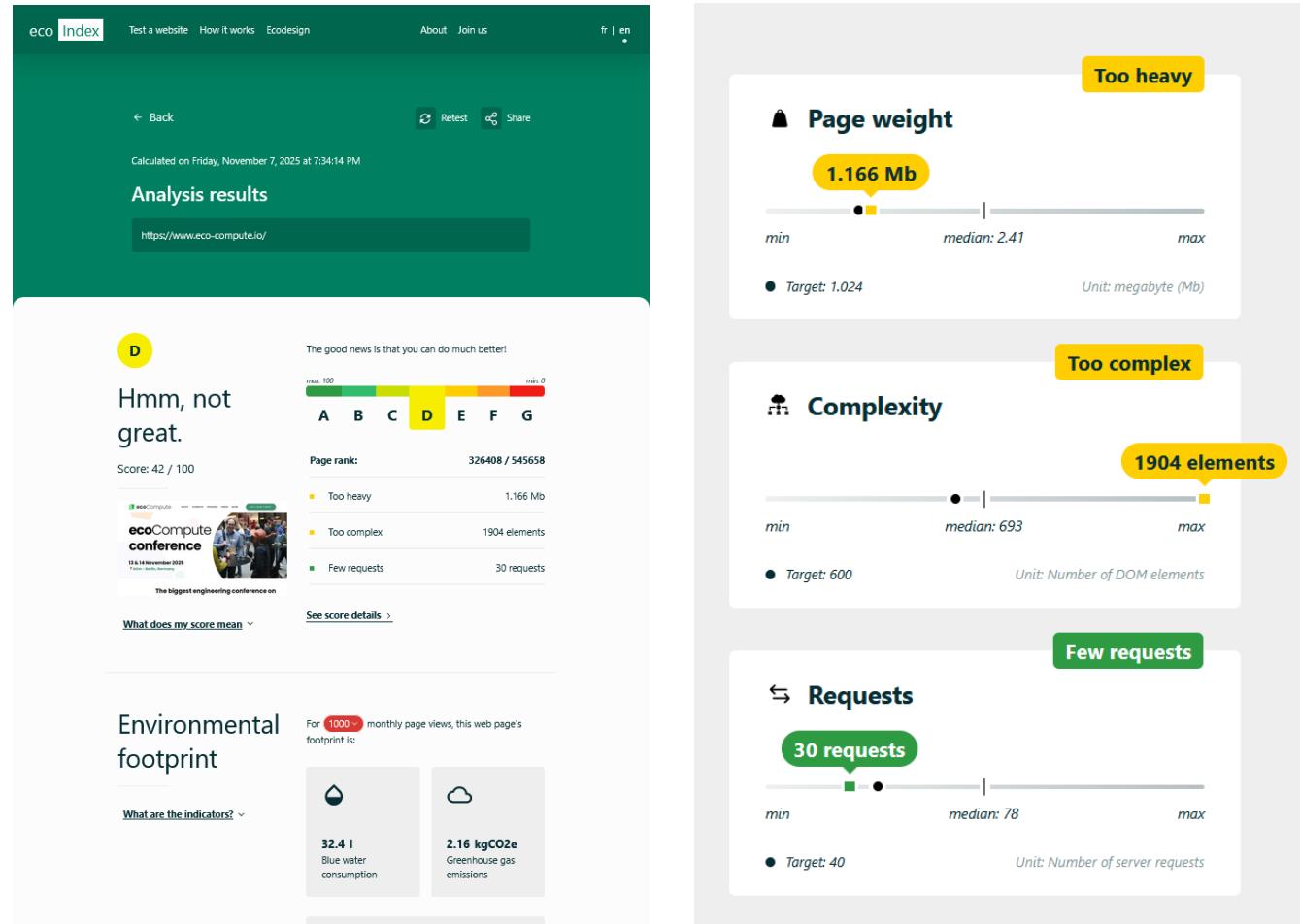
Properly size images

94 OUT OF 100



ecolIndex

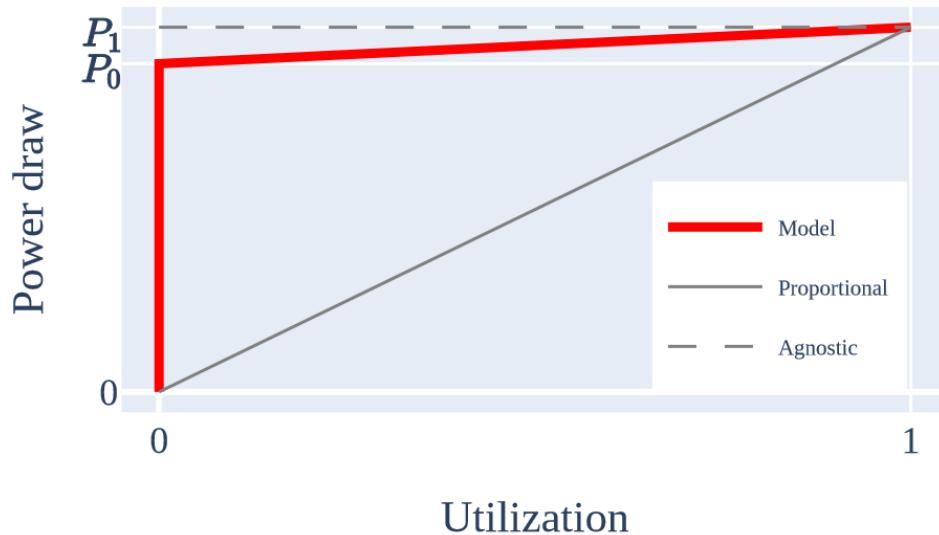
Data Transfer + Complexity + Requests



Data transfer as proxy: problems

No proportionality

- Data $\not\sim$ Network energy
- Data $\not\sim$ User devices energy



Typical power profile of network hardware

Source: Jacob, R., & Vanbever, L. (2023). The internet of tomorrow must sleep more and grow old. <https://doi.org/10.1145/3630614.3630620>

Average values, concrete context is ignored

- Physical distance
 - between user device and server
- Transmission path
 - DSL, WiFi, mobile communications, satellite etc.

Access Network	kWh/GB (2020)
Wide (WAN)	0.007
Fixed (FAN)	0.07
Radio (RAN)	0.2

Energy intensity of network transfer in different access networks

Source: Coroama, V. (2021). Investigating the inconsistencies among energy and energy intensity estimates of the internet. Swiss Federal Office of Energy SFOE. https://vs.inf.ethz.ch/publ/papers/Coroama2021_InternetEnergy.pdf

Data transfer as proxy: what's it worth?

What it's NOT good for:

- ✗ Detailed carbon accounting → too imprecise
- ✗ Consequential claims → not credible
 - Example: "By reducing data volume by X MB, you saved Y kg CO₂"

What it IS good for: "Attributional Reasoning"

- ✅ Internal allocation: "Department X is responsible for Y% of our data footprint"
- ✅ Identifying hotspots and key drivers
- ✅ Creating incentives to optimize

Data transfer as proxy: positive effects

- **Direct:**
Less data = less processing, transmission, storage
- **Indirect:**
Leaner apps → longer device lifespans, less hardware waste
- **Cultural shift:**
Encourages efficiency mindset

Estimating carbon emissions of network impact

Use the **Energy Intensity Model** (kWh/GB) for

- optimization
- tracking relative improvements

But:

- ⚠ Estimates ≠ actual savings (networks don't scale linearly)
- ⚠ Report separately – don't add the network impacts to client-side or SCI scores
- ⚠ Use as directional compass, not precise measurement

Bottom line: Guide optimization decisions, don't claim exact savings

Estimating CO₂ emissions of network impact

HOW TO MEASURE AND ACT ON NETWORK CARBON EMISSIONS IN GREEN SOFTWARE

Tue, Aug 5, 2025 - by Arne Tarara & David Kopp 

We have gotten pretty good at measuring the emissions from things like computing, storage and memory usage, because the hardware is right in front of us. But when it comes to network traffic, things get murky.

SO WHAT IS THE CARBON FOOTPRINT OF SENDING A CAT MEME?

The internet is a tangled web of cables, routers, and towers and your data might take a wildly unpredictable route from Berlin to Amsterdam (via Belgium, Poland or Denmark).

Basically, we often can't know the exact path or what networking hardware is used along the way, which makes it difficult to know how much energy is really being used. Academia has looked at this problem in the past through different approaches and this blog article shall analyse which of these models is most useful for Green Software Practitioners.

<https://www.green-coding.io/blog/network-carbon-emissions-in-green-software/>

Website Carbon Calculators – Conclusion

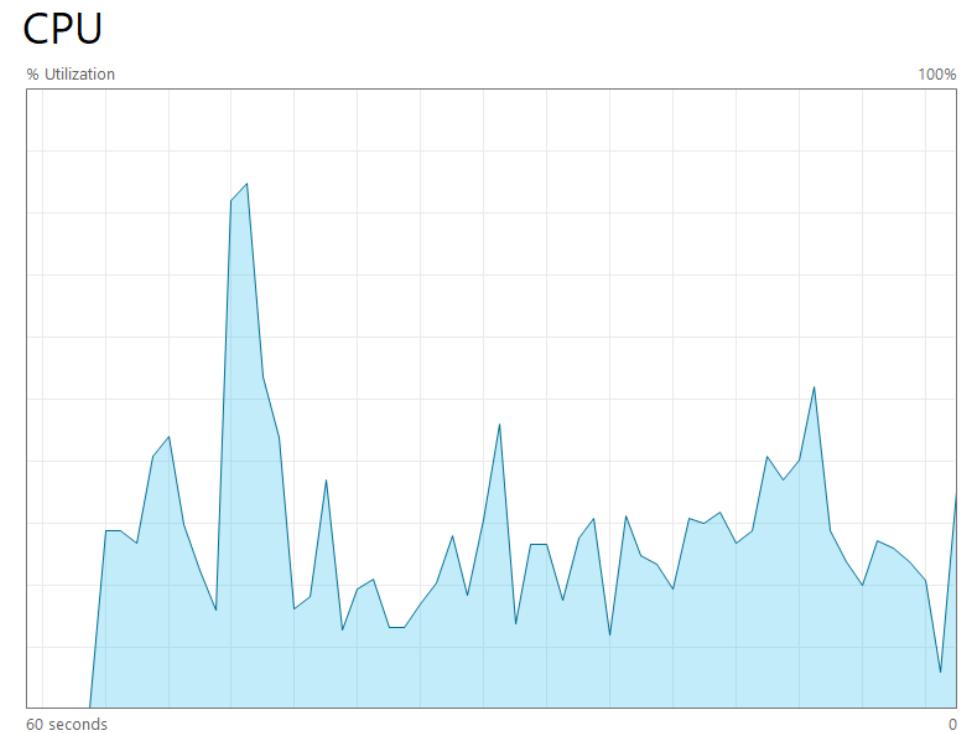
- **Benefits:**
 - Estimation of the carbon footprint per website visit with little effort
 - Easy comparison with other websites
- **Problems:**
 - Data transfer as the main proxy metric
 - may lead to false conclusions
 - Important factors are left out
 - User interactions: Accepting cookies, lazy loading, visiting multiple pages, etc.
 - Compute-intensive background activities: Animations, JavaScript calculations, etc.
 - Colors used, dark mode (affect the energy consumption of the screen)
 - Lack of detailed analysis options
- **Positive:**
 - Creates an incentive to reduce data volume

How can we better measure environmental impacts?

- **Direct measurement on the client side**
 - CPU/GPU/memory/energy monitoring
 - Make the costs of complex DOM and CSS structures and JS parsing visible
- **Recording of aspects other than “just” loading**
 - Real usage scenarios with interactions
 - Acceptance of cookies
 - Lazy loading of resources
 - Background activities
 - Animations, etc.
- **Profiling for detailed analysis**
 - Identification of bottlenecks
- However: Estimation of network impact is still necessary

Proxy Metric: Hardware Utilization

- Bottom-up approach
- Measure the **utilization** of hardware components on a **reference device** and convert it into energy values
- Big advantage:
 - It actually measures what happens on the client!
- Yet, energy consumption needs to be calculated



[How It Works?](#)[Light Mode](#)

Digital Sustainability Report

Client: www.eco-compute.io

Date: November 7, 2025 - November 8, 2025

Overview

Coverage: views / 1 page [i](#)



0.12 g



0.17 Wh



Rating [i](#)

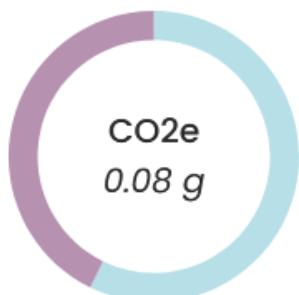


<https://web.cardamon.io/reports/ANvF7>

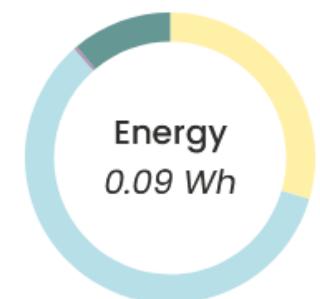
Frontend

CO₂e**0.08 g**

Energy

0.09 Wh

Operational
0.05 g
Embodied
0.03 g



CPU
0.03 Wh
Screen
0.05 Wh
Data
0.00 Wh
Idle
0.01 Wh

Network

CO₂e**0.04 g**

Energy

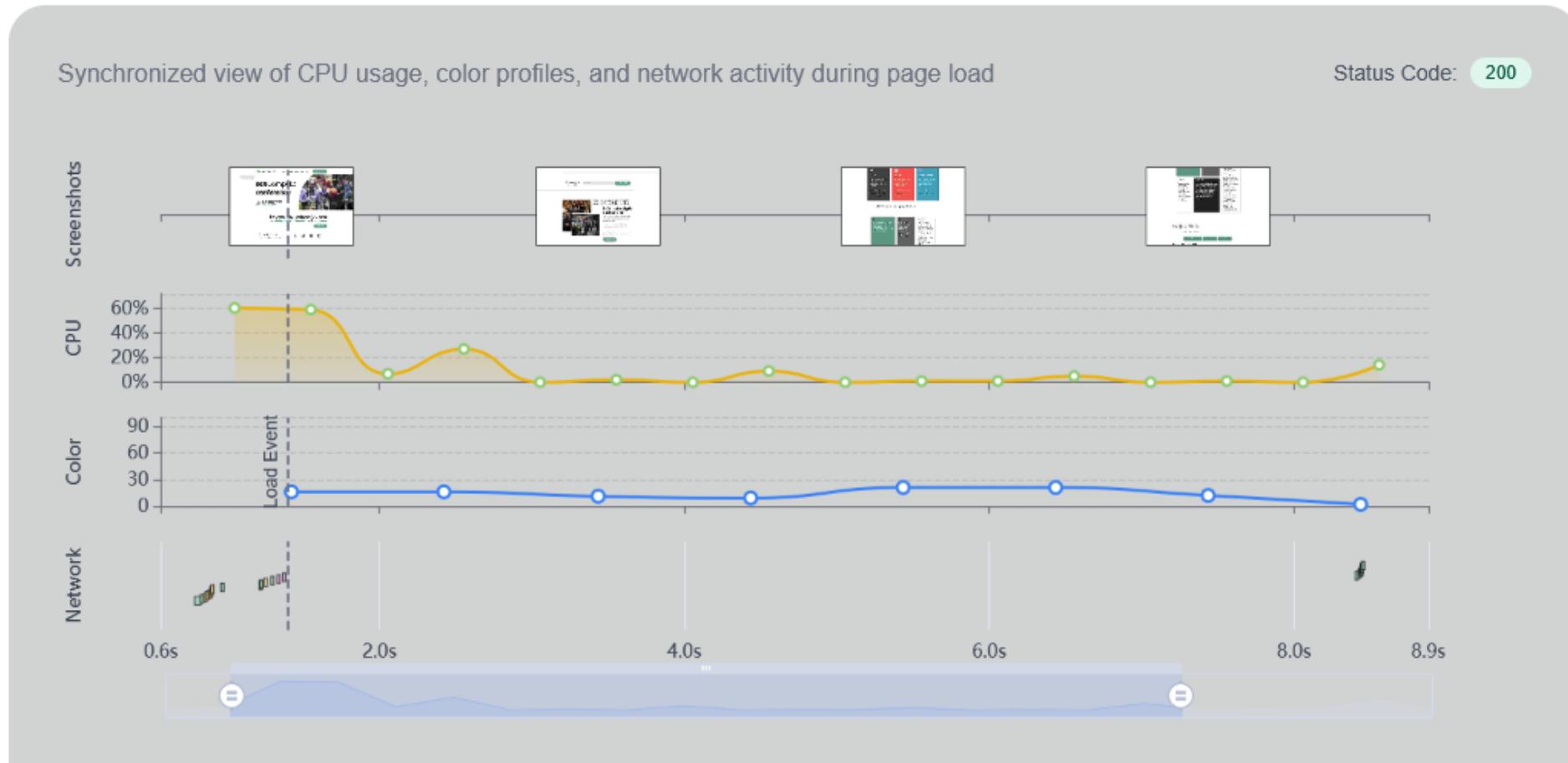
0.08 Wh

<https://web.cardamon.io/reports/ANvF7>

Cardamon Web – Analysis



Page Load Timeline



<https://web.cardamon.io/reports/ANvF7>

GreenFrame CLI



- Installation

```
$ curl https://assets.greenframe.io/install.sh | bash
```

- Measurement

```
$ greenframe analyze https://www.eco-compute.io/
```

```
✓ Check configuration file  
✓ Retrieving Git information  
✓ Analysis is in progress locally  
✓ Docker version 27.2.0, build 3ab4256  
✓ Running 1 scenario(s)...
```

Analysis complete !

Result summary:

main scenario completed

The estimated footprint is 16.66 mg eq. co₂ ± 2.6% (37.693 mWh).

<https://docs.greenframe.io/commands/>

Direct Energy Measurement

- on a generic device:

- Green Metrics Tool / webNRG

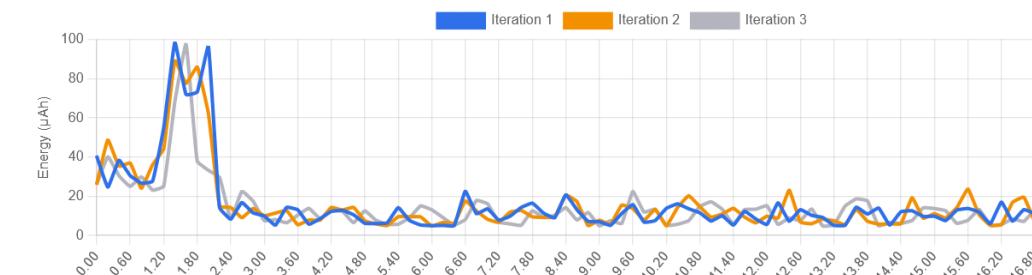
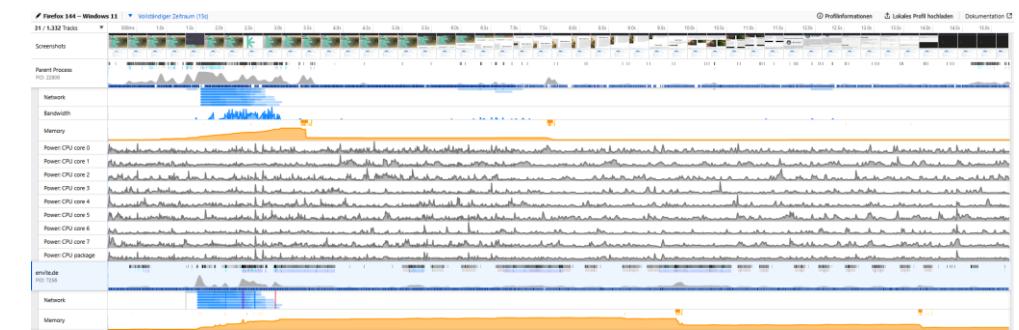
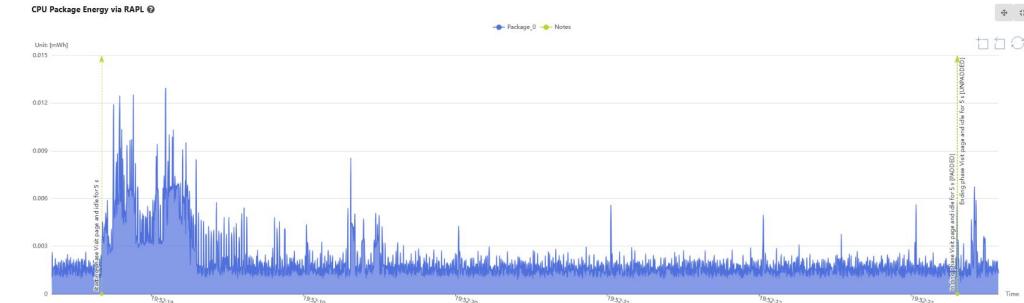


- Firefox Profiler



- on a real end user device:

- Greenspector Studio





What? websites produce carbon emissions?

Websites emit carbon through three factors: **Hosting**, **Network Traffic** and **User Viewing**

While [others look at green hosting](#) we created **webNRG** to measure **Network Traffic** and the power consumption while **Viewing** the page.

Check your site now and find out how emission your website creates for a **typical 10k users per month!**

 Website (e.g. www.my-page.io)

 Your e-mail (optional. we ping you when measurement is done)

Send me results: One Time Every week

You can also leave e-mail empty and check back here in ~5-30 Minutes

Measure

- **Energy Measurement using the Green Metrics Tool**

- Loads the page using Playwright and waits for 5 seconds
- CPU + DRAM energy is captured via RAPL (2ms intervals)
- Cached reverse proxy: Isolation from browser startup and network latency
- Rendering Energy Label: A+ (best) to F
(25% power increments per grade)



- **Network Traffic & Carbon**

- Captured at adapter level (actual transferred data)
- Network Data Label: Same grading system as the SWDM
- Carbon calculated using energy intensity model
(constant: 41 Wh/GB)



<https://website-tester.green-coding.io/methodology.html>

WebNRG – Results



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

Tested on Sat Nov 08 2025 18:53:58 GMT+0100 (Central European Standard Time)



Rendering Energy

The CPU power consumption for rendering was **3.40 W**

With a visit time of **5.63 s** this equates to **5.32 mWh**

If you have 10.000 people visiting your page per month this would consume **0.05 kWh** of energy



Network Data

The network data transfer the website was **2255.19 kB** for loading and staying on the page for **5.63 s**

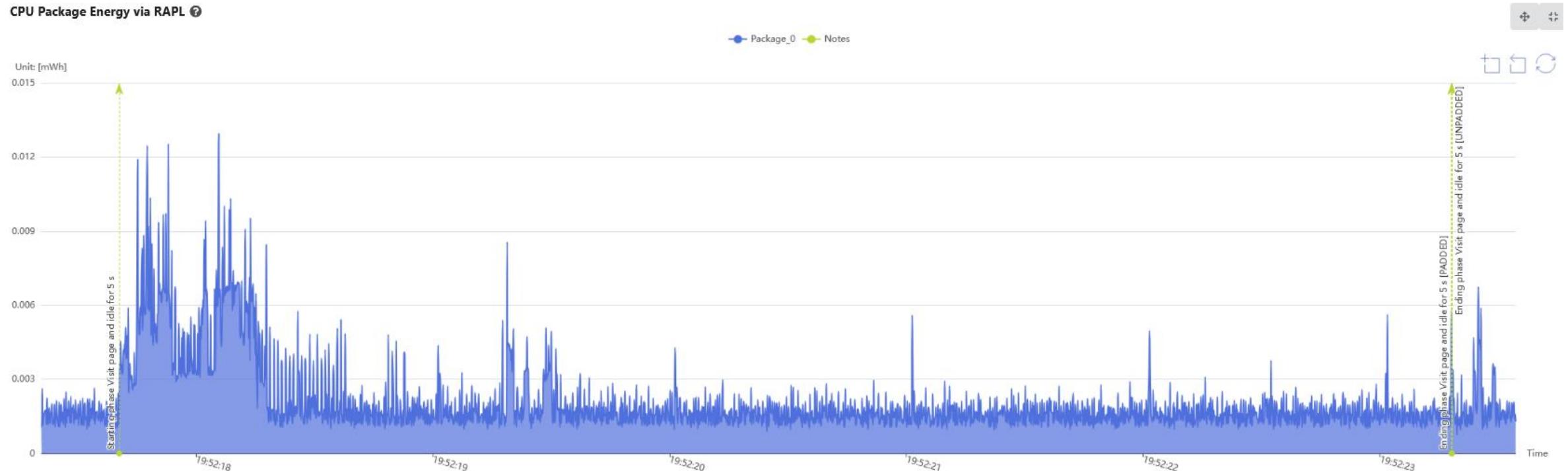
Assuming you have 10,000 visitors per month this website would produce about **9.70 kg**

<https://website-tester.green-coding.io/details.html?page=https%3A%2F%2Fwww.eco-compute.io>



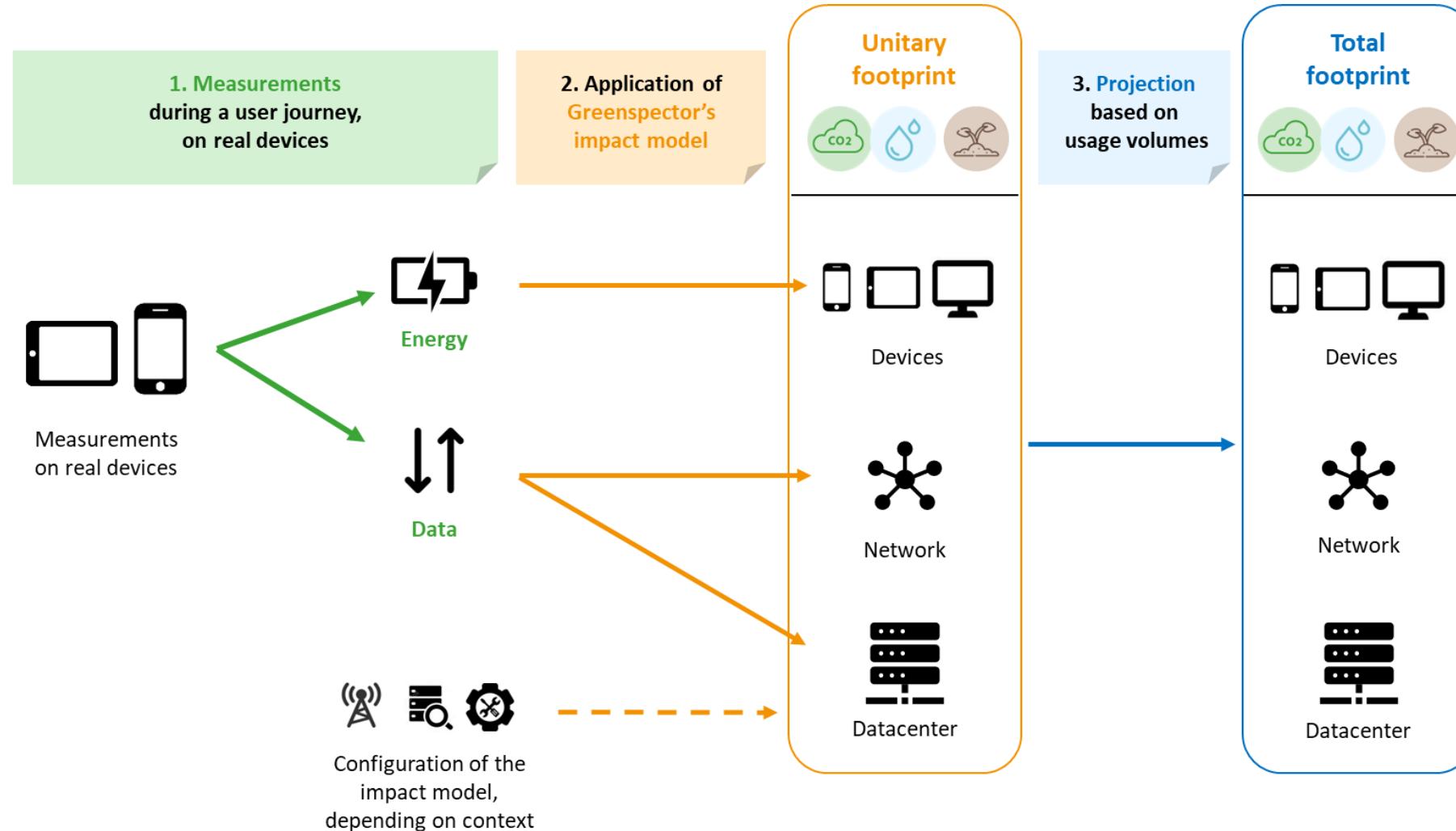
WebNRG – Measurement Details

⌚ Phase Duration	via Syscall
5.63 s	?
🌐 Network Traffic	via cgroup
2.26 MB	?
CPU	CPU Package Energy
	via RAPL
5.32 mWh	?
DRAM	DRAM Energy
	via RAPL
1.42 mWh	?



<https://metrics.green-coding.io/stats.html?id=dc49d51a-b89f-4c8a-943e-e4c001dad428>

Greenspector Studio – Methodology



Greenspector Studio – Benchmark



New analysis

App description

This information will allow us to configure the measurements.

What is the name of your application? _____

ecoCompute

What do you call this measurement? _____

7.11.2025

i This name will be used to compare other versions. It may be the same version code as your software, the current date...

On which smartphone do you want to measure?

Galaxy S7 Galaxy S9

Is your application web or mobile (Android)?

Web Android

i Your application is based on web technology that can be consulted in a browser (website, PWA, intranet, etc.) or is an Android mobile application (native, hybrid, etc.).

Next

Configuring the web application

In order to carry out the tests, we need the URL of your site.

What is the domain name or root URL of your application? _____

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

i The URL must use Hypertext Transfer Protocol Secure (HTTPS)

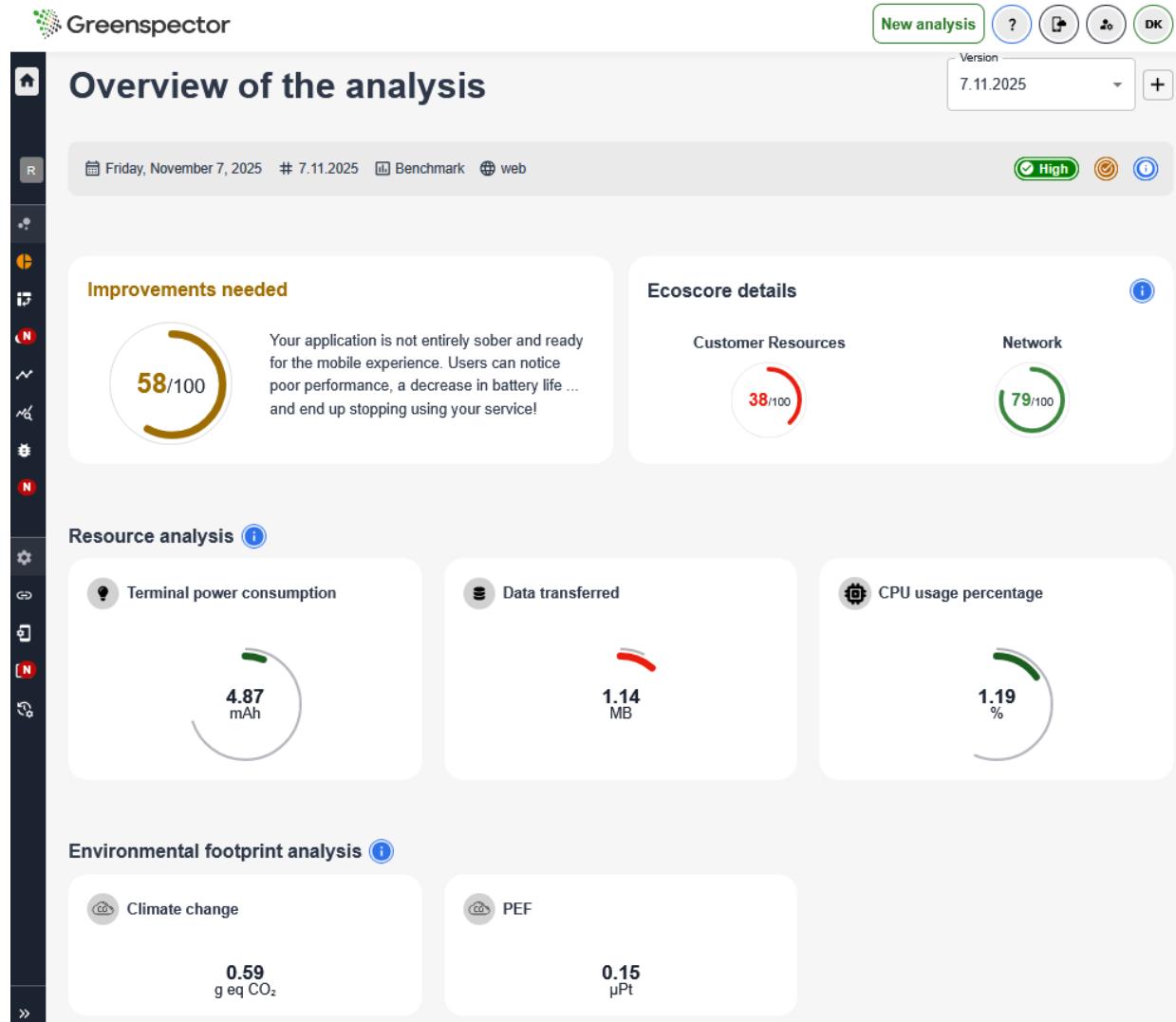
Is your URL public?

Yes No

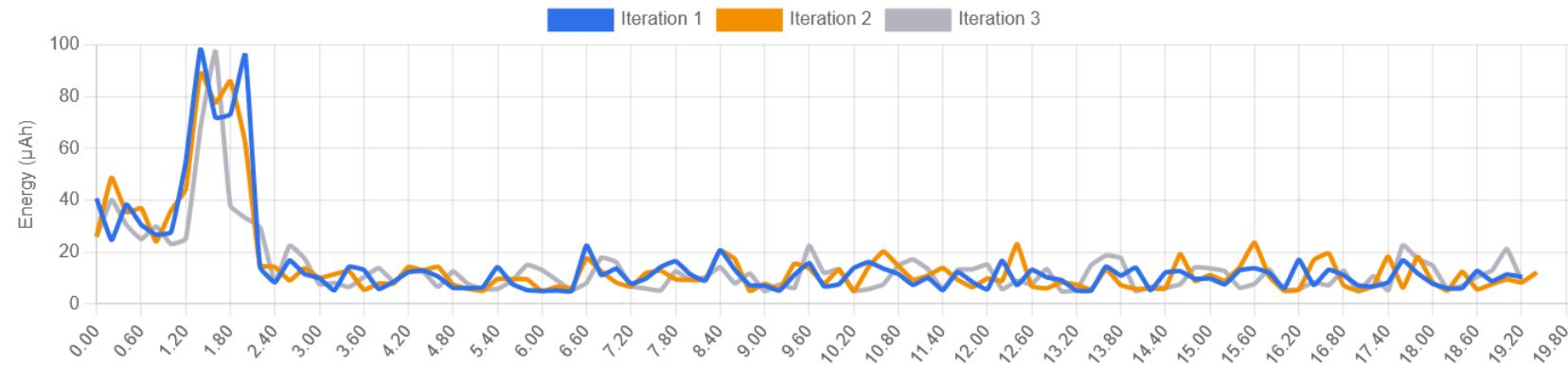
i To measure your site on our test cloud, the URL must be accessible on our device. Otherwise, you will be able to measure on your local device.

Save

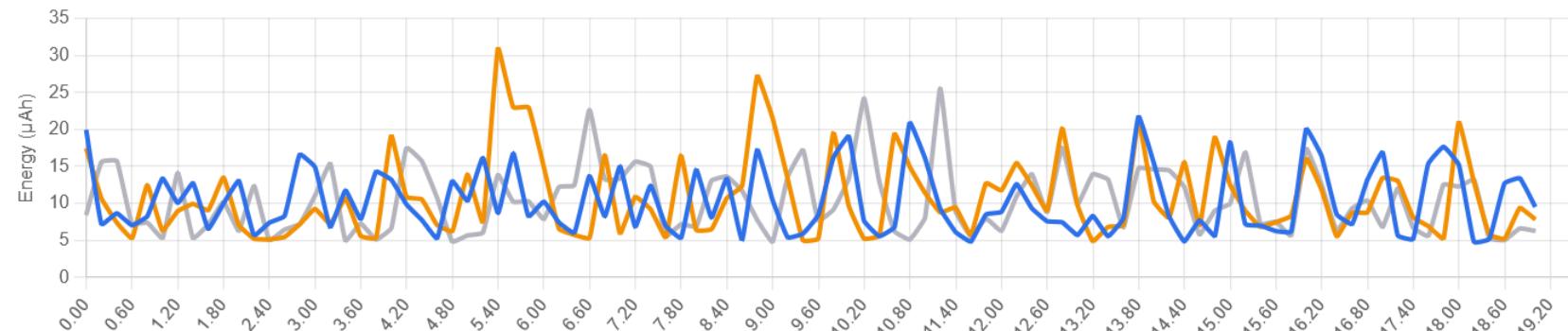
Greenspector Studio – Analysis



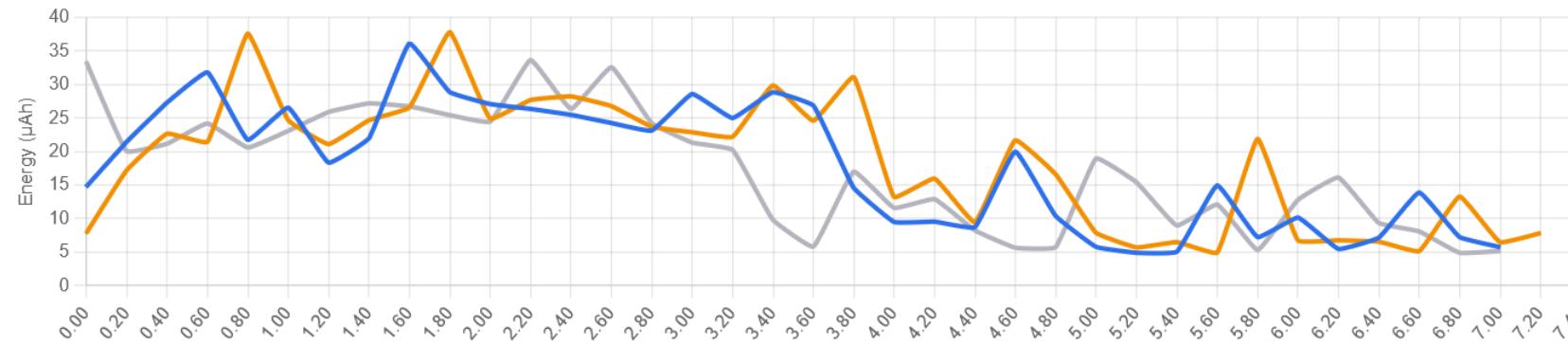
Greenspector Studio – Measurement Details



Loading



Idle



Scrolling

Overview of results for eco-compute.io

Methodology	Tool	Incl. server estimation	CO ₂ e (mg)	Energy (mWh)	Notes
Data transfer as main proxy metric	WebsiteCarbon.com	✓	120		
	Kastor	✓	353		
	Beacon	✓	444		
	Ecograder	✓	460		
	ecolIndex	✓	2160		own methodology, not SWDM
Hardware utilization as proxy metric	GreenFrame CLI	✗	17	37.7	
	Cardamon Web (client)	✗	80	92	only client
	Cardamon Web (network)	✗	40	82	only network (impacts are estimated)
Energy measurement	WebNRG (client)	✗	2.9	6.7	only CPU + DRAM
	WebNRG (network)	✗	81	285	only network (impacts are estimated)
	Greenspector Studio	✓	590	18	low carbon intensity of France is used

Agenda

Introduction

Methodologies & Tools

➤ User Interactions

Good & Bad Websites

Conclusion

From Page Loads to Real Interactions

- In reality, users interact with the website
 - Scrolling, clicking, navigating...



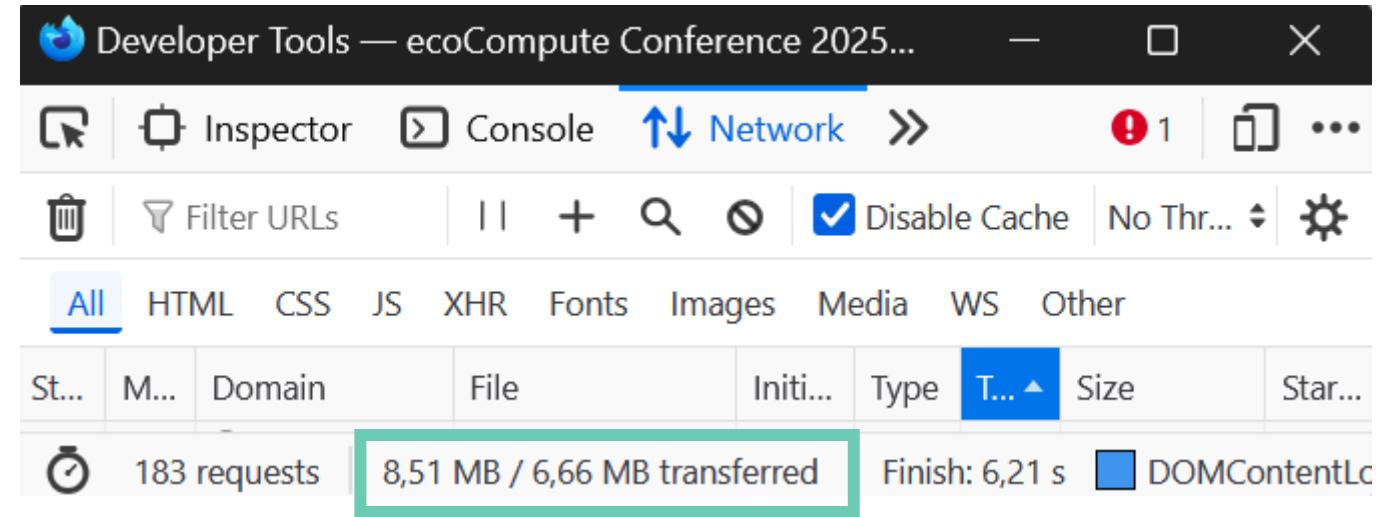
The image shows a web browser window displaying the homepage of the ecoCompute conference. The URL in the address bar is www.eco-compute.io. The page has a dark header with the ecoCompute logo and navigation icons. The main content features a large, bold title 'ecoCompute conference' with a yellow triangle graphic behind it. Below the title is a large red 'SOLD OUT' stamp. At the bottom, the text '13 & 14 November 2025' is displayed. The footer contains the 'envite' logo.

First step: Scrolling down

- The simplest and most common page interaction
- Only a few tools are including scrolling in their measurements by default
 - Greenspector Studio: scrolling for ~3s
 - Cardamon: scrolling for 10s
 - ecoIndex: scrolling to bottom

Scrolling on websites: eco-compute.io

Tool	Data (MB)
Greenspector Studio	1.14
ecoIndex	1.17
Cardamon Web	1.32



→ Automatic scrolling with the tools did not work as expected!

Scrolling on websites: eco-compute.io

- Tools are typically using `window.scrollTo()`
- This does not work on the eco-compute.io website, due to:

```
body, html {  
    height: 100%;  
}
```

- "`height: 100%`" makes the body the scroll container
- Possible workaround: `document.body.scrollTo()`

Scrolling on websites: developer-week.de

Tool	Data (MB)	Scrolling?	Notes
Ecograder	1.3	✗	
WebNRG	5.3	✗	
Greenspector Studio	8.2	✓	scrolling for 3 seconds
Cardamon Web	22.4	✓	scrolling for 10s
ecoIndex	31.5	✓	scrolling to bottom of the page

Big differences (web page contains a video that is lazy loaded during scrolling)

User Journeys

- Automated execution of a typical usage scenario in a (headless) browser
- Advantages:
 - Environmental impact of frequently used or resource-intensive use cases
 - Helpful for reporting
 - Good starting point for optimizations
 - Recording of potentially resource-intensive aspects:
 - Accepting cookies
 - Lazy loading of resources
 - Background activities
 - Animations
 - ...
 - Applying the Software Carbon Intensity (SCI) standard

SCI for Web

- root & branch (makers of Cardamon) are currently working on this topic: <https://cardamon.io/sci>



Oliver Winks @ Green IO London (2025)
Source: [LinkedIn](#)

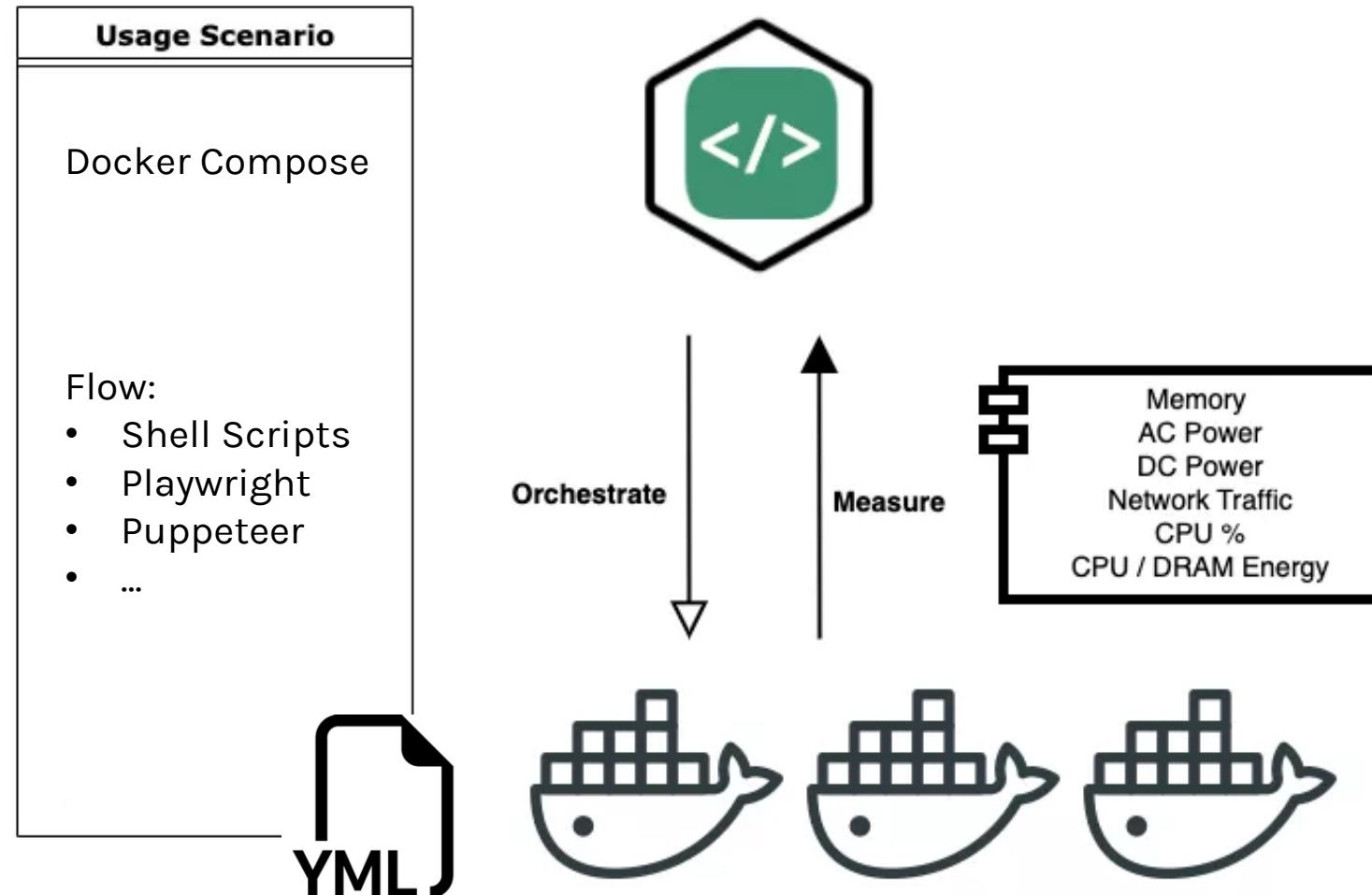
- Green Metrics Tool supports SCI within a single usage scenario

Measuring the environmental impacts of automated user journeys – Tools

- **GreenFrame**
 - Energy measurement: Conversion of utilization data into energy consumption
 - Automation: Playwright with headless browser
- **Cardamon**
 - Energy measurement: Conversion of utilization data into energy consumption
 - Automation: Any tool (e.g., Playwright) with headless browser
- **Green Metrics Tool**
 - Energy measurement: Energy measurement on reference device (server)
 - Automation: Any tool (e.g., Playwright) with headless browser
- **Greenspector Studio**
 - Energy recording: Energy measurement on real end device (smartphone/tablet)
 - Automation: Part of the tool; own DSL



Energy Measurement with the Green Metrics Tool



<https://docs.green-coding.io/docs/prologue/measurement-process/>

Energy Measurement with the Green Metrics Tool



usage_scenario.yml (excerpt):

```
name: "Website User Journey"

services:
  playwright:
    image: greencoding/gcb_playwright:v21

flow:
  - name: Execute user journey
    container: playwright
    commands:
      - type: console
        command: python3 /repo/playwright-flow.py
```

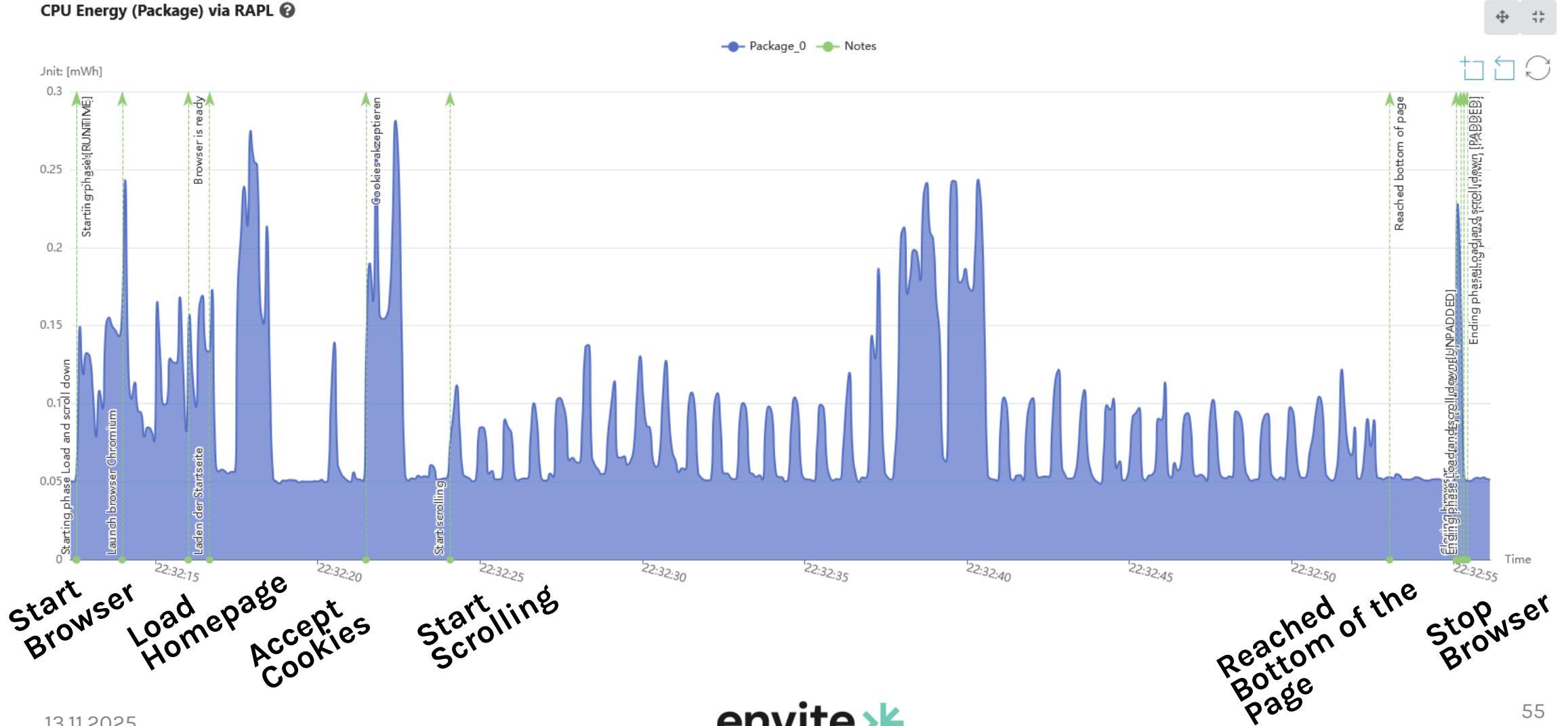
Energy Measurement with the Green Metrics Tool



playwright-flow.py:

```
browser = await playwright.chromium.launch(headless=False, args=["--headless=new"], slow_mo=2500)
context = await browser.new_context(viewport={"width": 1280, "height": 720})
page = await context.new_page()
# Load Home Page
await page.goto(website_url)
# Wait, until the cookie banner is visible
await page.locator('#uc-main-dialog').wait_for(state='visible')
# Accept cookies
await page.get_by_role('button', name='Accept all').click()
# Wait until the cookie banner disappears
await page.locator('#uc-main-dialog').wait_for(state='hidden')
# Go to page "Program"
await page.get_by_text('→Program').scroll_into_view_if_needed()
await page.get_by_role('link', name='→Program').click()
# ...
```

Scenario: Load the home page, accept cookies, scroll to the bottom of the page



Greenspector Measurement Script



```
launchBrowser
browserGoToUrl,$WEBSITE_URL

# Load home page
assertNotExistsId,uc-main-dialog
measureStart,CHRGT_home_no_cookies
pressEnter
pause,${PAUSEAFTERACTION}
waitForElementId,uc-main-dialog
pause,${PAUSEAFTERLOAD}
measureStop

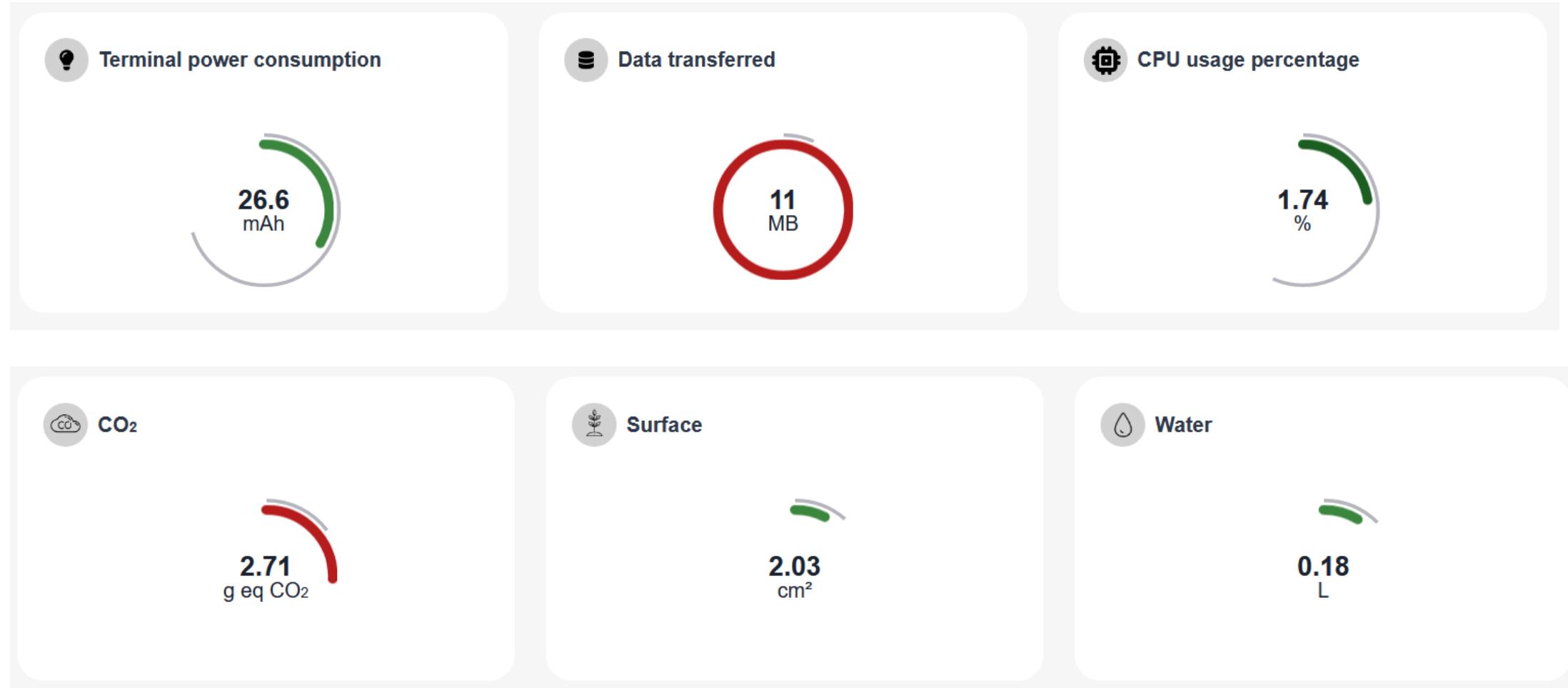
# Measure background activities
measureStart,PAUSE_home_no_cookies
pause,${PAUSEDURATION}
measureStop

# Accept cookies
measureStart,CHRGT_home_accept_cookies
clickById,accept
pause,${PAUSEAFTERLOAD}
measureStop

# Measure background activities
measureStart,PAUSE_home_accept_cookies
pause,${PAUSEDURATION}
measureStop

# Go to the button “→Program”
measureStart,SCROLL_to_button_to_pogramm
scrollToText,→Program
pause,${PAUSEAFTERACTION}
measureStop
```

Resource consumption & environmental impacts



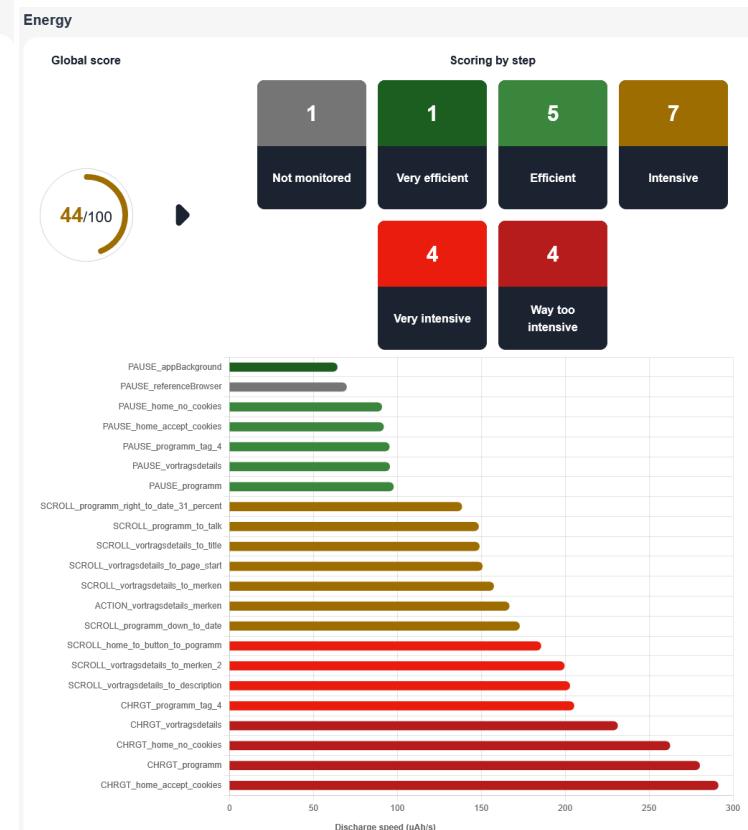


Results per Step

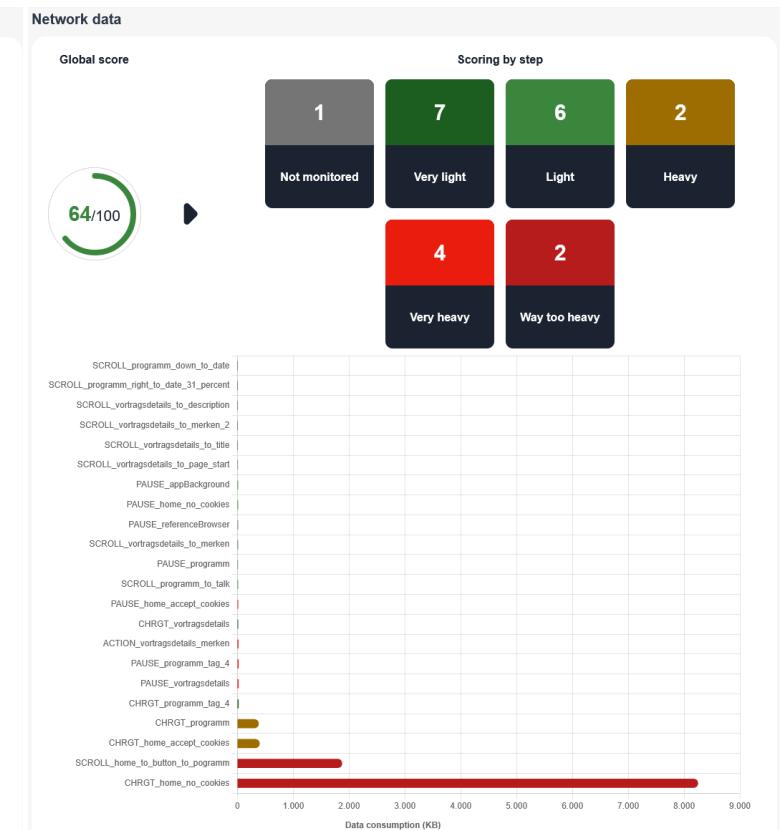
Time



Energy



Network



Tool Overview: Our Recommendations

	Measurement	Assessment
Methodology	Data transfer as the main proxy metric Hardware utilization as the main proxy metric	Energy measurement Analysis of best practices
Tools	<ul style="list-style-type: none">• CO2.js• Website Carbon Calculator• Ecograder• Kastor• EcoIndex.fr• Klimatest• Beacon• ...	<ul style="list-style-type: none">• GreenFrame^(€)• Cardamon Web• WebNRG / Green Metrics Tool• Greenspector Studio^(€) <ul style="list-style-type: none">• GreenIT-Analysis• Ecograder• Kastor

(€) Only really useful in the paid version

Agenda

Introduction

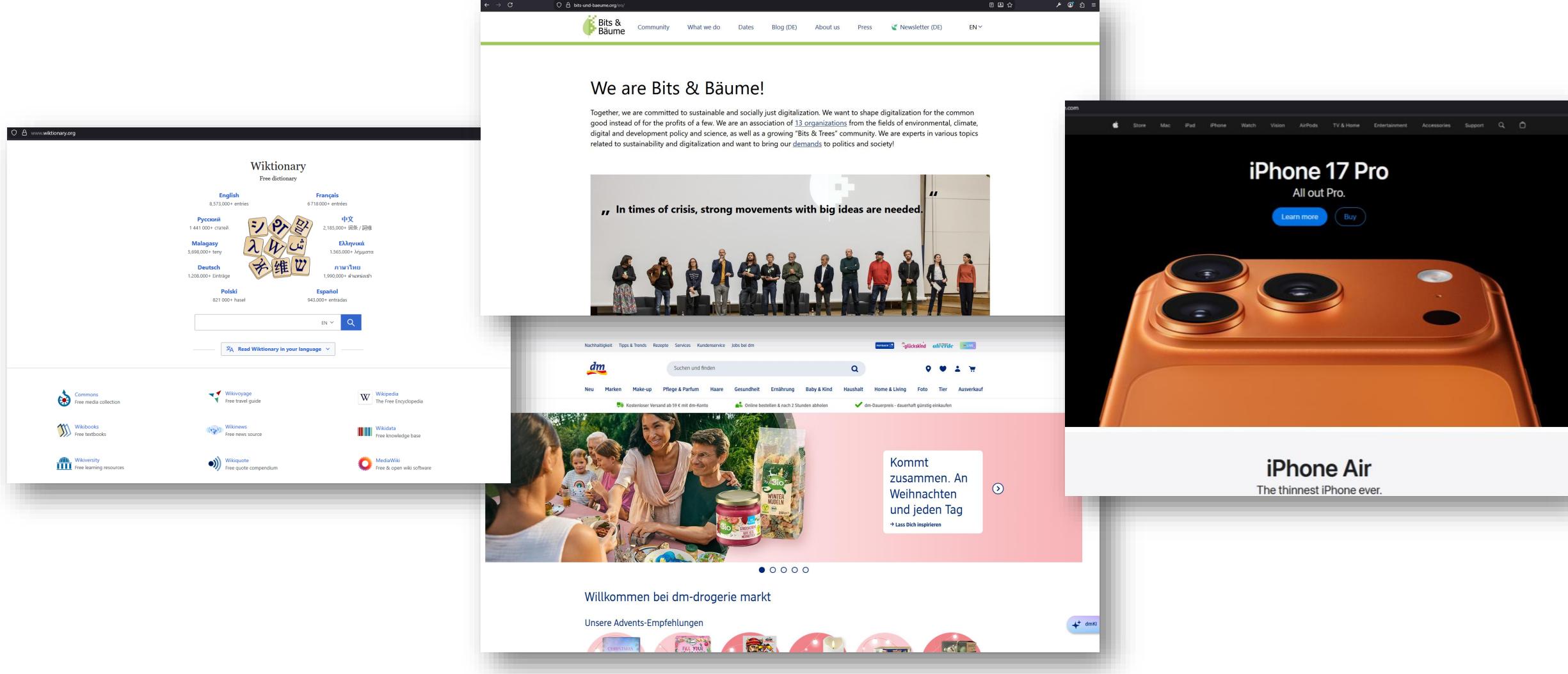
Methodologies & Tools

User Interactions

›* Good & Bad Websites

Conclusion

What makes websites good or bad?



The image displays four distinct web pages or advertisements side-by-side, each representing a different approach to website design and user experience:

- Wiktionary (Good Example):** A screenshot of the Wiktionary homepage, showing a clean layout with language statistics and a search bar. It includes links to sister projects like Wikipedia and Commons.
- Bits & Bäume (Good Example):** A screenshot of the Bits & Bäume website. It features a prominent image of a group of people standing in front of a whiteboard with the quote "In times of crisis, strong movements with big ideas are needed." The layout is professional and informative.
- dm-drogerie markt (Mixed):** A screenshot of the dm-drogerie markt website. While it has a clear navigation bar and product images, the overall aesthetic is cluttered and less polished compared to the other examples.
- iPhone 17 Pro (Bad Example):** A screenshot of an advertisement for the iPhone 17 Pro. The image is dark and focuses on the phone's camera system, which some might find visually unappealing or overwhelming.

What makes websites good or bad?



	Rendering Energy Score	Network Data Score
wiktionary.org		
bits-und-baeume.org		
apple.com		
dm.de		

wiktionary.org

www.wiktionary.org

Wiktionary

Free dictionary

English

8,573,000+ entries

Русский

1 441 000+ статей

Malagasy

5,698,000+ teny

Deutsch

1.208.000+ Einträge

Polski

821 000+ haszów



Français

6 718 000+ entrées

中文

2,185,000+ 词条 / 詞條

Ελληνικά

1.565.000+ λήμματα

ภาษาไทย

1,990,000+ คำและนิยาม

Español

943,000+ entradas

EN ▾



Read Wiktionary in your language ▾



Commons
Free media collection



Wikivoyage
Free travel guide



Wikipedia
The Free Encyclopedia



Wikibooks
Free textbooks



Wikinews
Free news source



Wikidata
Free knowledge base



Wikiversity
Free learning resources



Wikiquote
Free quote compendium



MediaWiki
Free & open wiki software



Rendering Energy

The CPU power consumption for rendering was **3.16 W**

With a visit time of **5.45 s** this equates to **4.79 mWh**

If you have 10.000 people visiting your page per month this would consume **0.05 kWh** of energy



Network Data

The network data transfer the website was **114.99 kB** for loading and staying on the page for **5.45 s**

Assuming you have 10,000 visitors per month this website would produce about **0.49 kg**

<https://website-tester.green-coding.io/details.html?page=https://www.wiktionsary.org>



Website carbon results for: [wiktionary.org](#)

A+

Hurrah! This web page achieves a carbon rating of A+

This is cleaner than 99% of all web pages globally



Learn about our [rating system](#)

This page was last tested on 18 Aug, 2025. [Test again](#)

<https://www.websitecarbon.com/website/wiktionary-org/>

Overview

Coverage: 1 views / 1 page i

CO₂e

0.08 g

Energy

0.09 Wh

Rating i

Load Rating ?

A+

A

B

C

D

E

F

Scroll Rating ?

<https://web.cardamon.io/reports/H6Kcs>



wiktionsary.org

Developer Tools — Wiktionary — https://www.wiktionary.org/

Inspector Console Debugger Network Style Editor Performance ...

Filter URLs | II + ⌂ ⓘ Disable Cache | No Throttling ⚙

All HTML CSS JS XHR Fonts Images Media WS Other

Status	Method	Domain	File	Type	Transferr...	Size
200	GET	www.wiktionary.org	/	html	18,56 kB	75,20 kB
200	GET	www.wiktionary.org	index-a282805166.js	js	7,14 kB	16,31 kB
200	GET	www.wiktionary.org	gt-ie9-38c8b5f74a.js	js	1,55 kB	586 B
200	GET	www.wiktionary.org	Wiktionary-logo-tiles_1x.png	png	35,17 kB	34,21 kB
200	GET	www.wiktionary.org	wiktionary.png	png	7,61 kB	6,66 kB
200	GET	www.wiktionary.org	piece.ico	vnd.micr...	7,60 kB	6,62 kB

⌚ 6 requests | 139,59 kB / 77,62 kB transferred | Finish: 642 ms | DOMContentLoaded: 459 ms | load: 483 ms

- Only 6 requests
- Only 139 kB

The screenshot shows the top navigation bar of the website. It includes a back/forward button, a search icon, the URL 'bits-und-baeume.org/en/' in the address bar, and various site icons. Below the address bar is the main navigation menu with links: 'Community', 'What we do', 'Dates', 'Blog (DE)', 'About us', 'Press', 'Newsletter (DE)', and 'EN ▾'. A green horizontal bar runs across the page below the navigation.

We are Bits & Bäume!

Together, we are committed to sustainable and socially just digitalization. We want to shape digitalization for the common good instead of for the profits of a few. We are an association of [13 organizations](#) from the fields of environmental, climate, digital and development policy and science, as well as a growing "Bits & Trees" community. We are experts in various topics related to sustainability and digitalization and want to bring our [demands](#) to politics and society!





Rendering Energy

The CPU power consumption for rendering was **3.29 W**

With a visit time of **5.52 s** this equates to **5.03 mWh**

If you have 10.000 people visiting your page per month this would consume **0.05 kWh** of energy



Network Data

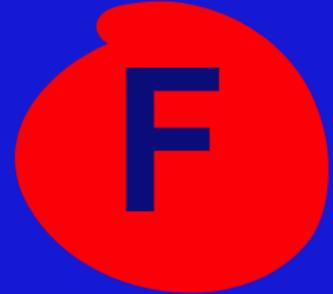
The network data transfer the website was **5512.85 kB** for loading and staying on the page for **5.52 s**

Assuming you have 10,000 visitors per month this website would produce about **23.69 kg**

<https://website-tester.green-coding.io/details.html?page=https://bits-und-baeume.org>



Website carbon results for: [bits-und-baeume.org](#)



Oh no! This web page achieves a carbon rating of F

This is dirtier than 71% of all web pages globally



[Learn about our rating system](#)

This page was last tested on 11 Nov, 2025.

<https://www.websitecarbon.com/website/bits-und-baeume-org/>

Overview

Coverage: 1 views / 1 page ⓘ

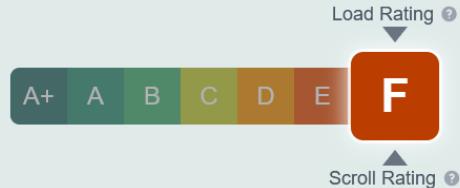
CO2e

0.21 g

Energy

0.35 Wh

Rating ⓘ



Frontend



CO2e

0.08 g



Energy

0.09 Wh

Network



CO2e

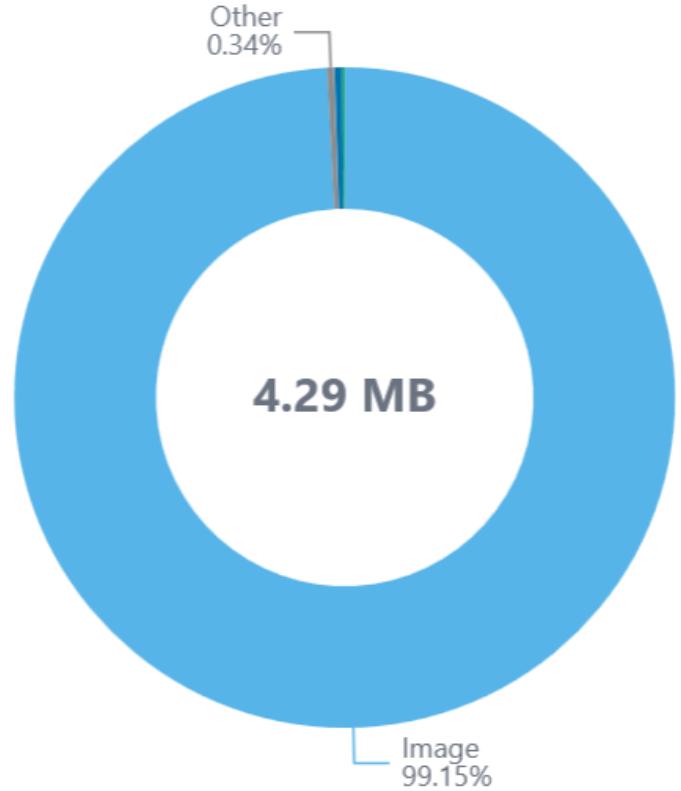
0.13 g



Energy

0.27 Wh

<https://web.cardamon.io/reports/vqHrK>



All Resources

Resource	Size
Image	4.25 MB
Document	15.78 KB
Other	15.04 KB
Stylesheet	5.56 KB
Manifest	707 B

<https://web.cardamon.io/reports/vqHrK>

- Bad: a lot of data transferred over the network
 - 4.25 MB unoptimized images
 - But: Rendering is highly efficient
 - WebNRG: Rendering Energy Score of A
- Using data transfer only is here a bad proxy for the environmental impacts of the web page
- Why is the rendering so efficient?



HTML & CSS & no JavaScript:

A screenshot of the Network tab in Mozilla Firefox's developer tools. The tab bar at the top includes icons for pause, add, search, and refresh, followed by 'All', 'HTML' (which is selected), 'CSS', 'JS', 'XHR', and then 'Fonts' and 'Images'. Below the tab bar is a table with four columns: 'File', 'Type', 'Transferred', and 'Size'. There are two rows of data: the first row shows '/' as the file, 'html' as the type, '16,29 kB' as transferred, and '95,01 kB' as size; the second row shows 'main.4d4bef4d8fcc5f0db816.css' as the file, 'css' as the type, '5,82 kB' as transferred, and '17,48 kB' as size. The table has a light gray background with white borders between the rows and columns.

- Server-side rendering is used
- No JavaScript at all!



iPhone Air

The thinnest iPhone ever.

envite ➤



Rendering Energy

The CPU power consumption for rendering was **3.67 W**

With a visit time of **5.73 s** this equates to **5.85 mWh**

If you have 10.000 people visiting your page per month this would consume **0.06 kWh** of energy

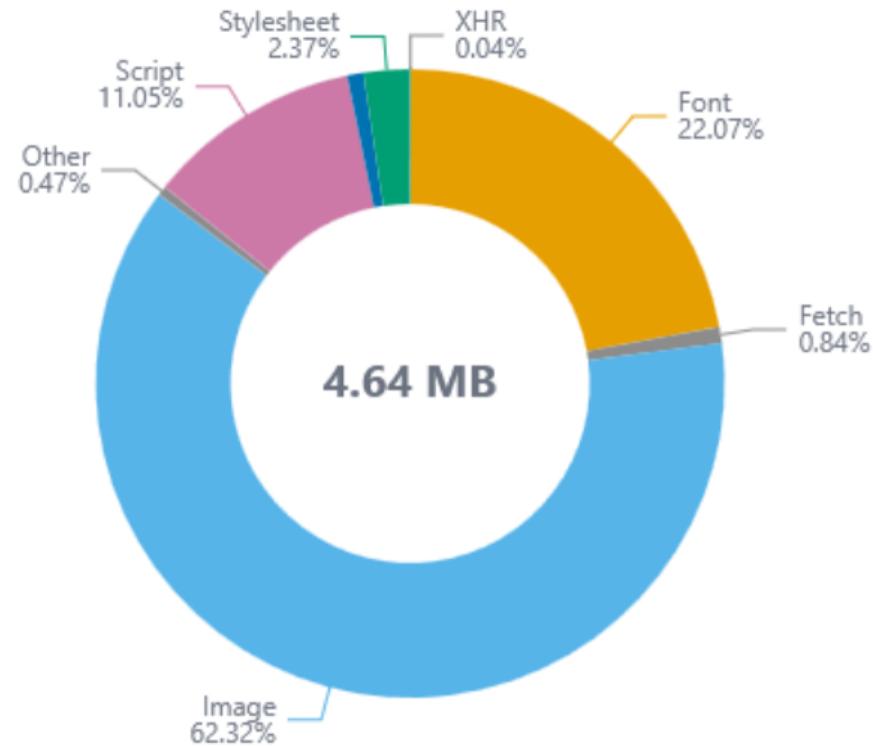


Network Data

The network data transfer the website was **3510.41 kB** for loading and staying on the page for **5.73 s**

Assuming you have 10,000 visitors per month this website would produce about **15.09 kg**

<https://website-tester.green-coding.io/details.html?page=https://www.apple.com>



All Resources

Resource	Size
Image	2.89 MB
Font	1.02 MB
Script	525.42 KB
Stylesheet	112.45 KB
Fetch	39.95 KB
Document	39.76 KB
Other	22.6 KB

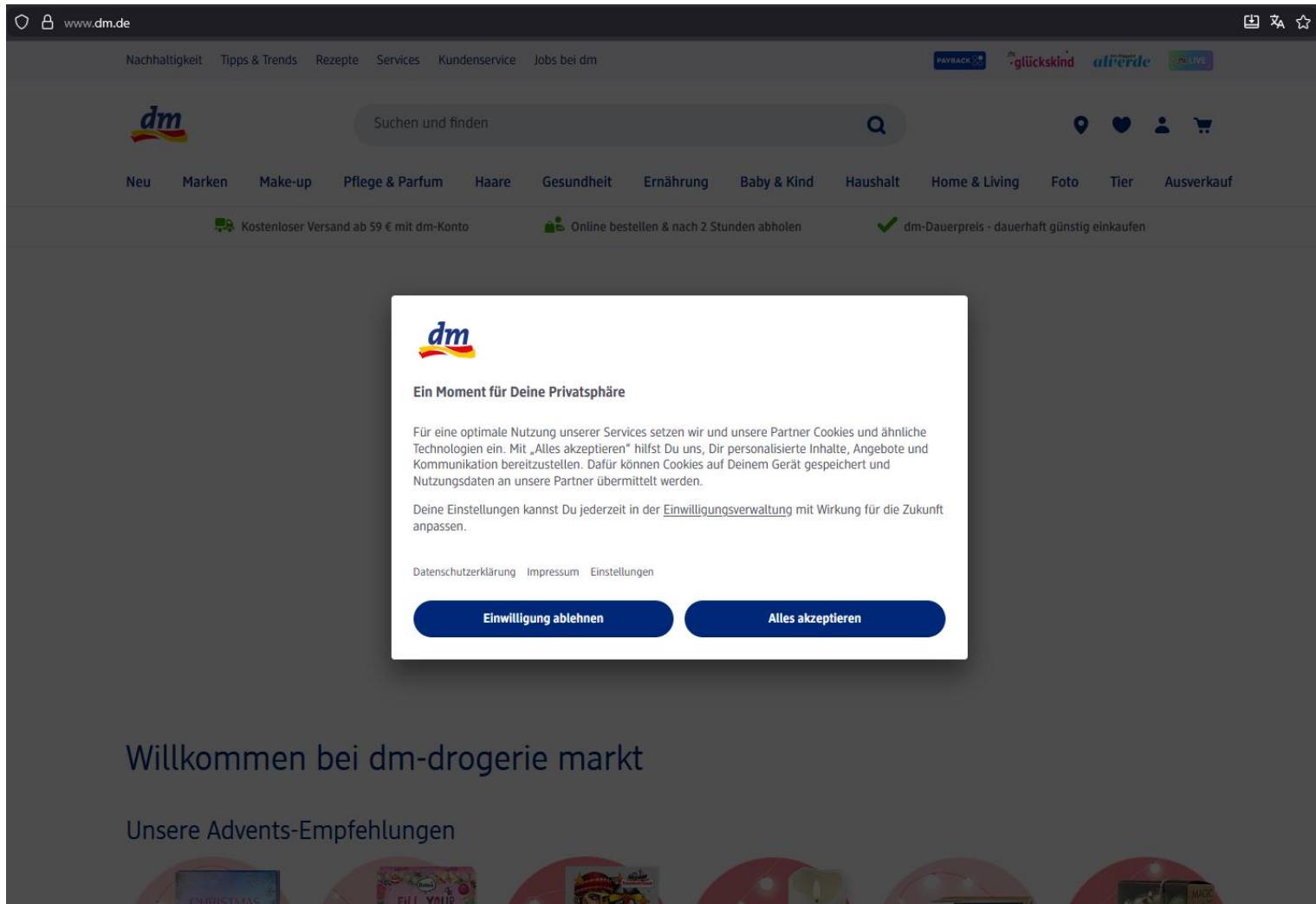
<https://web.cardamon.io/reports/wLCu9>

apple.com

- Bad: a lot of data transferred over the network (4.6 MB)
 - 1 MB of custom fonts!
 - Unoptimized Images (JPEG, 2.8 MB)
- Good:
 - Server-side rendering is used
 - Only a few “nice-to-have” JS scripts (web page works with JS disabled)

JavaScript:

File	Transferred	Size
autofilms.built.js	102,15 kB	478,33 kB
ac-analytics.js	104,03 kB	463,71 kB
main.built.js	66,31 kB	255,92 kB
localeswitcher.built.js	57,39 kB	191,42 kB
globalheader.umd.js	165,08 kB	163,91 kB
fam-gallery.built.js	28,21 kB	103,72 kB
data-relay.js	6,48 kB	17,18 kB
head.built.js	6,71 kB	14,79 kB
ac-globalfooter.built.js	4,55 kB	10,20 kB
auto-relay.js	1,29 kB	197 B



Nachhaltigkeit Tipps & Trends Rezepte Services Kundenservice Jobs bei dm

PAYBACK dm-glückskind dm-Magazin dm LIVE

dm Suchen und finden     

Neu Marken Make-up Pflege & Parfum Haare Gesundheit Ernährung Baby & Kind Haushalt Home & Living Foto Tier Ausverkauf

 Kostenloser Versand ab 59 € mit dm-Konto  Online bestellen & nach 2 Stunden abholen  dm-Dauerpreis - dauerhaft günstig einkaufen



Kommt zusammen. An Weihnachten und jeden Tag 

→ Lass Dich inspirieren

● ○ ○ ○ ○

Willkommen bei dm-drogerie markt

Unsere Advents-Empfehlungen





Rendering Energy

The CPU power consumption for rendering was **7.89 W**

With a visit time of **5.72 s** this equates to **12.58 mWh**

If you have 10.000 people visiting your page per month this would consume **0.13 kWh** of energy



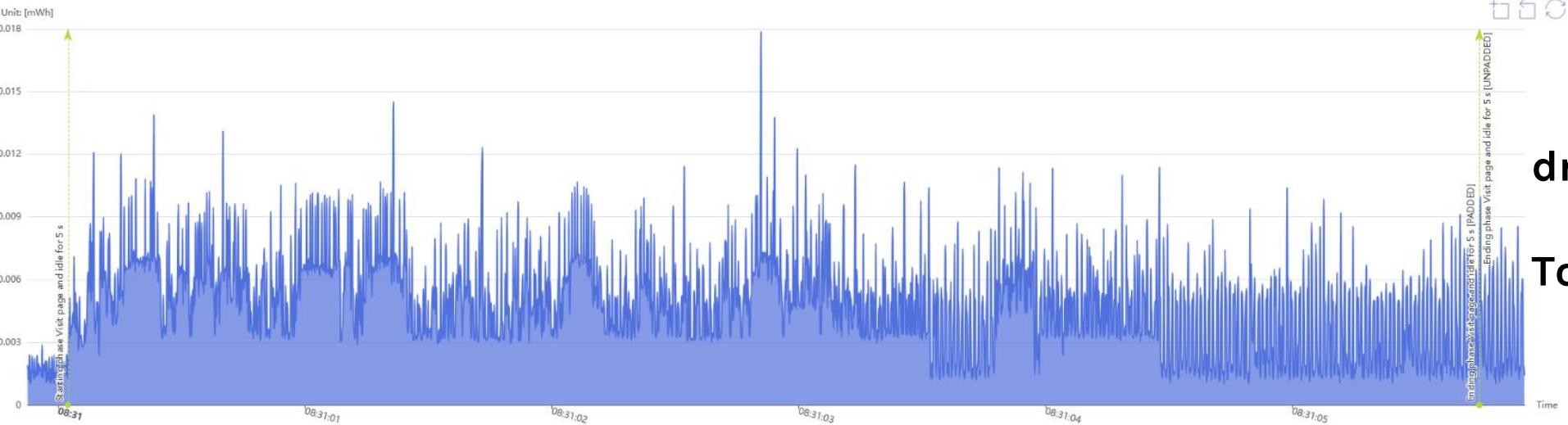
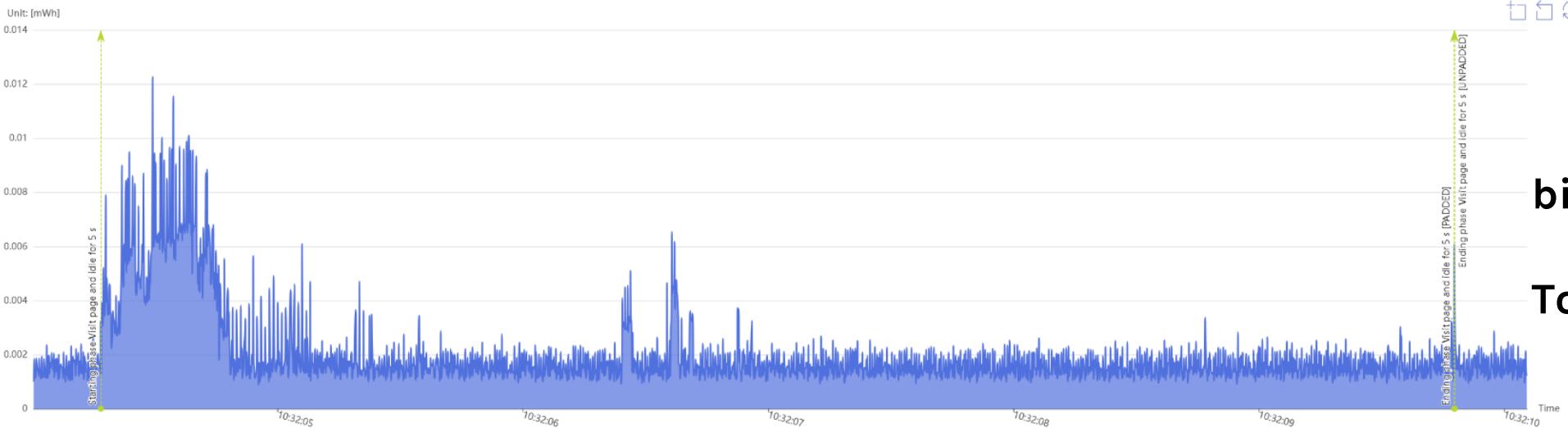
Network Data

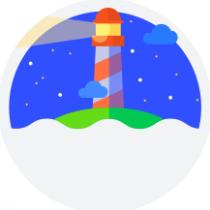
The network data transfer the website was **3177.30 kB** for loading and staying on the page for **5.72 s**

Assuming you have 10,000 visitors per month this website would produce about **14.27 kg**

<https://website-tester.green-coding.io/details.html?page=https://www.dm.de>

dm.de – Comparison Energy Consumption





📱 Mobile 💻 Desktop

35 Performance	100 Accessibility	96 Best Practices	100 SEO
--	---	---	---

Performance

Values are estimated and may vary. The [performance score](#) is calculated directly from these metrics. See calculator.

▲ 0–49 ■ 50–89 ● 90–100

METRICS

▲ First Contentful Paint 7.2 s	▲ Largest Contentful Paint 26.1 s
▲ Total Blocking Time 930 ms	● Cumulative Layout Shift 0.035
▲ Speed Index 11.3 s	

Captured at Nov 11, 2025, 11:55 AM GMT+1 Emulated Moto G Power with Lighthouse 13.0.1 Single page session
Initial page load Slow 4G throttling Using HeadlessChromium 137.0.7151.119 with lr

📱 Mobile 💻 Desktop

28 Performance	95 Accessibility	96 Best Practices	100 SEO
--	--	---	---

Performance

Values are estimated and may vary. The [performance score](#) is calculated directly from these metrics. See calculator.

▲ 0–49 ■ 50–89 ● 90–100

METRICS

● First Contentful Paint 0.7 s	▲ Largest Contentful Paint 4.7 s
▲ Total Blocking Time 740 ms	▲ Cumulative Layout Shift 0.265
▲ Speed Index 4.3 s	

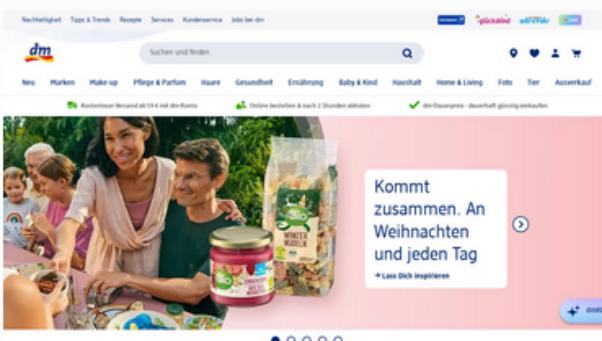
Captured at Nov 11, 2025, 11:55 AM GMT+1 Emulated Desktop with Lighthouse 13.0.1 Single page session
Initial page load Custom throttling Using HeadlessChromium 137.0.7151.119 with lr

<https://pagespeed.web.dev/analysis/https-www-dm-de/mt8gqozxeo>

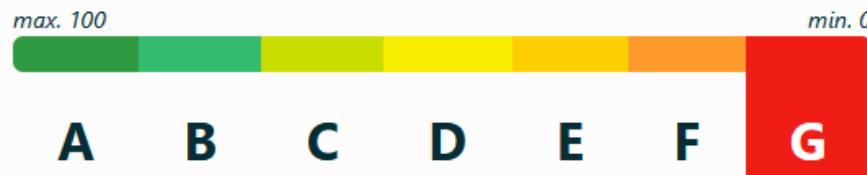


Ouch.

Score: 8 / 100



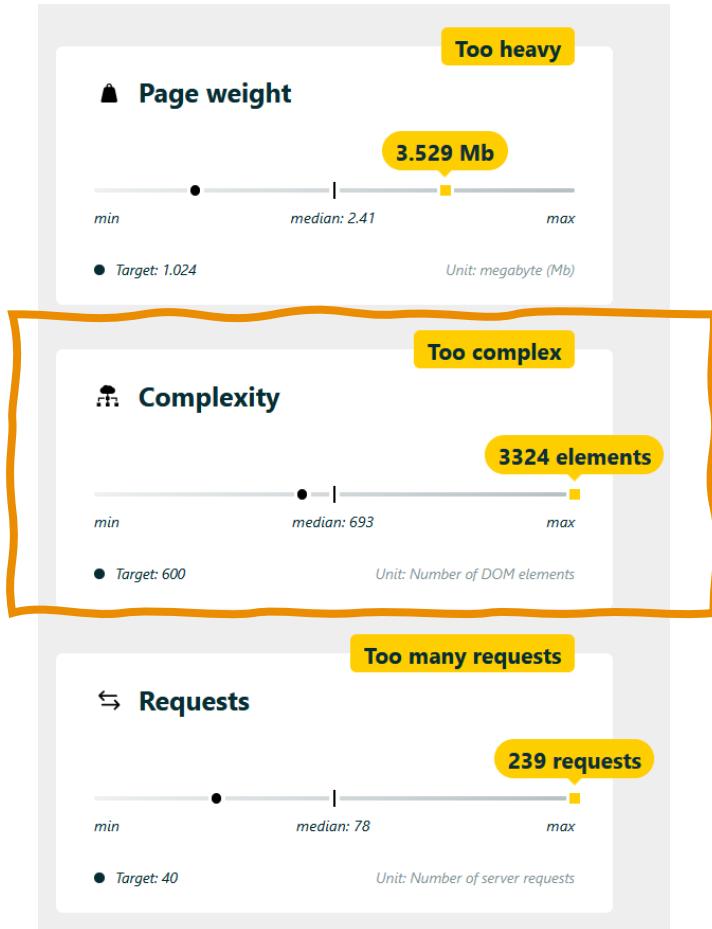
Let's not hide it: it hurts. Time to act!



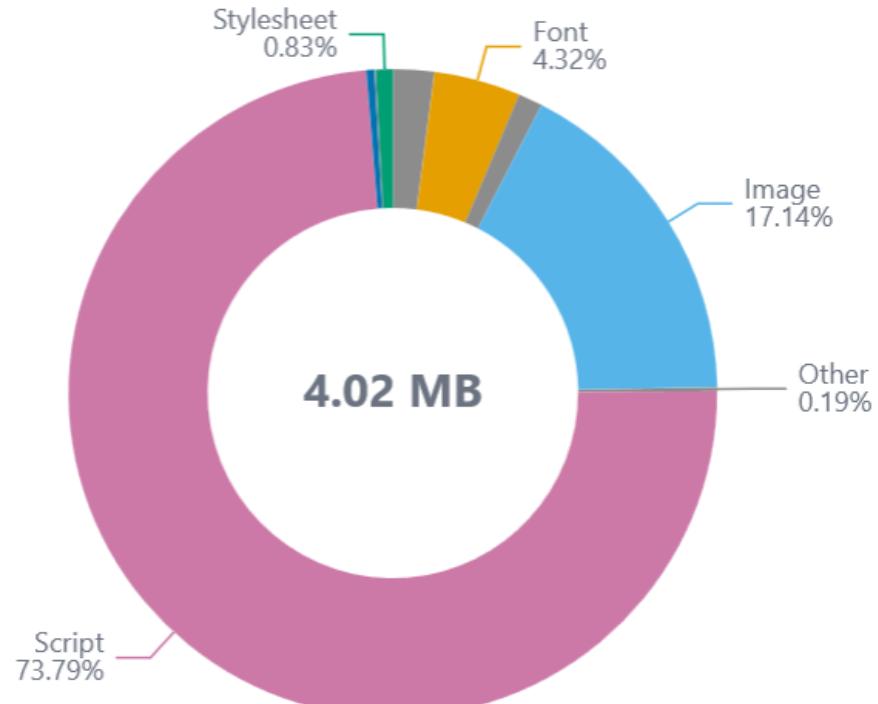
Page rank:

534083 / 546563

- Too heavy 3.529 Mb
- Too complex 3324 elements
- Too many requests 239 requests



<https://www.ecoindex.fr/en/result/?id=844ac0b4-3382-4b67-8f67-09a9e409c470>



All Resources

Resource	Size
Script	2.96 MB
Image	704.8 KB
Font	177.58 KB
XHR	84.13 KB
Fetch	49.94 KB
Stylesheet	34.1 KB
Document	16.16 KB

<https://web.cardamon.io/reports/sTVww>

- Good:
 - images are optimized! (webp, biggest image has only 80 kB)
 - no videos!
 - caching is used!
 - ...
- Bad:
 - >200 requests!
 - ~3 MB of JavaScript!
 - a lot of duplicated and unused scripts
 - login.js >300 kB transferred size

Agenda

Introduction

Methodologies & Tools

User Interactions

Good & Bad Websites

➤ Conclusion

Conclusion

- **Tools & Methodologies**
 - Understand the scope and limitations of each tool
 - Results may vary significantly between different approaches
 - Measure beyond just data transfer
 - Select the right methodology & tool for your goals
- **User Interactions**
 - The more your tests reflect actual user behavior, the more valuable your insights
- **Act on Results**
 - Leverage recommendations as a starting point
 - Transform insights into concrete actions

Questions?



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