



# Digital Sustainability

**How Can We Build Software  
With the Planet in Mind?**

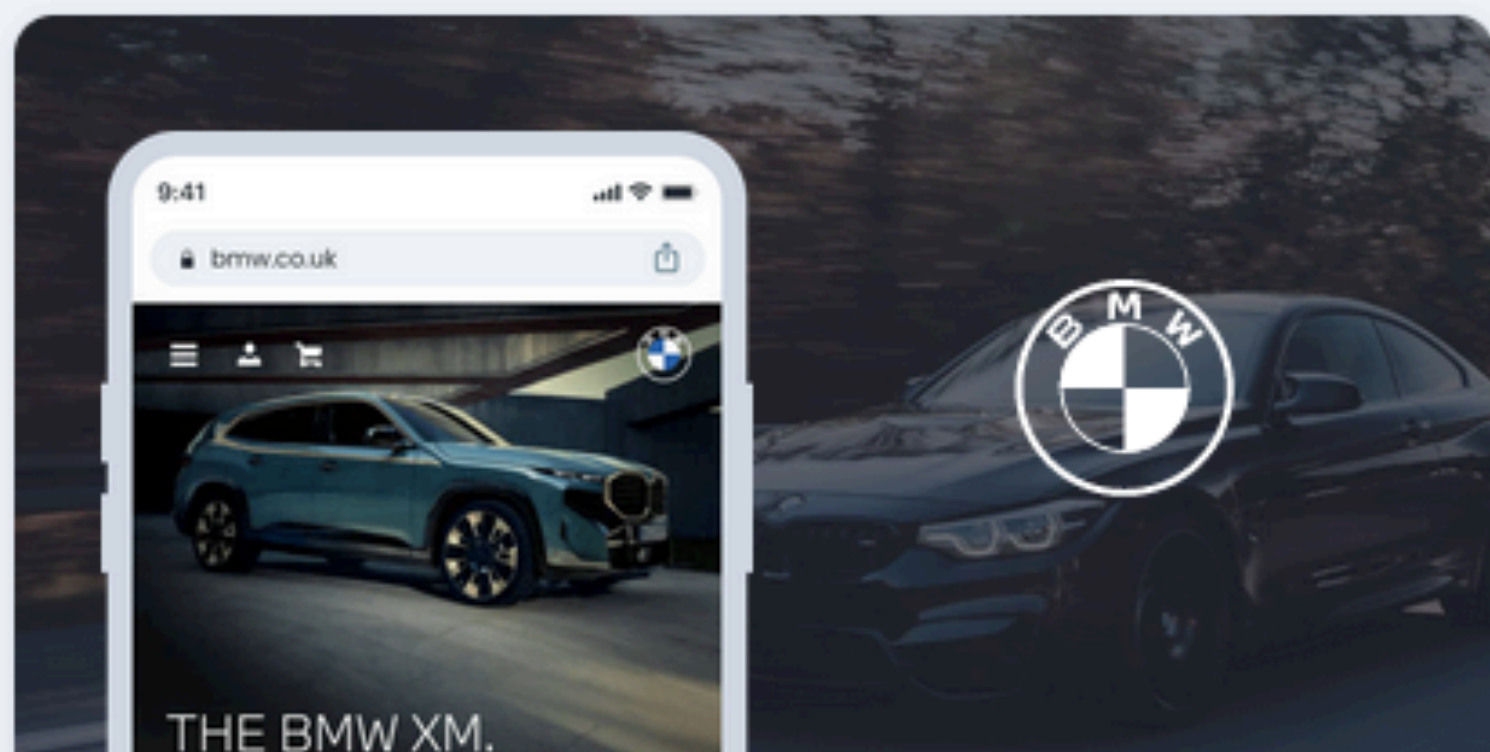


**Brian Louis Ramirez**  
Web Performance Engineer



CUSTOMER SUCCESS STORIES

# Speed Kit makes leading brands faster



„Speed Kit has been rolled out for **118 countries** and achieved a **1.5x faster LCP.**”

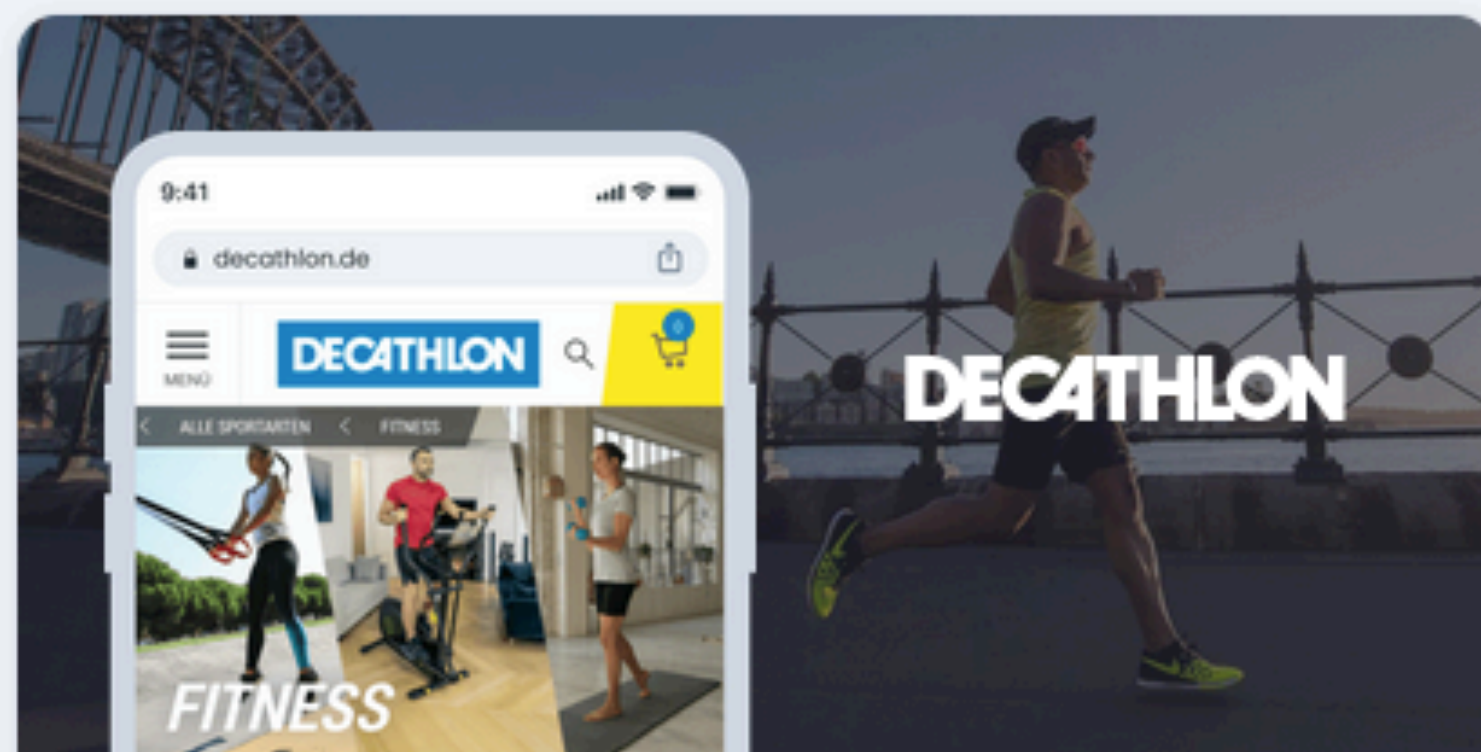
BMW (Bayerische Motoren Werke AG)

**33%**

Faster FCP

**65%**

Less Image Data



„Speed Kit accelerated our site by **2.5x** [...]. There is no doubt about the **great ROI.**”

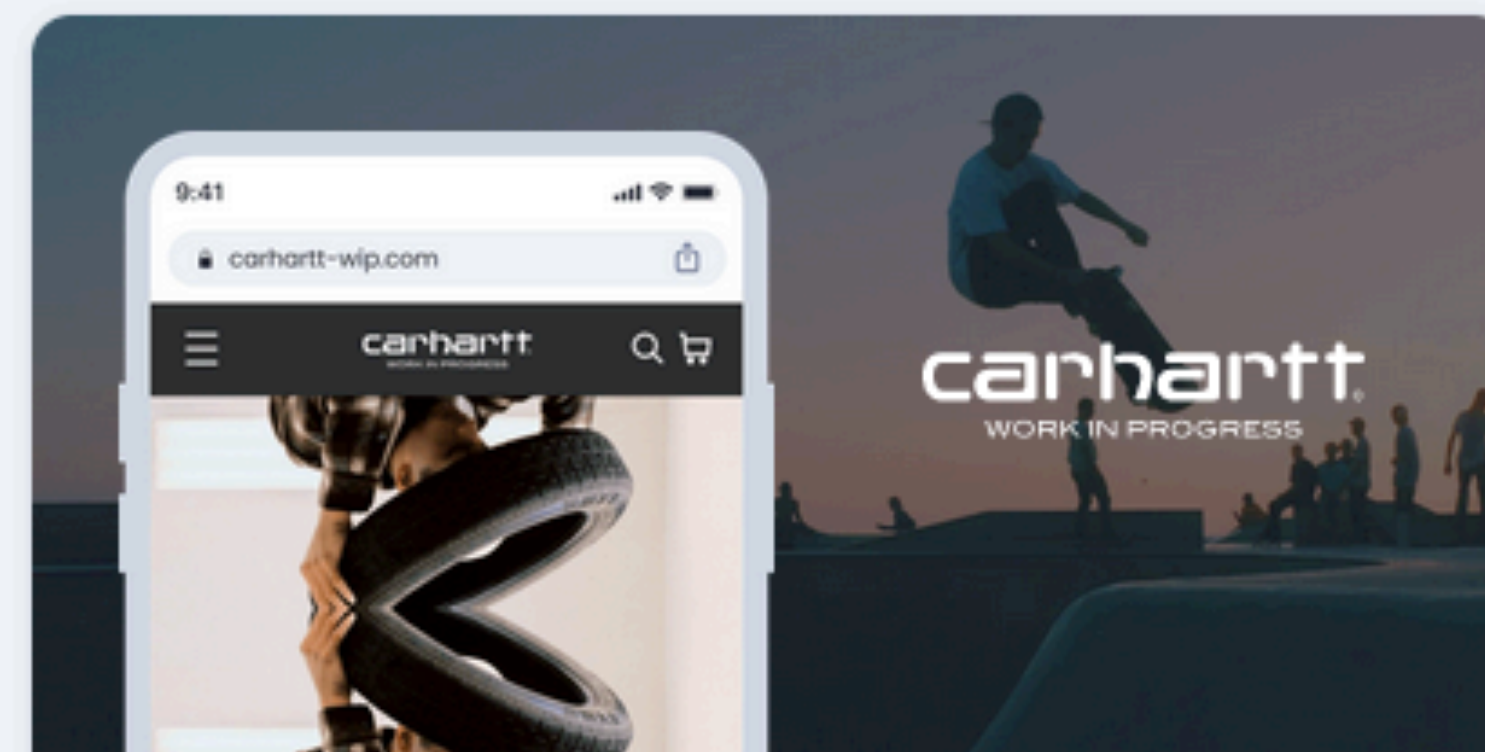
Florian Bischoff, Director E-Commerce

**2.5x**

Faster FCP

**2 Weeks**

Until ROI Achieved



„We were able to go **live within a matter of days** [...] across our three biggest markets.”

Marc Lohausen, Head of E-Commerce

**1.9x**

Faster FCP

**1 Week**

Until Go Live



**The Internet is  
the largest machine  
ever built.**

# The Internet Machine



Energy,  
Land,  
Water,  
Resources



Data Centers

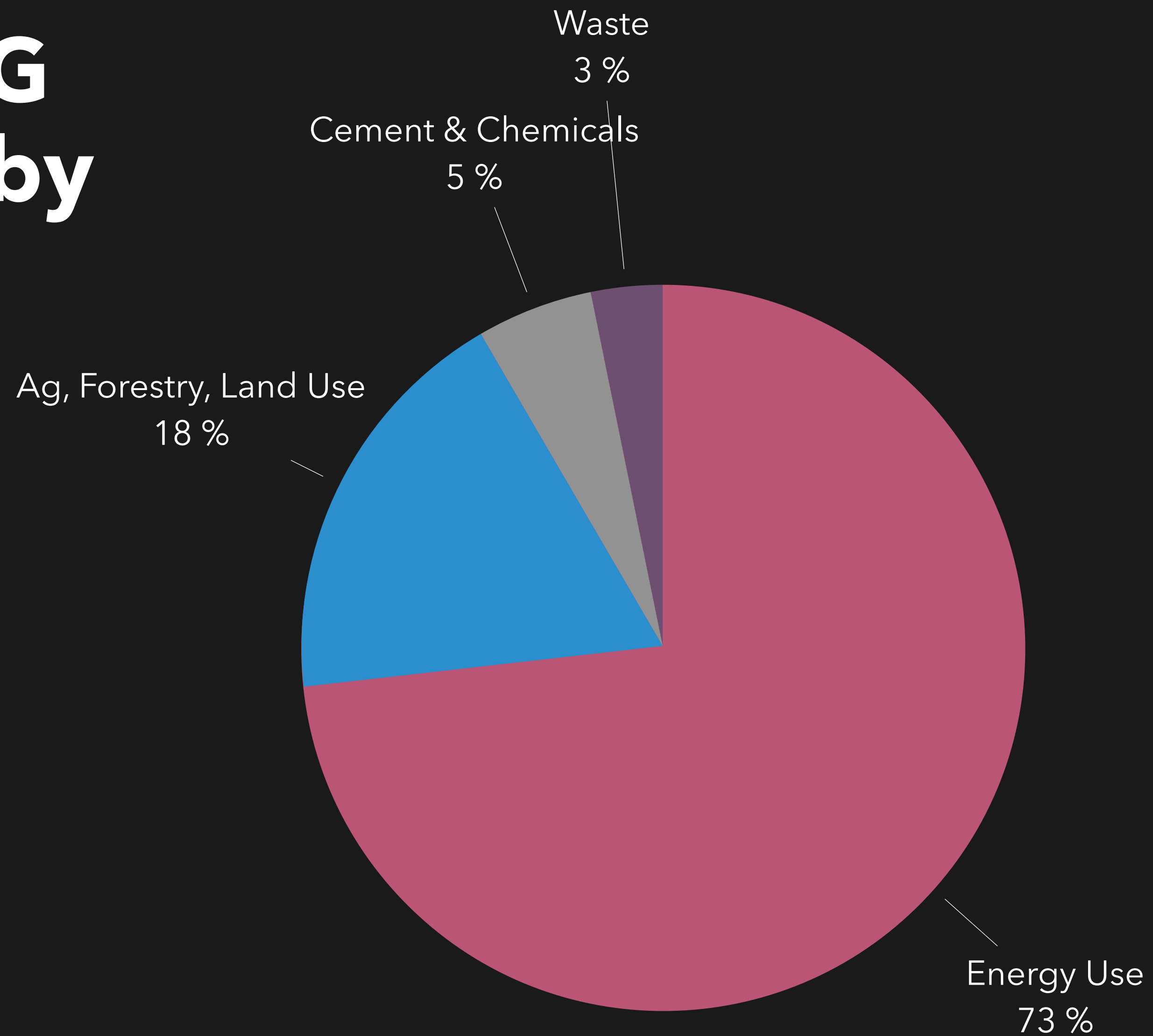


Networks

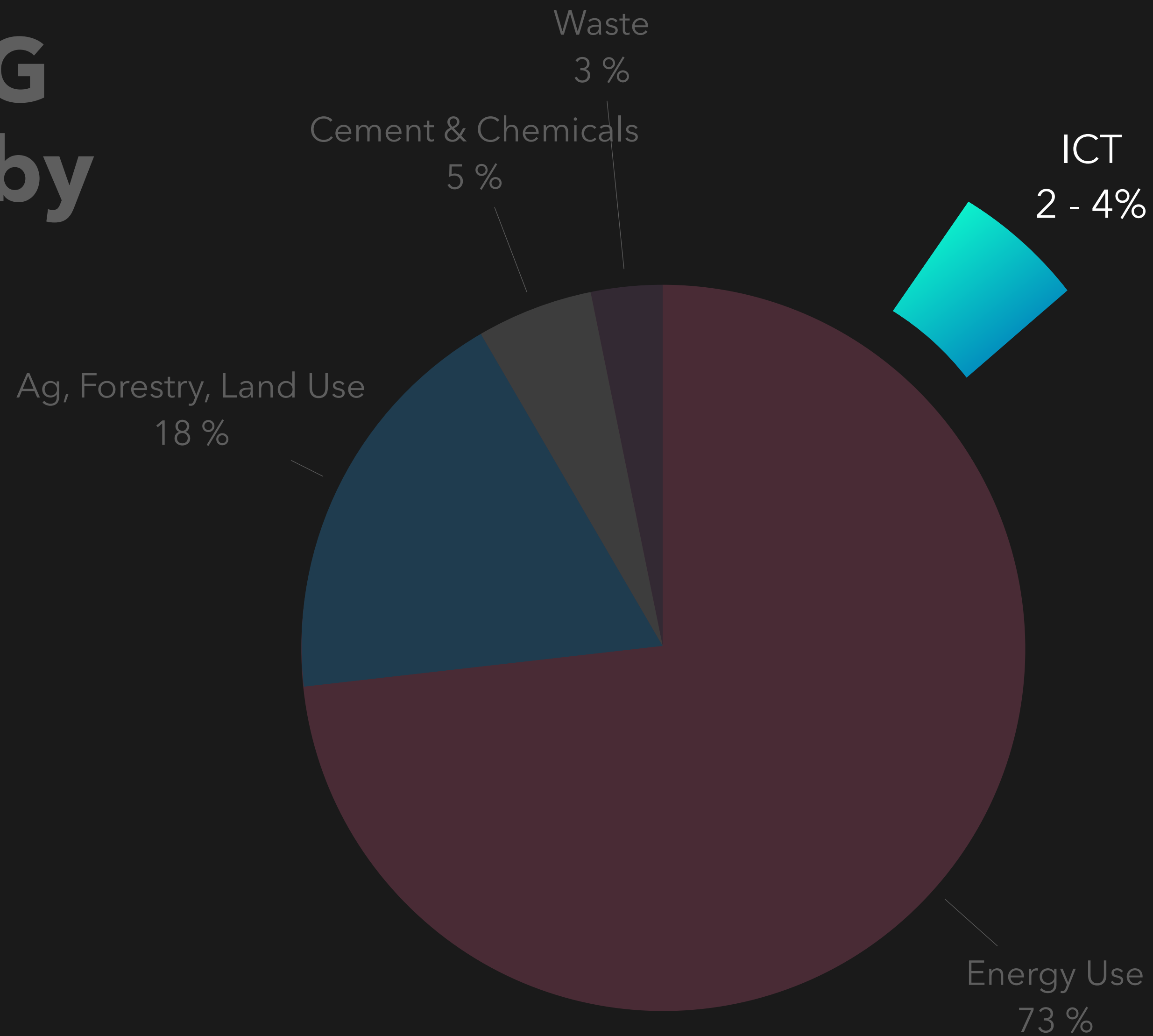


Devices

# Global GHG Emissions by Sector



# Global GHG Emissions by Sector



## Review

# The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations

Charlotte Freitag,<sup>1</sup> Mike Berners-Lee,<sup>1</sup> Kelly Widdicks,<sup>2,\*</sup> Bran Knowles,<sup>2</sup> Gordon S. Blair,<sup>2</sup> and Adrian Friday<sup>2</sup>

<sup>1</sup>Small World Consulting, Gordon Manley Building, Lancaster Environment Centre, Lancaster University, Lancaster, Lancashire LA1 4YQ, UK

<sup>2</sup>School of Computing and Communications, InfoLab21, Lancaster University, Lancaster, Lancashire LA1 4WA, UK

\*Correspondence: [k.v.widdicks@lancaster.ac.uk](mailto:k.v.widdicks@lancaster.ac.uk)

<https://doi.org/10.1016/j.patter.2021.100340>

**THE BIGGER PICTURE** To avoid catastrophic consequences from climate change, all sectors of the global economy, including *Information Communication Technology (ICT)*, must keep their greenhouse gas (GHG) emissions in line with the Paris Agreement. We examine peer-reviewed estimates of ICT's GHG emissions, which put ICT's share of global GHG emissions at 1.8%–2.8%. We find pronounced differences and much debate concerning the underlying assumptions behind the peer-reviewed studies, which could suggest that global emissions from ICT are as high as 2.1%–3.9%. All study analysts agree that ICT emissions *will not reduce* without major concerted political and industrial efforts, and we provide three reasons for anticipating that ICT emissions are actually going to *increase* without intervention. Our analysis suggests not all ICT carbon pledges are ambitious enough to meet climate targets, and that policy mechanisms for enforcing sector-wide climate target compliance are lacking. Without a global carbon constraint, sector-wide regulations are required to keep ICT's carbon footprint aligned with the Paris Agreement. With a global carbon constraint, ICT would be a greater enabler of productivity and utility, creating opportunity for the sector to be financially successful as a critical part of a global net zero society.

## SUMMARY

In this paper, we critique ICT's current and projected climate impacts. Peer-reviewed studies estimate ICT's current share of global greenhouse gas (GHG) emissions at 1.8%–2.8% of global GHG emissions; adjusting for truncation of supply chain pathways, we find that this share could actually be between 2.1% and 3.9%. For ICT's future emissions, we explore assumptions underlying analysts' projections to understand the reasons for their variability. All analysts agree that ICT emissions will not reduce without major concerted efforts involving broad political and industrial action. We provide three reasons to believe ICT emissions are going to increase barring intervention and find that not all carbon pledges in the ICT sector are ambitious enough to meet climate targets. We explore the underdevelopment of policy mechanisms for enforcing sector-wide compliance, and contend that, without a global carbon constraint, a new regulatory framework is required to keep the ICT sector's footprint aligned with the Paris Agreement.

## INTRODUCTION

The Information and Communication Technology (ICT) sector has seen massive and accelerating growth in the last 30 years

use of operational emissions (from energy use and maintenance) and end-of-life emissions (disposal). Yet estimates of ICT's footprint and whether it is in fact growing in impact, or held stable or even reducing by efficiency gains and Moore's Law, is uncertain



## Review

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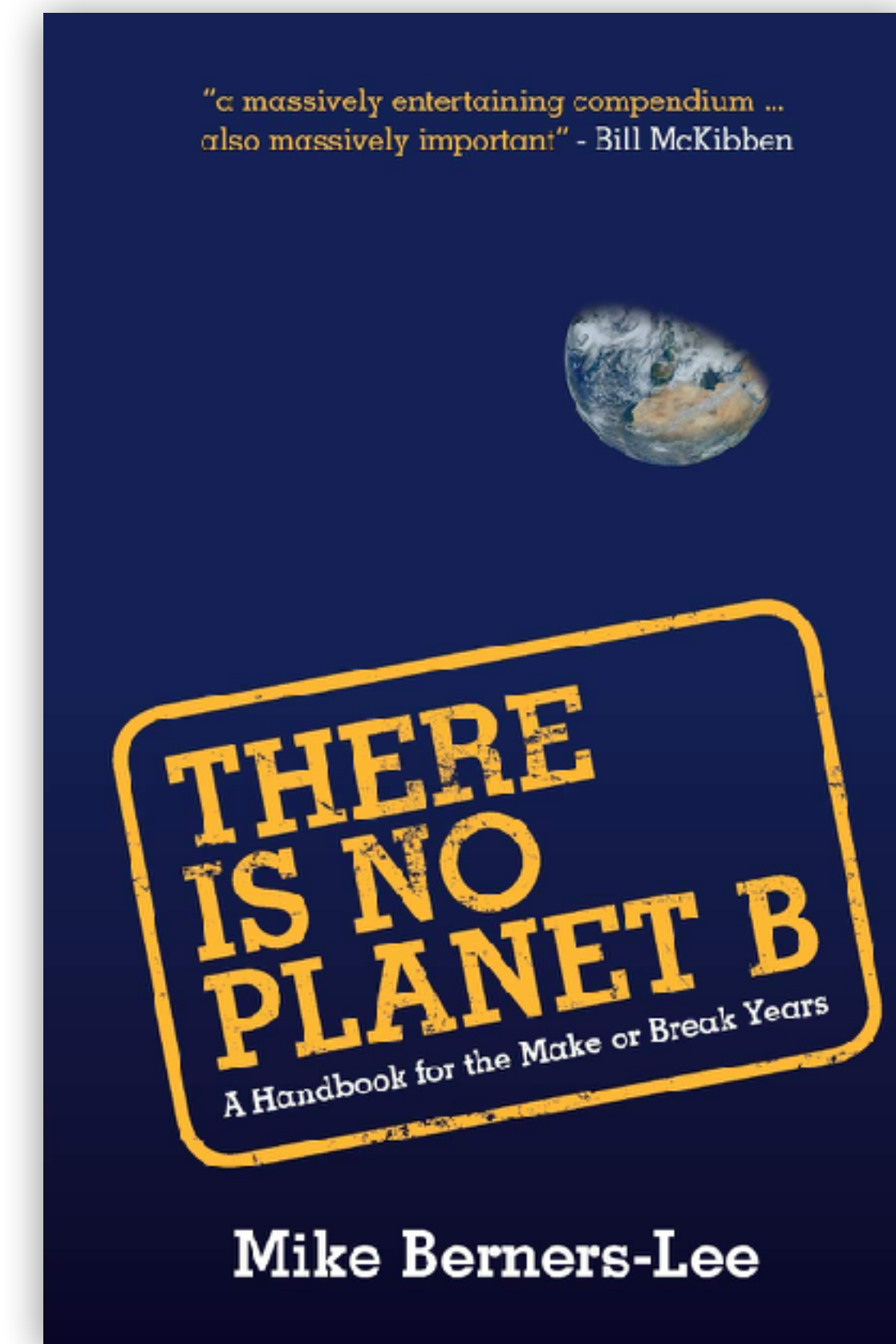
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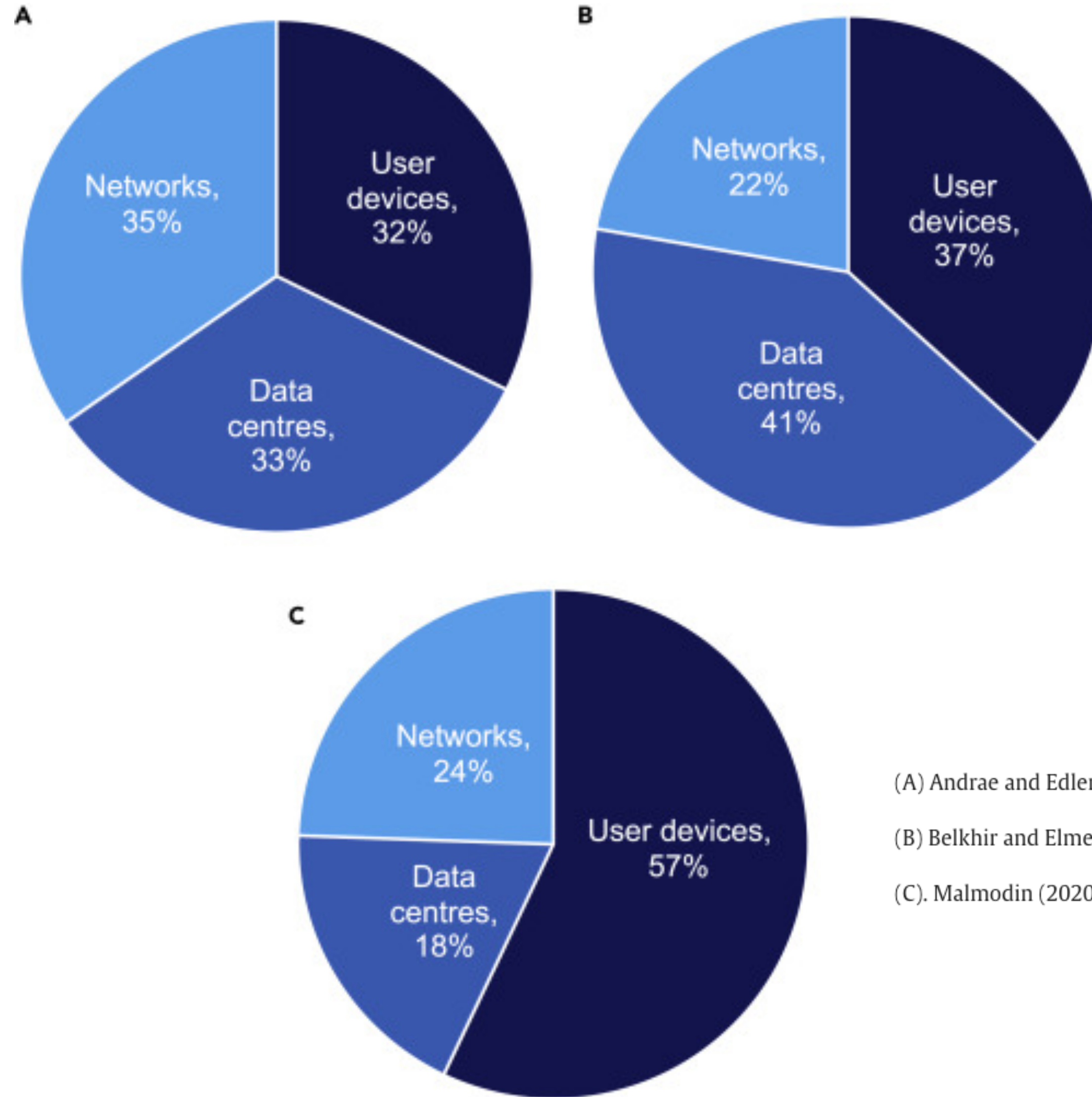
Source: “The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations” (2021) by Charlotte Freitag, Mike Berners-Lee, et al.

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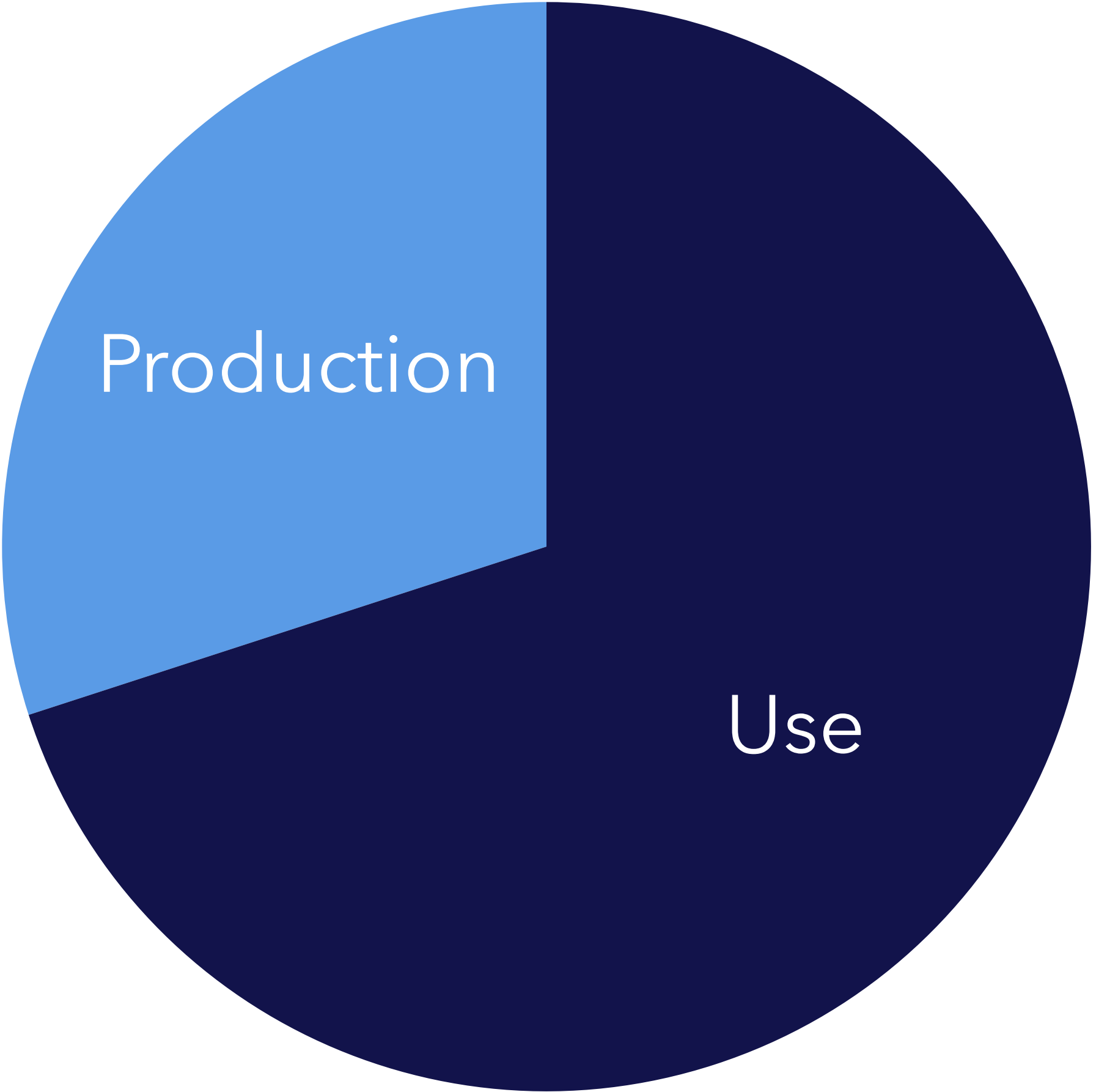
use of operational emissions (from energy use and maintenance) and end-of-life emissions (disposal). Yet estimates of ICT's footprint and whether it is in fact growing in impact, or held stable or even reducing by efficiency gains and Moore's Law, is very much

# Estimates of ICT GHG emissions in 2020



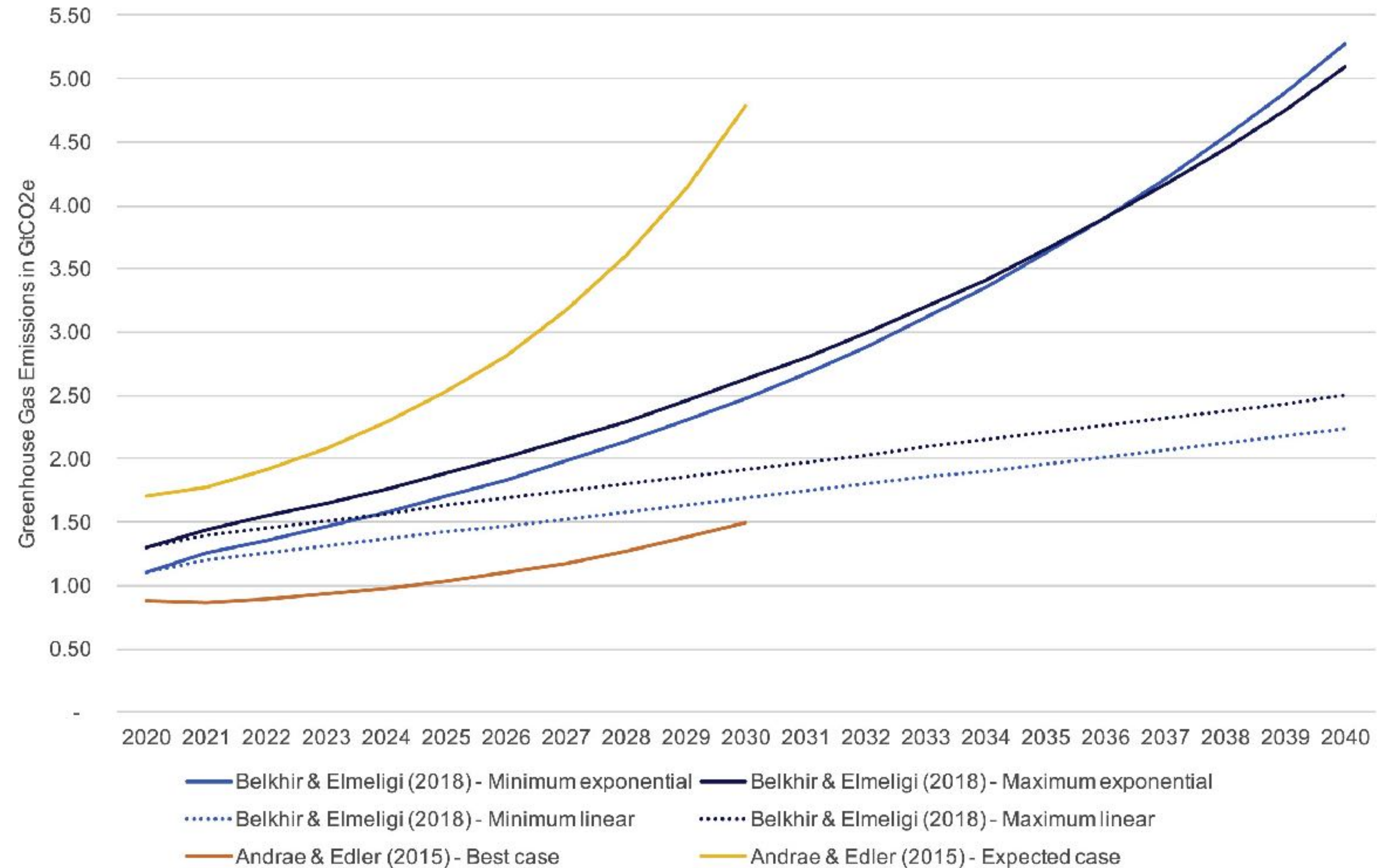
(A) Andrae and Edler (2015): 2020 best case (total of 623 MtCO<sub>2</sub>e).  
(B) Belkhir and Elmeligi (2018): 2020 average (total of 1,207 MtCO<sub>2</sub>e).  
(C). Malmodin (2020): 2020 estimate (total of 690 MtCO<sub>2</sub>e).

**Around 70%  
of ICT's  
footprint is  
due to use**



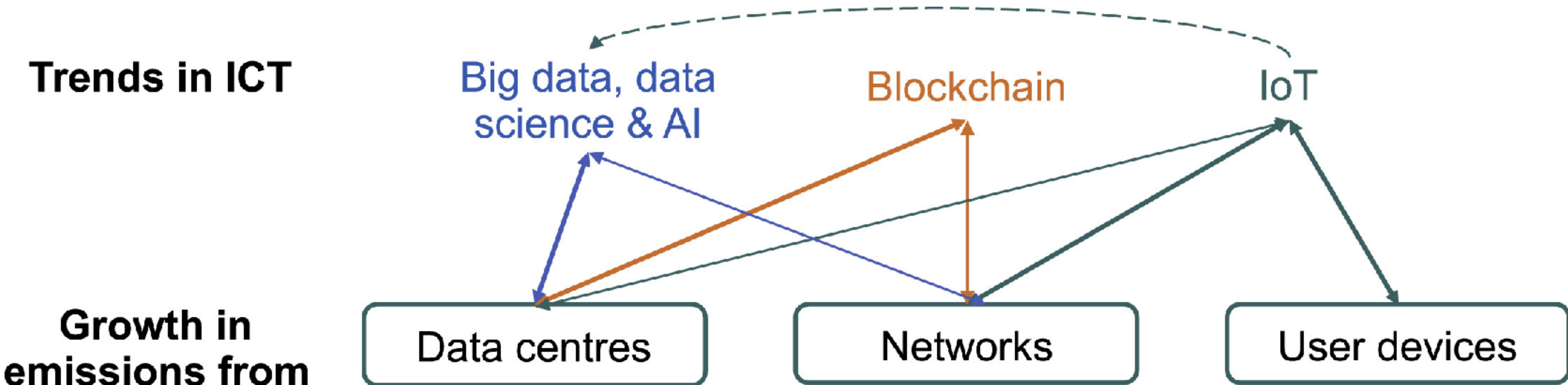
Source: [“The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations”](#) (2021) by Charlotte Freitag, Mike Berners-Lee, et al.

# Projected GHG emissions from ICT



Source: [“The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations”](#) (2021) by Charlotte Freitag, Mike Berners-Lee, et al.

# Trends in ICT



Source: [“The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations”](#) (2021) by Charlotte Freitag, Mike Berners-Lee, et al.

[HOME](#) > [TECH](#)

# Data centers are sprouting up as a result of the AI boom, minting fortunes, sucking up energy, and changing rural America

Daniel Geiger, Ellen Thomas, and Alistair Barr Oct 13, 2023, 6:15 PM CEST



Getty Images

■ The AI boom has triggered a surge in spending on data centers.

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## Data centers are sprouting up as a result of the AI boom, minting fortunes, sucking up energy, and changing rural America

Daniel Geiger, Ellen Thomas, and Alistair Barr Oct 13, 2023, 6:15 PM CEST

- **The AI boom has triggered a surge in spending on data centers.**
- **These data centers require billions of dollars of investment and huge amounts of energy.**



Getty Images

■ **The AI boom has triggered a surge in spending on data centers.**

**80% of all digital data  
is never accessed  
or used again  
after it is stored.**

Gerry McGovern, *World Wide Waste*







**In 2020, there were  
14 billion mobile devices worldwide**



**By 2025, there could be  
18.2 billion mobile devices worldwide**

The image features a series of high-voltage power lines and towers stretching across the frame. The scene is set against a vibrant, monochromatic red background, suggesting a sunset or sunrise. A bright, glowing sun is positioned in the center of the image, partially obscured by the power lines. The overall composition is a silhouette of the power grid against the bright sky.

**The more we consume,  
the more resources use.**

A photograph of a server room with several open server racks. The racks are filled with dense, colorful cables (orange, blue, green) and numerous glowing green lights, likely from network ports or server components. The racks are dark, and the overall scene is dimly lit, emphasizing the vibrant colors of the hardware.

**Digital is physical.**

**Digital is social.**

AMAZON

RESPECT  
WORKERS!

RESPECT  
COMMUNITIES!

NEW YORK  
CHANGE

ALIGN

LOCAL

A young boy is sitting on a large pile of rocks and debris. He is wearing a light-colored, long-sleeved shirt and dark pants. He is looking down at his hands, which are resting on the rocks. The background is a vast expanse of similar rocks and debris, suggesting a construction site or a place of significant destruction. The overall tone is somber and reflective.

**Digital is human.**

**ICT is part of  
the climate problem**

# Our targets

## Global greenhouse gas emissions and warming scenarios

Our World  
in Data

Each pathway comes with uncertainty, marked by the shading from low to high emissions under each scenario.  
- Warming refers to the expected global temperature rise by 2100, relative to pre-industrial temperatures.

Annual global greenhouse gas emissions  
in gigatonnes of carbon dioxide-equivalents

150 Gt

100 Gt

50 Gt

Greenhouse gas emissions  
up to the present

0

1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100

**No climate policies**

4.1 – 4.8 °C

→ expected emissions in a baseline scenario if countries had not implemented climate reduction policies.

**Current policies**

2.5 – 2.9 °C

→ emissions with current climate policies in place result in warming of 2.5 to 2.9°C by 2100.

**Pledges & targets (2.1 °C)**

→ emissions if all countries delivered on reduction pledges result in warming of 2.1°C by 2100.

**2°C pathways**

**1.5°C pathways**

Data source: Climate Action Tracker (based on national policies and pledges as of November 2021).  
OurWorldinData.org – Research and data to make progress against the world's largest problems.

Last updated: April 2022.  
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# Business as usual?

**...but ICT can be part of  
climate solutions**

hello

iea.org

About News Events Programmes Help centre

iea Search everything

Energy system Topics Countries Data Reports

Energy system / Decarbonisation Enablers / Digitalisation

# Digitalisation

Overview Tracking

### Why is it important?

In electricity systems, digital technologies can help integrate increasing shares of variable renewables and improve the reliability of grids, while for end-users they can improve energy and material efficiency and reduce emissions. Moreover, digital services like videoconferencing offer low-carbon alternatives to travel while also...

### What is the role in clean energy transitions?

Integrating large quantities of variable solar and wind generation, whose peak output may not match moments of peak demand, requires more sophisticated management of electrical grids. Digital technologies and data hold tremendous potential to forecast and...

### Where do we need to go?

Advances in digital technologies and services, declining costs and ubiquitous connectivity have accelerated the digital transformation of energy in recent years, particularly in electricity networks. However, much of the progress so far is limited to developed countries and further efforts by policy makers and industry are necessary to...

The image is a screenshot of the International Energy Agency (IEA) website. The browser's address bar shows 'iea.org'. The website's navigation menu includes 'About', 'News', 'Events', 'Programmes', and 'Help centre'. Below the navigation is a search bar with the text 'Search everything' and a magnifying glass icon. To the right of the search bar are dropdown menus for 'Energy system', 'Topics', 'Countries', 'Data', and 'Reports', along with a user profile icon. The main content area features a large heading 'Digitalisation' in a light blue font. Below the heading, there is a large text block in black font that reads: 'Digital technologies and data hold tremendous potential to forecast and match electrical supply and demand, thereby **cutting costs, improving efficiency and resilience, and reducing emissions.**' To the left of this text is a vertical teal bar. Below the main text are three columns of text, each with a heading: 'Why is it important?', 'What is the role in clean energy transitions?', and 'Where do we need to go?'. The first column discusses the importance of digital technologies in electricity systems. The second column discusses the role of digital technologies in clean energy transitions. The third column discusses the need for digital technologies in electricity networks.

# IEA Recommendations

The screenshot shows the IEA website with a grid of recommendations. A red hand-drawn box highlights the following four recommendations:

- Policy makers**  
**Develop innovative and forward-looking policy frameworks**
- Policy makers**  
**Ensure robust data management systems and ensure data access**
- Policy makers**  
**Setting the rules for data governance**
- Private sector**  
**Measure, report and reduce the energy and environmental impacts of digitalisation**
- Private sector**  
**Prioritise open source and interoperability**
- Private sector**  
**Enhance digital resilience across the energy value chain**

Other visible recommendations include:

- Policy makers**  
**Prioritise capacity building in digitalisation and energy, and create opportunities for sharing and learning**
- Policy makers**  
**Promote interoperability and the use of international standards**
- Policy makers**  
**Support research, innovation, development and deployment, and digitally enabled business models**

The background of the screenshot shows a page titled "Digitalisation" under the "Energy system / Decarbonisation" category. The navigation menu includes "About", "News", "Events", "Programmes", and "Help centre". The IEA logo and a search bar are also visible.

The image shows a browser window displaying a McKinsey Digital article. The browser's address bar shows the URL: <https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/playing-offense-with-green-tech>. The page features the McKinsey Digital logo on the left and navigation links for 'Digital', 'How We Help Clients', 'Our Insights', 'Our People', and 'Contact Us' in the center. On the right, there are links for 'Sign In' and 'Subscribe', along with a search icon. The main content area has a background image of a green plant growing from a microchip on a circuit board. The article title, 'Playing offense with green tech to achieve net-zero emissions', is prominently displayed in white text. Below the title, it indicates the date 'December 8, 2022' and the type 'Article'. At the bottom of the page, there are icons for 'Share', 'Print', 'Download', and 'Save'.

Using green tech to fight climat

https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/playing-offense-with-green-tech

McKinsey Digital

Digital  
How We Help Clients [Our Insights](#) Our People Contact Us

Sign In | [Subscribe](#)

# Playing offense with green tech to achieve net-zero emissions

December 8, 2022 | Article

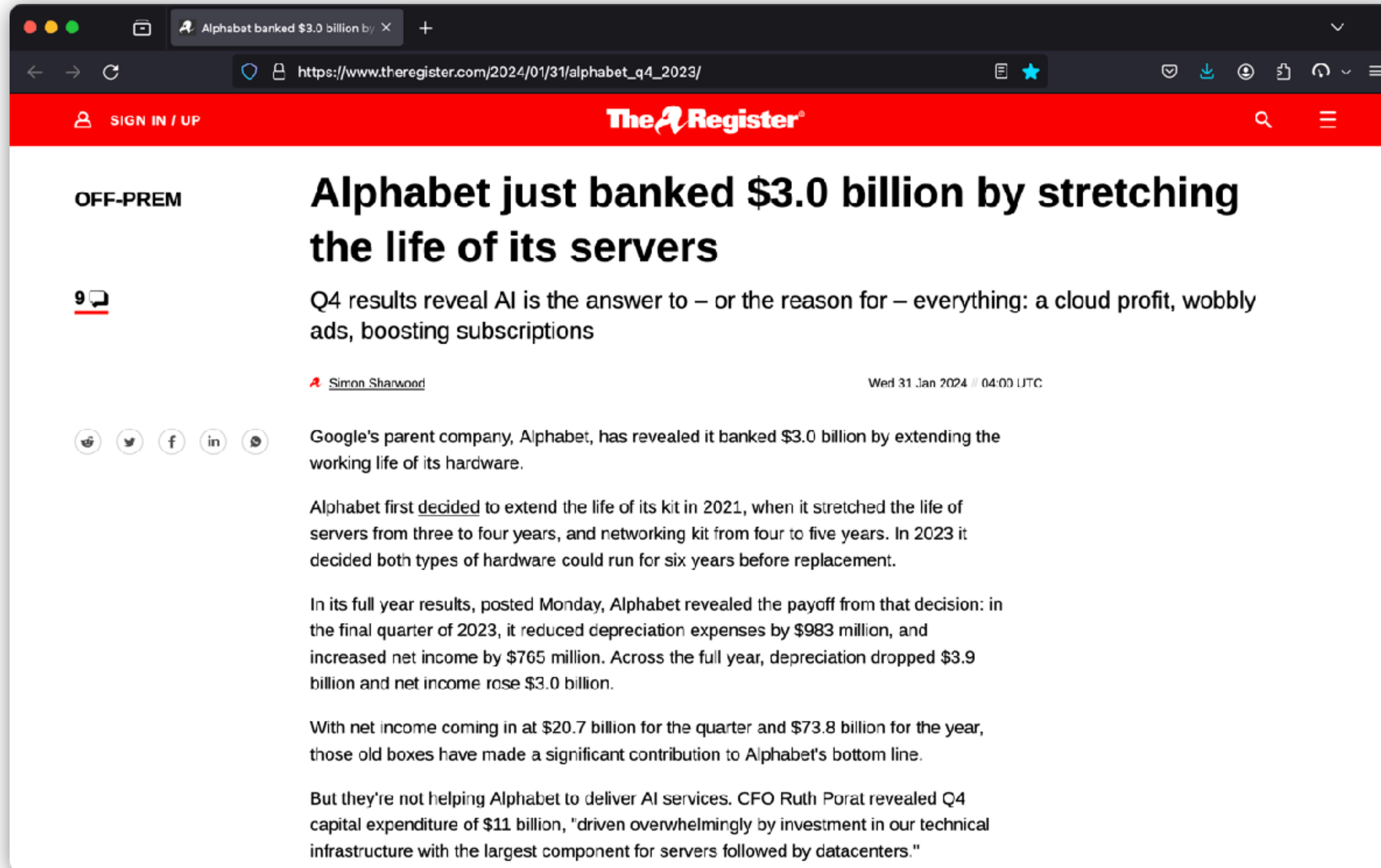
Share Print Download Save

Source: "[Playing offense with green tech to achieve net-zero emissions](#)" (Dec. 8, 2022) by McKinsey Digital

The image shows a screenshot of a web browser displaying a McKinsey Digital article. The browser's address bar shows the URL: <https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/playing-offense-with-green-tech>. The page header includes the McKinsey Digital logo, navigation links for 'Digital', 'How We Help Clients', 'Our Insights', 'Our People', and 'Contact Us', and a search icon. The article title is 'Playing offense with green tech to achieve net-zero emissions', dated December 8, 2022. The main content is a list of four bullet points. At the bottom of the article, there are icons for 'Share', 'Print', 'Download', and 'Save'.

- Technology and analytics are key to achieving net-zero emissions and meeting ambitious carbon reduction goals.
- Companies can use technology to identify emission hot spots and prioritize investments for maximum impact.
- IT can also help companies develop a green prioritization matrix to assess and prioritize decarbonization efforts based on their green impact, business impact, and feasibility.
- By focusing on carbon transparency, decarbonization solutions at scale, and using a green prioritization matrix, companies can achieve green impact without sacrificing profit.

# Extending server life saves money



The screenshot shows a web browser window with a dark theme. The address bar displays the URL [https://www.theregister.com/2024/01/31/alphabet\\_q4\\_2023/](https://www.theregister.com/2024/01/31/alphabet_q4_2023/). The page header is red with the 'The Register' logo and navigation icons. The article title is 'Alphabet just banked \$3.0 billion by stretching the life of its servers'. The author is Simon Sharwood, and the date is Wednesday, 31 Jan 2024, 04:00 UTC. The article text discusses how Alphabet saved \$3.0 billion by extending server life from 3 to 6 years.

Alphabet just banked \$3.0 billion by stretching the life of its servers

Q4 results reveal AI is the answer to – or the reason for – everything: a cloud profit, wobbly ads, boosting subscriptions

Simon Sharwood Wed 31 Jan 2024 04:00 UTC

Google's parent company, Alphabet, has revealed it banked \$3.0 billion by extending the working life of its hardware.

Alphabet first decided to extend the life of its kit in 2021, when it stretched the life of servers from three to four years, and networking kit from four to five years. In 2023 it decided both types of hardware could run for six years before replacement.

In its full year results, posted Monday, Alphabet revealed the payoff from that decision: in the final quarter of 2023, it reduced depreciation expenses by \$983 million, and increased net income by \$765 million. Across the full year, depreciation dropped \$3.9 billion and net income rose \$3.0 billion.

With net income coming in at \$20.7 billion for the quarter and \$73.8 billion for the year, those old boxes have made a significant contribution to Alphabet's bottom line.

But they're not helping Alphabet to deliver AI services. CFO Ruth Porat revealed Q4 capital expenditure of \$11 billion, "driven overwhelmingly by investment in our technical infrastructure with the largest component for servers followed by datacenters."

Source: "[Alphabet just banked \\$3.0 billion by stretching the life of its servers](https://www.theregister.com/2024/01/31/alphabet_q4_2023/)" by Simon Sharwood on *The Register*, Jan. 31, 2024



**Software can enable  
decarbonization,**

**but it needs to do so sustainably.**

**What can we do to make the  
Web more sustainable?**

W3C Community Group  
Draft Report

# Web Sustainability Guidelines (WSG) 1.0

## Draft Community Group Report 10 October 2023

**Latest published version:**  
<https://w3c.github.io/sustyweb/>

**Latest editor's draft:**  
<https://w3c.github.io/sustyweb/>

**Editors:**  
[Alexander Dawson](#)  
[Tim Frick](#) (Mightybytes)

**Feedback:**  
[GitHub w3c/sustyweb](#) (pull requests, new issue, open issues)

**Implementation:**  
[Sustainable Web Design](#)

**Supplements:**  
[At A Glance](#)  
[Quick Reference](#)

Copyright © 2023 the Contributors to the Web Sustainability Guidelines (WSG) 1.0 Specification, published by the [Sustainable Web Design Community Group](#) under the [W3C Community Contributor License Agreement \(CLA\)](#). A human-readable [summary](#) is available.

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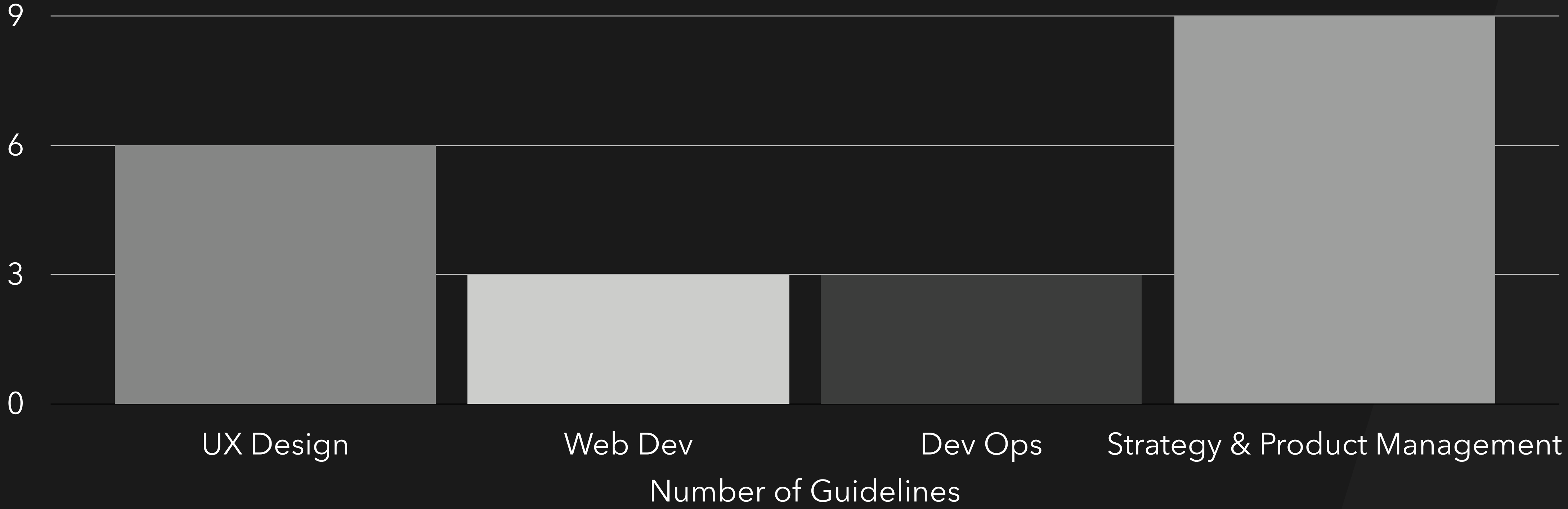
### Abstract

Web Sustainability Guidelines (WSG) 1.0 covers a wide range of recommendations for making websites and products more sustainable. Following these guidelines which utilize environment, social, and governance (ESG) principles throughout the decision-making processes, you can minimize your environmental impact through a mixture of user-centered design, performant web development, renewable infrastructure, sustainable business strategy, and (with metrics) various combinations of those mentioned. It should be noted that these guidelines will not address every possible mechanism or strategy to become sustainable, as such, these guidelines (which are notably Web orientated and focused) should be seen as a starting point in a sustainability journey (coverage does not extend for example to manufacturing or shipping of physical products). Following these guidelines will often make Web content more accessible, usable, and performant as a by-product.

UNOFFICIAL

# Web sustainability guidelines

High Impact, Low-/Medium Effort



Source: [“Web Sustainability Guidelines: Getting Started”](#) by Brian Louis Ramirez, based on Web Sustainability Guidelines, v1, 2023

# Web sustainability guidelines

High Impact, Low- or Medium-Effort

## **BUSINESS STRATEGY & PRODUCT MANAGEMENT**

Establish if a Digital Product or Service Is Necessary

Follow a Product Management and Maintenance Strategy

Implement Sustainability Onboarding Guidelines

Create One or More Impact Business Models

Share Economic Benefits

Promote Responsible Data Practices

Promote Responsible Emerging Technology Practices

Include Organizational Philanthropy Policies

Include E-Waste, Right-To-Repair, and Recycling Policies

## **UX**

Take a More Sustainable Approach to Image Assets

Avoid Unnecessary or an Overabundance of Assets

Avoid Manipulative Patterns

Take a More Sustainable Approach to Media Assets

Create a Stakeholder-Focused Testing & Prototyping Policy

Incorporate Compatibility Testing Into Each Release-Cycle

## **WEB DEV**

Ensure Your Solutions Are Accessible

Rigorously Assess Third-Party Services

Use Beneficial JavaScript and Its API's

## **DEV OPS**

Compress Your Files

Choose a Sustainable Hosting Provider

Automate To Fit the Needs

# Web sustainability guidelines

## High Impact, Low- or Medium-Effort

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### **DEV OPS**

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Choose a Sustainable Hosting Provider

Automate To Fit the Needs

# The biggest problems

Too much energy

Too many devices

# The biggest problems

## Too much energy

Build what's needed,  
delete what's not

Use green hosts  
& cloud

Minify, compress,  
cache

Use green defaults

## Too many devices



# Default effect

The tendency to favor the default option when given a choice between several options.

**Ask:**

Are the defaults set to  
maximize efficiency and  
minimize consumption?

### **Do you want to accept cookies?**

We use cookies for website analytics, retargeting, ad tracking and to personalize your experience.

**OK**

More Options

***DON'T***

**Do you want to share your analytics data?**

With your permission, we collect anonymous usage data to improve this website. [More information.](#)

Yes

No

## Low Power Mode

Mail fetch, background app refresh, automatic downloads and some visual effects are reduced or disabled in Low Power Mode.

Cancel

Continue

## High Power Mode

Mail fetch, background app refresh, automatic downloads and some visual effects are increased or enabled in High Power Mode.

Cancel

Continue

# The biggest problems

## Too much energy

Build what's needed,  
delete what's not

Use green hosts  
& cloud

Minify, compress,  
cache

Use green defaults

Lazy-load, use façades


## Too many devices

Google Chrome Canary File Edit View History Bookmarks Profiles Tab Window Help US Wed 6. Dec 17:19

Scroll-Snap

localhost:8080/scroll-snap/



# Scroll-Snap Demo



Elements Console Sources Network Performance Memory Application Security Lighthouse Recorder >> ⚙️

Filter  Invert  Hide data URLs  Hide extension URLs

All Fetch/XHR Doc CSS JS Font **Img** Media Manifest WS Wasm Other  Blocked response cookies  Blocked requests  3rd-party requests

Name	Status	Type	Initiator	Size	Time	Waterfall
1.jpg	200	jpeg	scroll-snap/:24	14.0 kB	3 ms	
2.jpg	200	jpeg	scroll-snap/:48	32.0 kB	3 ms	

2 / 8 requests 46.0 kB / 59.4 kB transferred 45.7 kB / 58.2 kB resources Finish: 30 ms DOMContentLoaded: 24 ms Load: 24 ms

DO



they don't shove megabytes worth of product images onto customers' devices like other shops usually do. Instead they apply the "pull principle" very effectively – and very in-line with an ethical brand – by only showing simple SVG silhouettes by default. If the grid is currently green enough, the user can decide to click on a silhouette to load a real product image, like so:



Click on the placeholder image (1.1 KB) to load the real image (23 - 65 KB, depending on browser)

The next best way to minimize image data is by not loading images until the user scrolls to then (i.e. lazy loading). For performance reasons however, any above the fold images

Network Performance Console Sources Memory

Filter:  Invert  Hide data URLs

All | Fetch/XHR | JS | CSS | **Img** | Media | Font | Doc | WS | Wasm | Manifest | Other  Has blocked cookies  Blocked Requests  3rd-party requests

50 ms 100 ms 150 ms 200 ms 250 ms 300 ms 350 ms 400 ms 450 ms 500 ms

Name	Status	Type	Initiator	Size	Time	Priority	Waterfall
green-by-default-auto... /img	200	svg+x...	(index) Parser	1.5 kB 3.9 kB	23 ms 22 ms	Low	
green-by-default-auto... /img	200	svg+x...	(index) Parser	1.5 kB 5.1 kB	26 ms 25 ms	Low	
green-by-default-place... /img	200	svg+x...	(index) Parser	1.3 kB 2.3 kB	24 ms 18 ms	Low	
green-by-default-cooki... /img	200	svg+x...	(index) Parser	485 B 1.1 kB	27 ms 25 ms	Low	

4 / 11 requests | 4.8 kB / 21.8 kB transferred | 12.4 kB / 54.6 kB resources | Finish: 414 ms | DOMContentLoaded: 212 ms | Load

# The biggest problems

## Too much energy

Build what's needed,  
delete what's not

Use green hosts  
& cloud

Minify, compress,  
cache

Use green defaults

Lazy-load, use façades

Optimize images,  
media

Optimize perf

Performance budgets

Carbon-aware coding

## Too many devices

HTML standards  
> JS

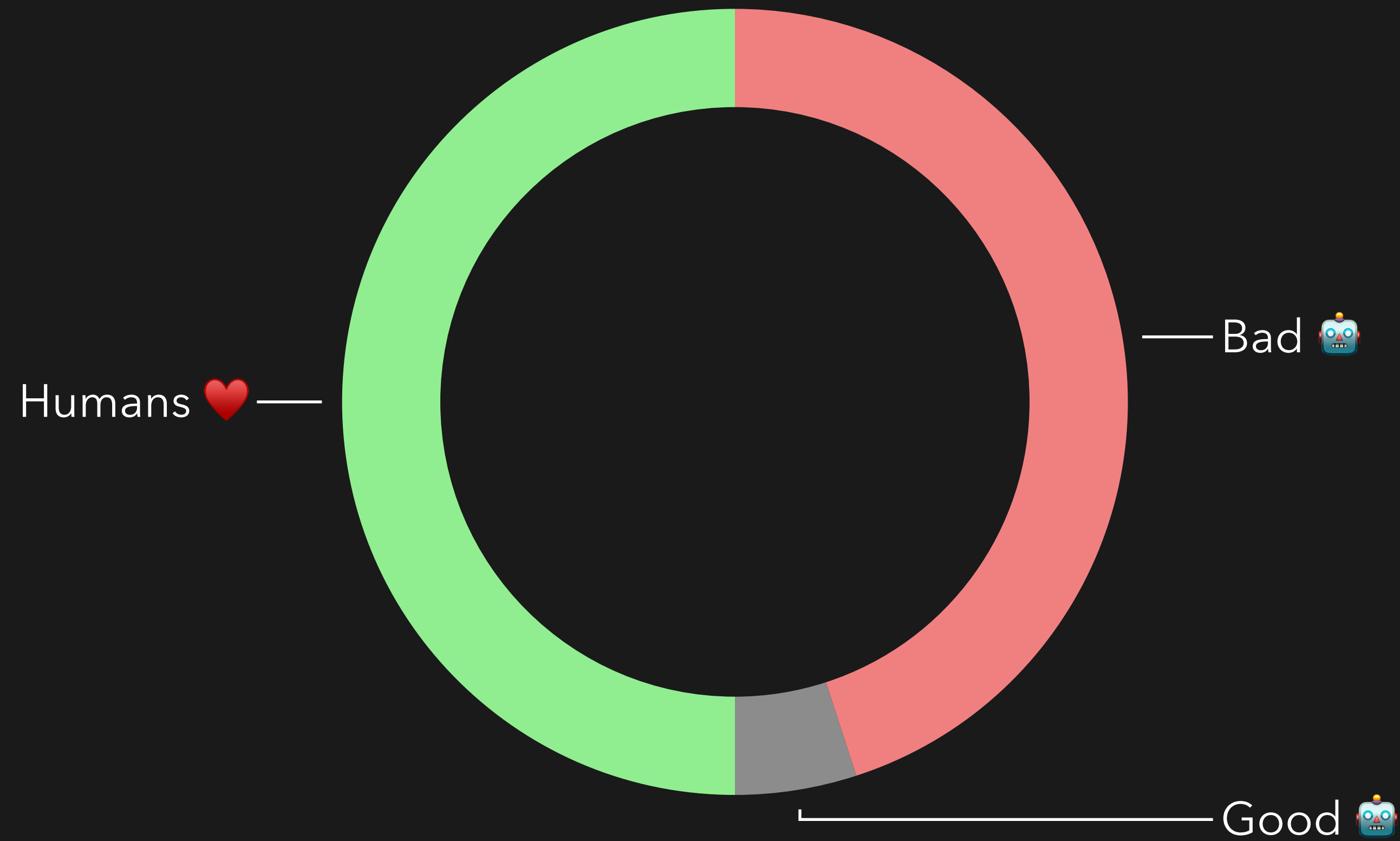
Support legacy,  
progressively

a11y

Sourcing &  
recycling policies

Optimize cloud

# Internet Traffic Sources



# Internet Traffic Sources

## Crawler Hints Beta

Crawler Hints provide high quality data to search engines and other crawlers when sites using Cloudflare change their content. This allows crawlers to precisely time crawling, avoid wasteful crawls, and generally reduce resource consumption on origins and other Internet infrastructure.

By enabling this service, you agree to share website information required for feature functionality and agree to the [Supplemental Terms](#) for Crawler Hints.



[Help](#) ▶

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## Human behavior

# The biggest problems

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delete what's not

Use green hosts  
& cloud

Minify, compress,  
cache

Use green defaults

Lazy-load, use façades

Optimize images,  
media

Optimize perf

Performance budgets

Carbon-aware coding

## Too many devices

HTML standards  
> JS

Support legacy,  
progressively

a11y

Sourcing &  
recycling policies

Optimize cloud

## Human behavior

Talk about  
sustainability

Green software  
training

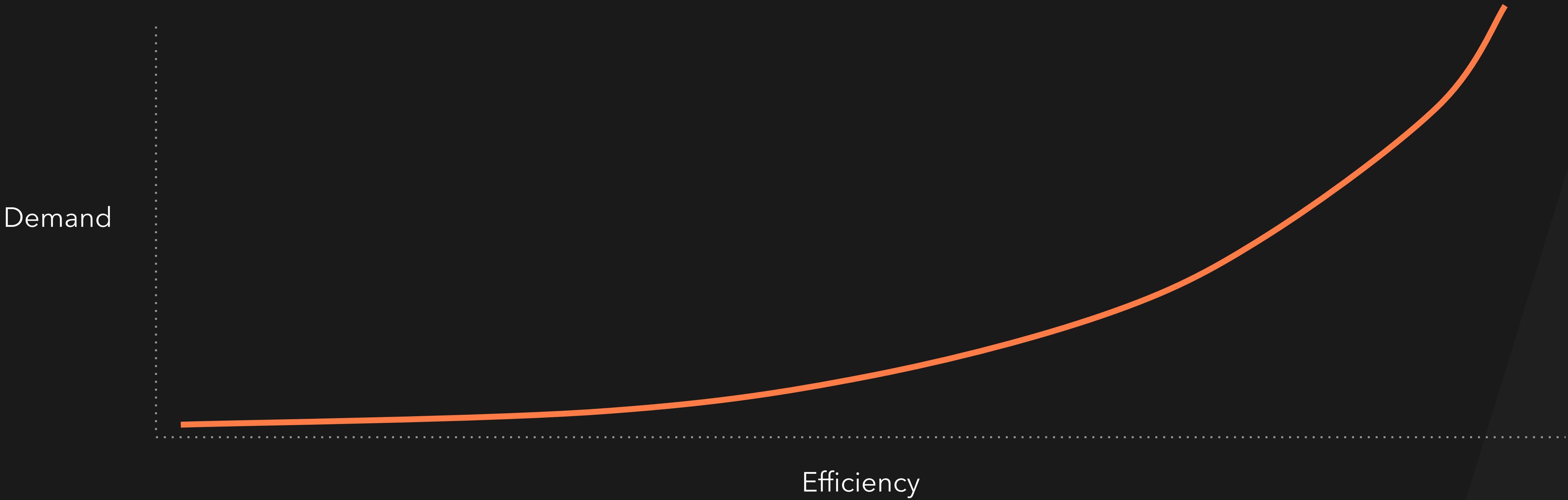
Set targets & limits

Grassroots action &  
community participation

Policy

# The Jevons Paradox

Increasing efficiency enables increased use



Source: [Wikipedia](#)



# The Jevons Paradox

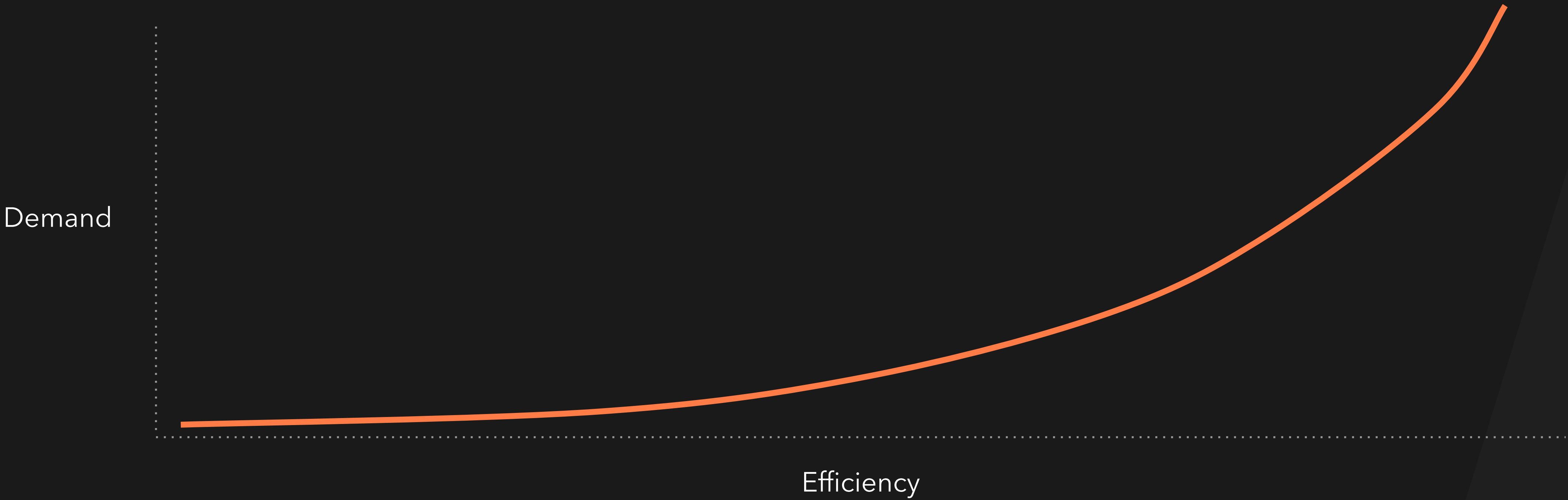
Increasing  
enables i

Demand



# The Jevons Paradox

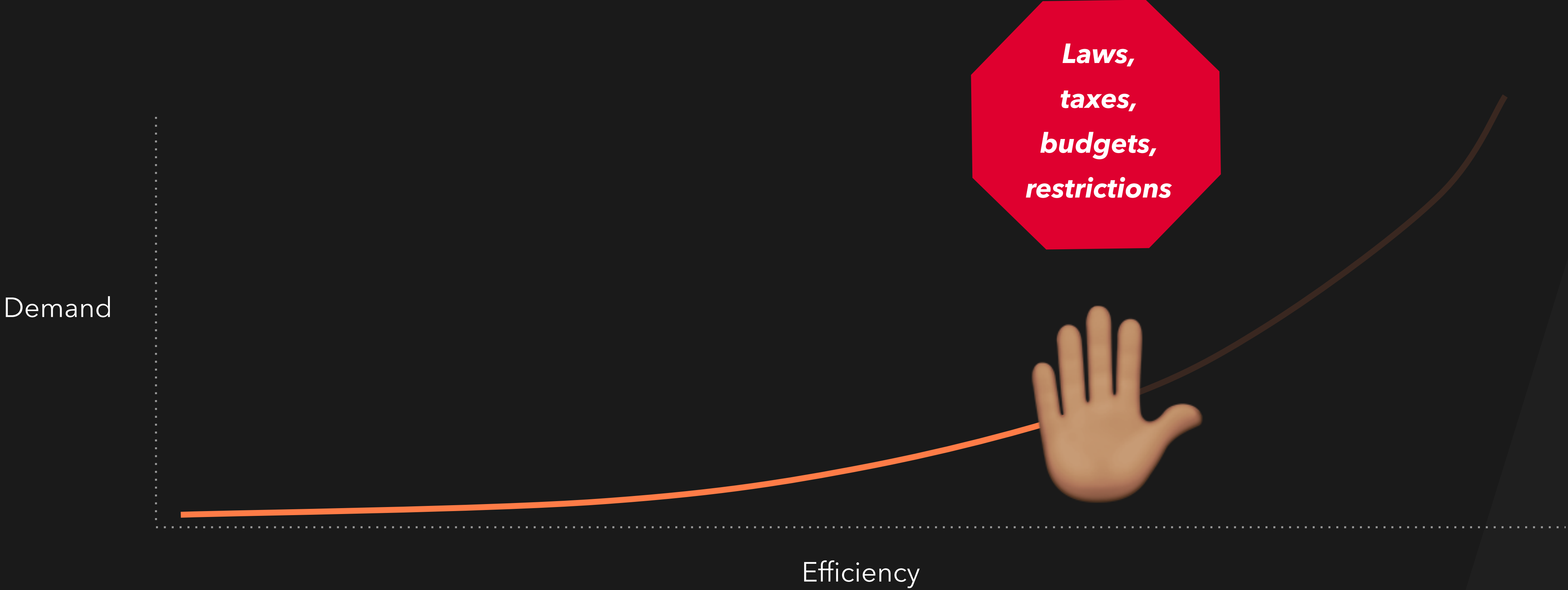
Increasing efficiency enables increased use



Source: [Wikipedia](#)

# The Jevons Paradox

Increasing efficiency enables increased use



Source: [Wikipedia](#)

# CSRD



The screenshot shows the European Commission website page for Corporate Sustainability Reporting. The page is in English and features a navigation menu with categories like Home, Regulation, Supervision, Financial markets, Banking & insurance, Sustainable finance, Digital finance, Consumer finance, Financial crime, and EU & worldwide. The main content area is titled "Corporate sustainability reporting" and includes a sub-header "What the EU is doing and why". The text explains that EU rules require large companies and listed companies to publish regular reports on social and environmental risks. A "PAGE CONTENTS" section lists "What the EU is doing and why", "Policy making timeline", "Relevant legislation", and "Related links". A "New rules on corporate sustainability reporting: The Corporate Sustainability Reporting Directive" section is also visible.

# CCDAA



The screenshot shows the California State Senate Bill No. 253 document. The document is titled "Senate Bill No. 253" and "CHAPTER 382". It is an act to add Section 38532 to the Health and Safety Code, relating to greenhouse gases, and making an appropriation therefor. The document is dated October 7, 2023, and was approved by the Governor and filed with the Secretary of State. The document is a Legislative Counsel's Digest and includes the following text:

**SB 253, Wiener. Climate Corporate Data Accountability Act.**  
The California Global Warming Solutions Act of 2006 requires the State Air Resources Board to adopt regulations to require the reporting and verification of statewide greenhouse gas emissions and to monitor and enforce compliance with the act. The act requires the state board to make available, and update at least annually, on its internet website the emissions of greenhouse gases, criteria pollutants, and toxic air contaminants for each facility that reports to the state board, as provided.

This bill would require the state board, on or before January 1, 2025, to develop and adopt regulations requiring specified partnerships, corporations, limited liability companies, and other business entities with total annual revenues in excess of \$1,000,000,000 and that do business in California, defined as "reporting entities," to publicly disclose to the emissions reporting organization, as defined, and obtain an assurance engagement on, starting in 2026 on a date to be determined by the state board, and annually thereafter, their scope 1 and scope 2 greenhouse gas emissions, as defined, and, starting in 2027 and annually thereafter, their scope 3 greenhouse gas emissions, as defined, from the reporting entity's prior fiscal year, as provided. The bill would require the state board to review during 2029, and update as necessary on or before January 1, 2030, these deadlines to evaluate trends in scope 3 emissions reporting and to consider changes to the deadlines, as provided. The bill would require a reporting entity to obtain an assurance engagement, performed by an independent third-party assurance provider, of the entity's public disclosure as provided. The bill would require the state board, in developing these regulations, to consult with the Attorney General, other government stakeholders, investors, stakeholders representing consumer and environmental justice interests, and reporting entities that have demonstrated leadership in full-scope greenhouse gas emissions accounting and public disclosure and greenhouse gas emissions reductions. The bill would also require the state board to ensure that the assurance process minimizes the need for reporting entities to engage multiple assurance providers and ensures sufficient assurance provider capacity, as well as timely reporting implementation, as required. The bill would further require the state board to contract with an emissions reporting organization to

92

The EU's Corporate Sustainability Reporting Directive (CSRD); California's SB 253, the Climate Corporate Data Accountability Act (CCDAA)

**How to measure impact?**



# The perfect green metric

The perfect source of energy data for our software would be in real time and able to scope to the granularity you currently desired.



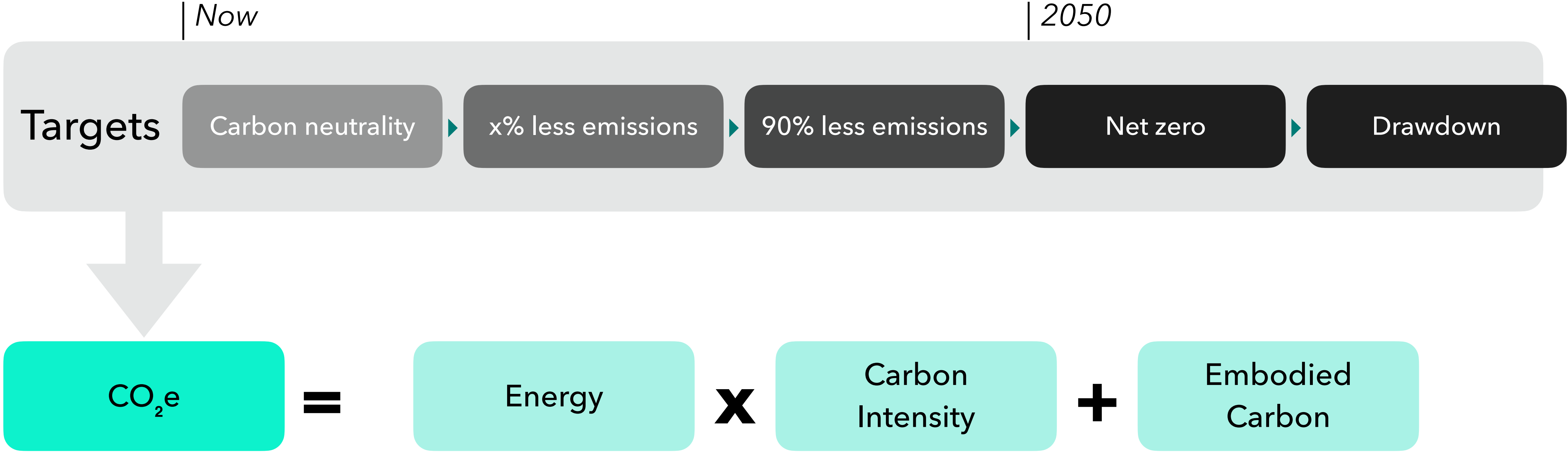
# The perfect green metric



References: [Building Green Software](#) (2024, preview) by Anne Currie, Sarah Hsu, Sara Bergman. “[Why do estimates for internet energy consumption vary so drastically?](#)” by Tom Greenwood. [Green Software Practitioner](#) by the Green Software Foundation. “[Calculating Digital Emissions](#)” on [sustainablewebdesign.org](#).

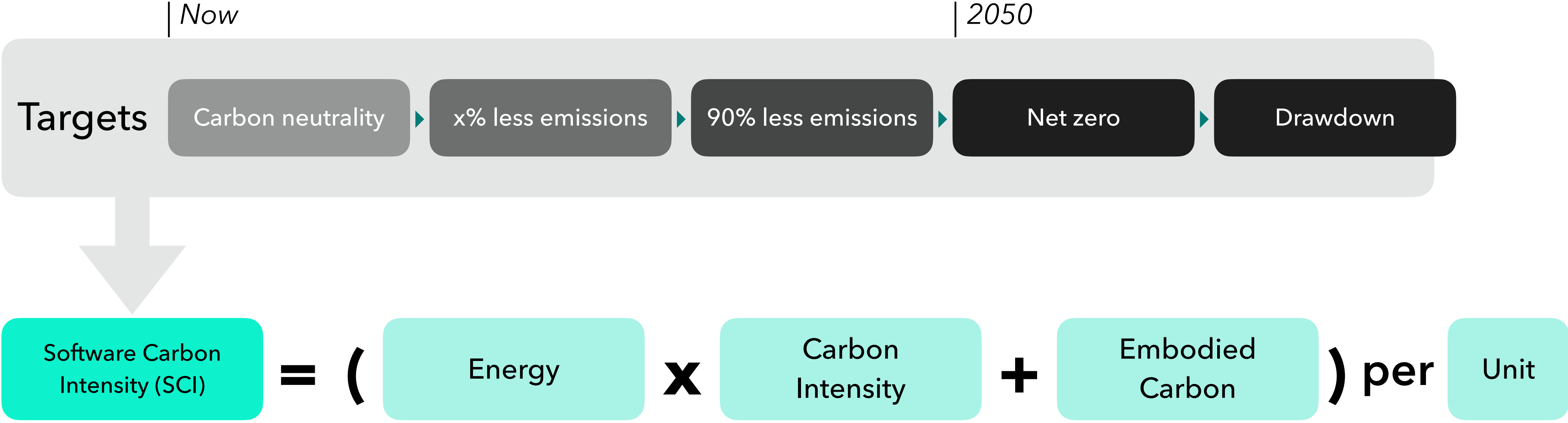


# The perfect green metric



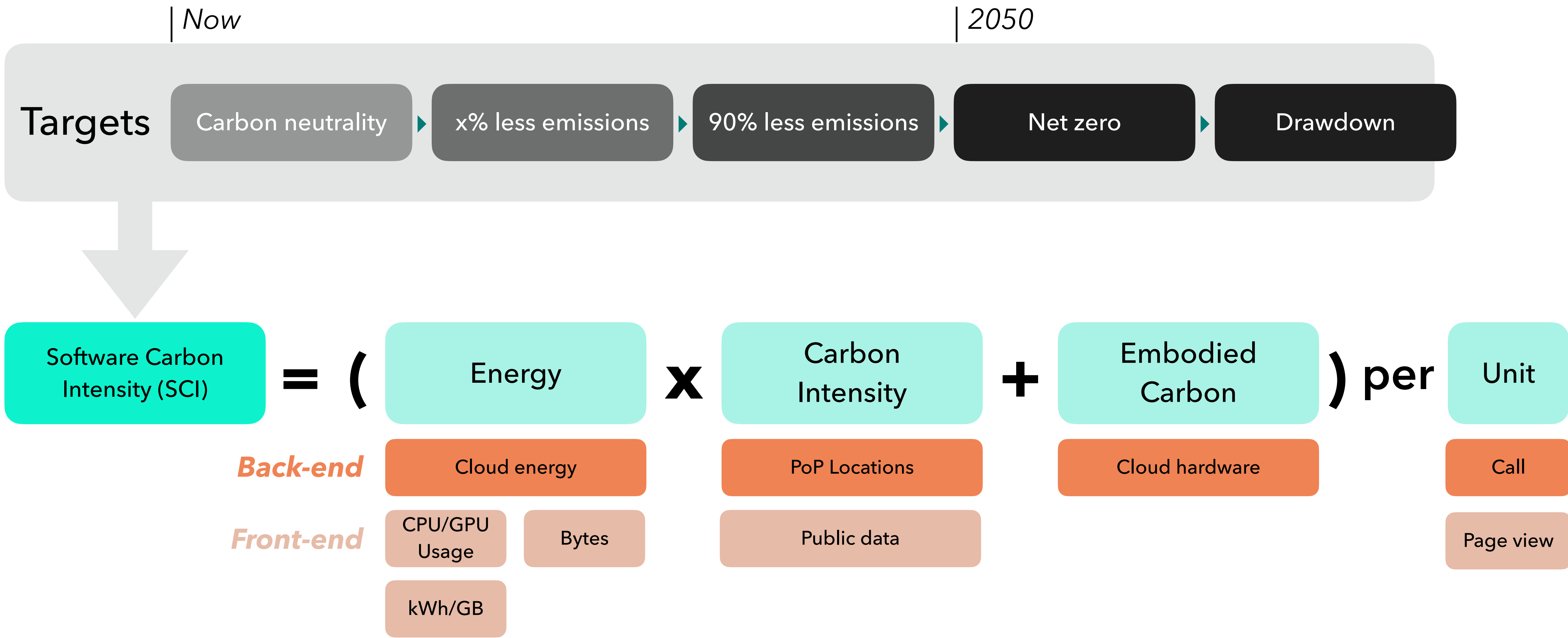
References: [Building Green Software](#) (2024, preview) by Anne Currie, Sarah Hsu, Sara Bergman. “[Why do estimates for internet energy consumption vary so drastically?](#)” by Tom Greenwood. [Green Software Practitioner](#) by the Green Software Foundation. “[Calculating Digital Emissions](#)” on [sustainablewebdesign.org](#).

# A good-enough green metric



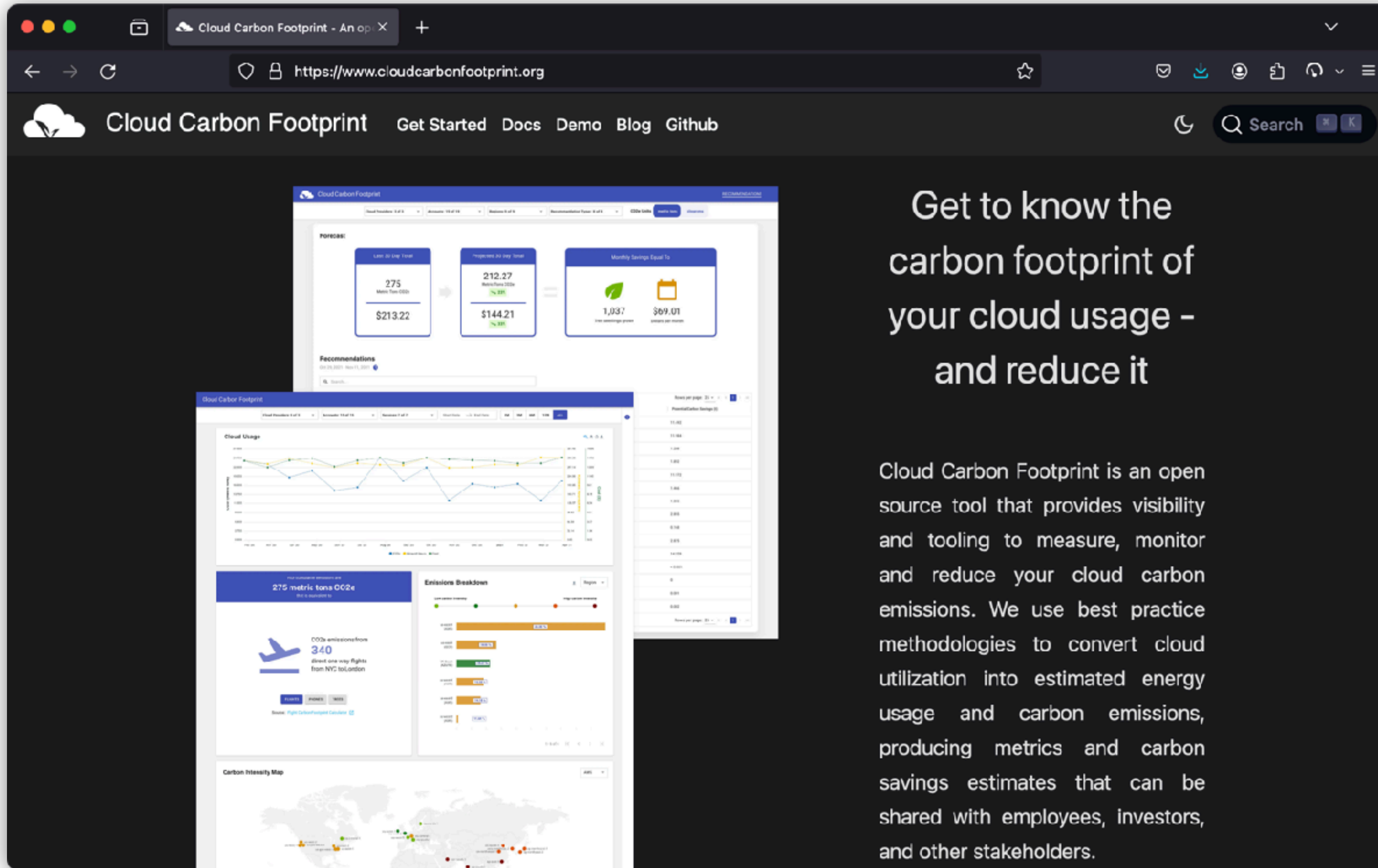
References: [Building Green Software](#) (2024, preview) by Anne Currie, Sarah Hsu, Sara Bergman. “[Why do estimates for internet energy consumption vary so drastically?](#)” by Tom Greenwood. [Green Software Practitioner](#) by the Green Software Foundation. “[Calculating Digital Emissions](#)” on [sustainablewebdesign.org](#).

# A good-enough green metric



References: [Building Green Software](#) (2024, preview) by Anne Currie, Sarah Hsu, Sara Bergman. “Why do estimates for internet energy consumption vary so drastically?” by Tom Greenwood. [Green Software Practitioner](#) by the Green Software Foundation. “Calculating Digital Emissions” on [sustainablewebdesign.org](#).

# Measuring the Cloud



The screenshot displays the Cloud Carbon Footprint website interface. At the top, there's a navigation bar with the logo and links for 'Get Started', 'Docs', 'Demo', 'Blog', and 'Github'. Below this, a search bar is visible. The main content area features several overlapping dashboard panels. One panel shows 'FORECAST' with three boxes: 'Last 12 days Total' (275 Metric Tons CO2e, \$213.22), 'Projected for this year' (212.27 Metric Tons CO2e, \$144.21), and 'Monthly Savings Equal To' (1,037 trees, \$69.01). Another panel shows 'Cloud Usage' with a line graph. A third panel displays 'Emissions Breakdown' with a bar chart. A fourth panel shows 'Carbon Intensity Map' with a world map. A fifth panel shows '275 metric tons CO2e' with a plane icon and text '340 direct one-way flights from NYC to London'. The interface is clean and modern, with a dark theme.

Get to know the carbon footprint of your cloud usage - and reduce it

Cloud Carbon Footprint is an open source tool that provides visibility and tooling to measure, monitor and reduce your cloud carbon emissions. We use best practice methodologies to convert cloud utilization into estimated energy usage and carbon emissions, producing metrics and carbon savings estimates that can be shared with employees, investors, and other stakeholders.



# Measuring the Front-End

## websitecarbon.com

Website Carbon Calculator

Carbon results for [unfccc.int/cop28](https://unfccc.int/cop28)

This page was last tested on 10 Apr, 2023. Test again

**Hurrah! This web page is cleaner than 66% of web pages tested**

## ecograder.com

Ecograder

Your Impact Report

Performance Impact

**EcoGrader Score: 81** (Out of 100)

**Emissions per PageLoad: 0.75** (grams of carbon dioxide)

Page Weight: 94 (25% of score)

UX Design: 74 (17% of score)

Green Hosting: 100 (13% of score)

Carbon Score: 63 (25% of score)

## sitespeed.io

Per domain (first run)

Domain	Estimated CO2 emissions	Transfer Size
images.svc.se	0.00009 grams (02.40 %)	729.9 KB
www.aftonbladet.se	0.57624 grams (21.54 %)	725.0 KB
cdn.bannerflow.com	0.47785 grams (17.86 %)	601.2 KB
gfx.aftonbladet-cdn.se	0.19511 grams (7.33 %)	246.8 KB
ib.adnxs.com	0.15065 grams (5.63 %)	126.5 KB
securepubads.g.doubleclick.net	0.08270 grams (3.00 %)	104.0 KB
s3/z.mxcdn.net	0.05839 grams (2.18 %)	49.1 KB
www.klar.se	0.04285 grams (1.64 %)	56.2 KB
cdn.adnxs.com	0.03455 grams (1.29 %)	29.0 KB
accn.adnxs.com	0.03289 grams (1.23 %)	27.6 KB
pp.p4.io	0.03161 grams (1.10 %)	39.0 KB
s3-eu-central-1.amazonaws.com	0.02440 grams (0.91 %)	20.5 KB
cogwheel.inventory.schibsted.io	0.01699 grams (0.64 %)	14.3 KB
static.svd.se	0.01612 grams (0.60 %)	13.5 KB

## CO2.js

THE GREEN WEB FOUNDATION

CO2.js - Overview

**In a hurry?** Check out our quickstart guide. Start calculating digital carbon emissions in 5 minutes with CO2.js

**What is CO2.js?** CO2.js is a JavaScript library that allows developers to estimate the emissions associated with their apps, websites and software.

**Why use it?** Being able to estimate the carbon emissions associated with digital activities can be of benefit to both development teams and end users.

## WebPageTest Carbon Control

Carbon Control

WebPageTest evaluates a website's carbon usage through the use of services such as the Green Web Foundation's Green Web Dataset and CO2.js

Green Hosting Check

Estimated Carbon Footprint

Page Weight: 1.4 MB

CO2 per new visit: 0.52g

Your Footprint, in Context...

- The average passenger vehicle emits 404 grams of CO2 per mile. This website emits that amount of CO2 every 777 visits.
- The median CO2 footprint of the top 1000 websites is 0.6 grams per visitor. This website emits 13% less than that per visit.
- A site's carbon footprint can vary by device and location, particularly if it relies on 3rd party ads.

## Statsy

Statsy

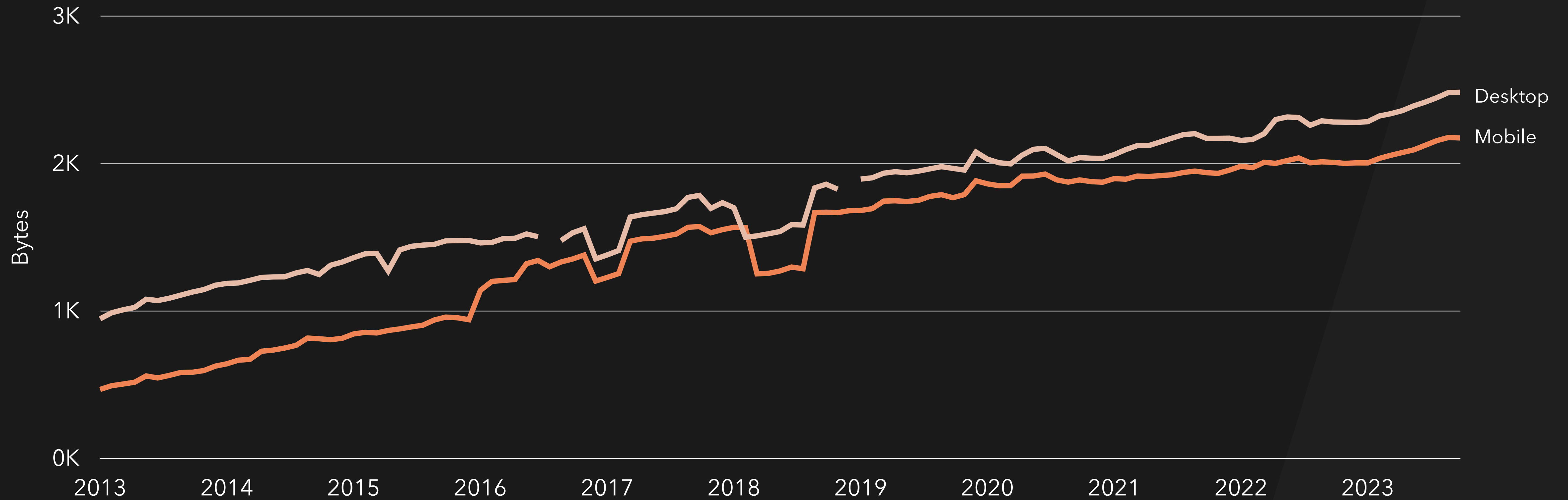
Measure and reduce carbon footprint of your website

Make a powerful stride towards a greener planet. With Carbon Control, unveil real-time insights into your website's environmental impact, and navigate effortlessly towards a more sustainable digital presence.

Carbon Footprint

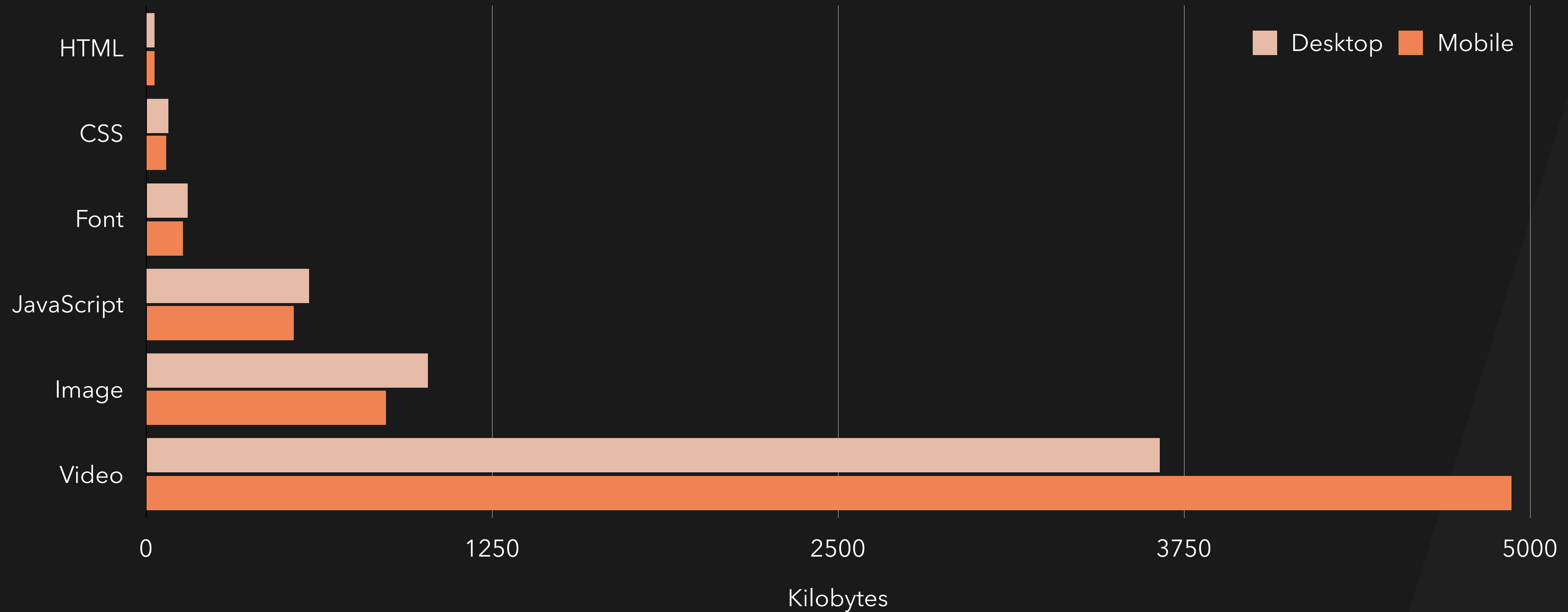
Real Time Analytics

# Webpages keep getting heavier



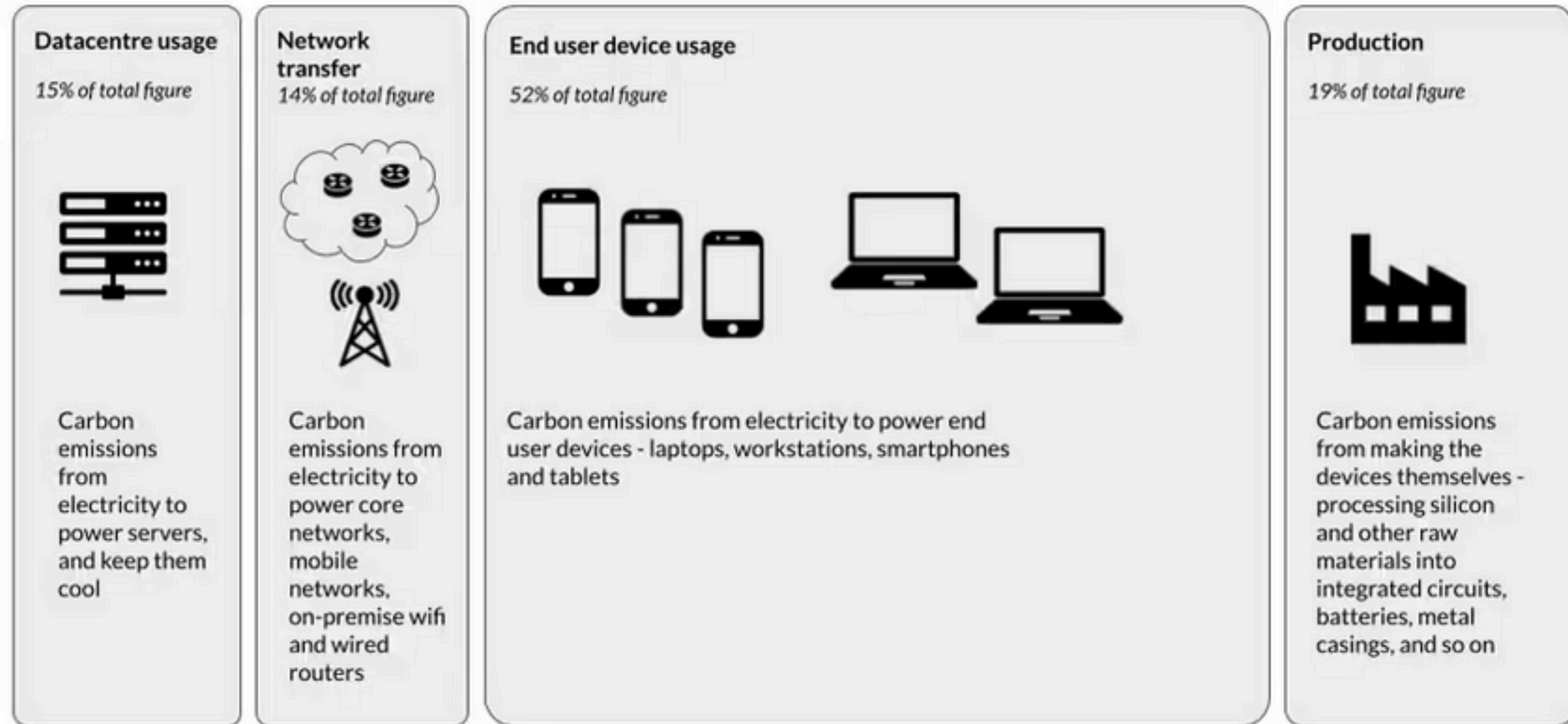
Source: [HTTP Archive](#), Aug 2013 - Sept 2023, no lens

# Median resource weight



Source: [HTTP Archive](#), September 2022 - September 2023

# The Sustainable Web Design Model

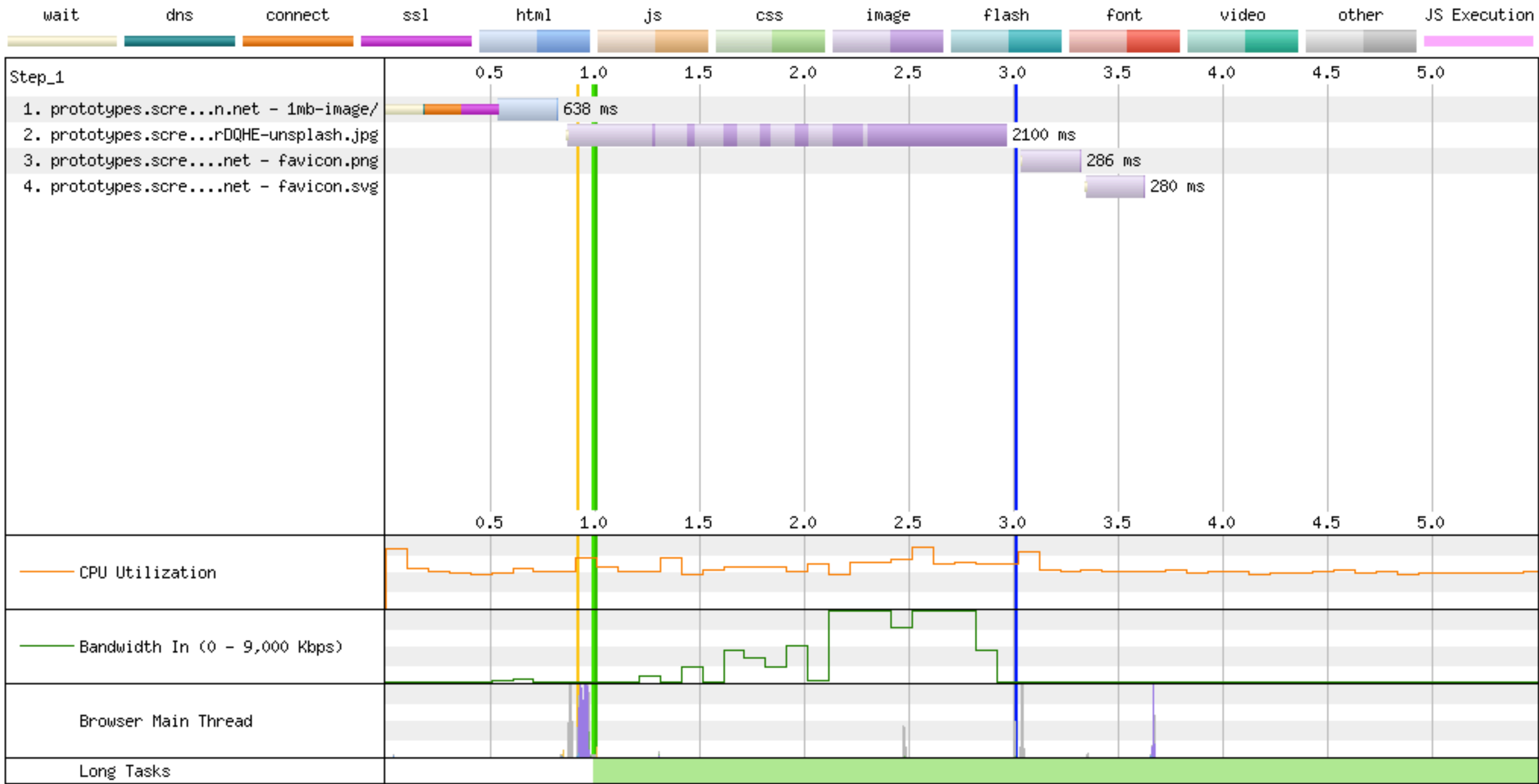




**Data transfer is  
a (weak) proxy for CO<sub>2</sub>e**

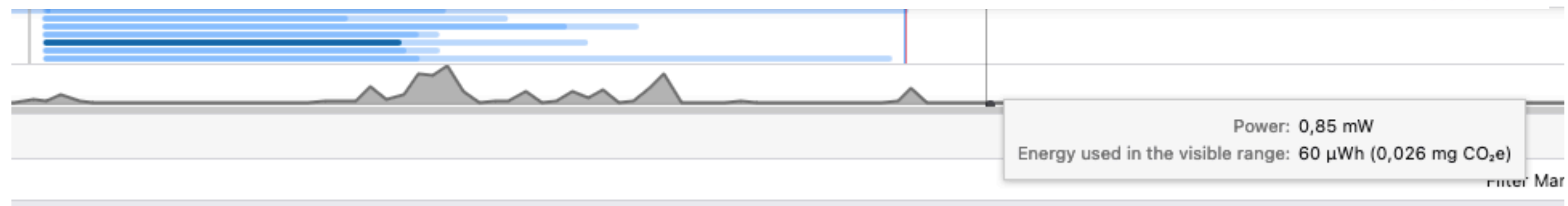
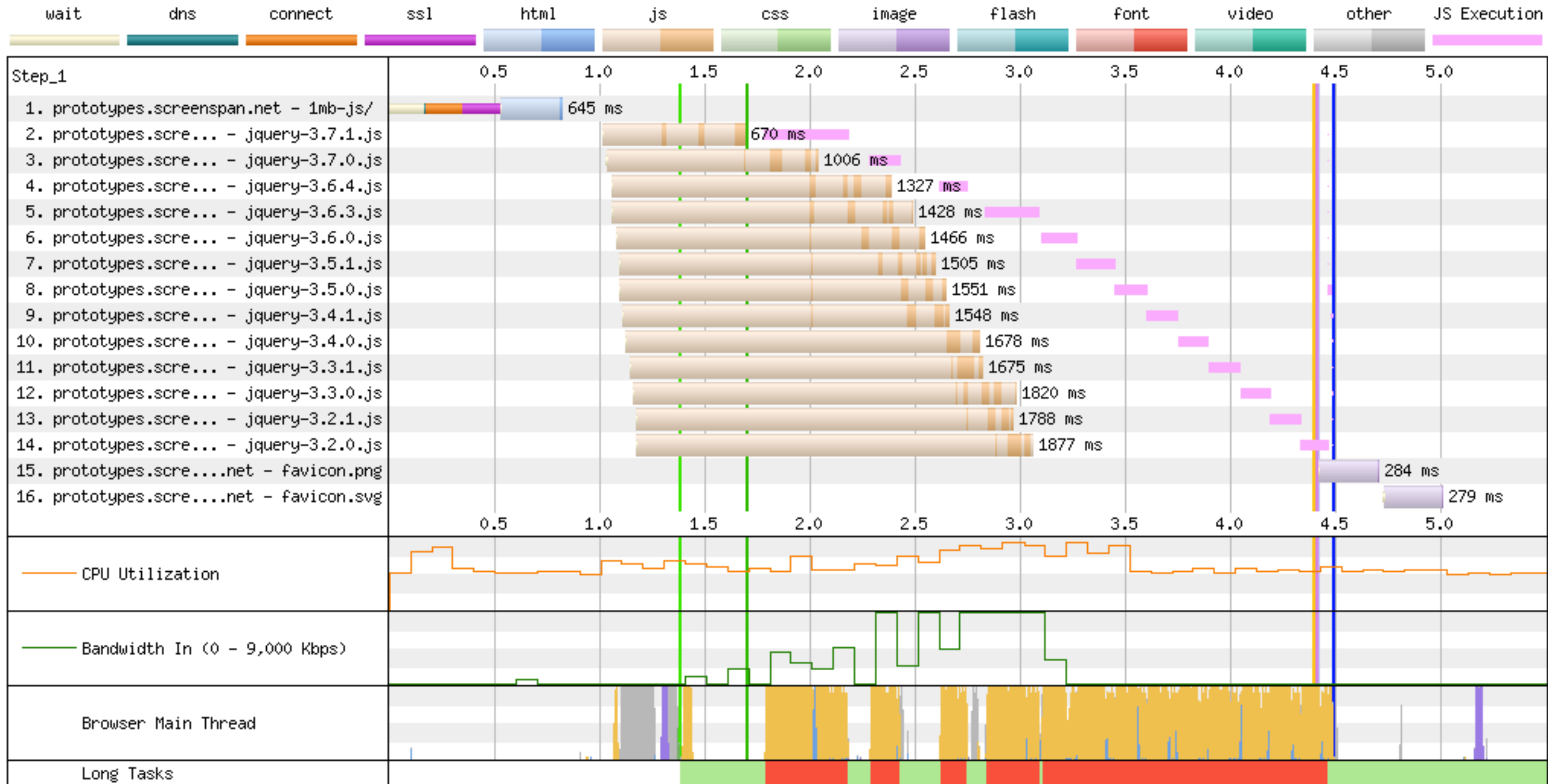
More info: “Why We Don’t Report Website Carbon Emissions” by DebugBear (Oct. 31, 2023);  
“Why web perf tools should be reporting website carbon emissions” by Fershad Irani (Dec. 5, 2023)

# 1 MB image file



Source: [WebPageTest](#), [Firefox Power Profiler](#)

# 1 MB of JavaScript



Source: [WebPageTest](#), [Firefox Power Profiler](#)

# We need APIs that help us measure sustainability

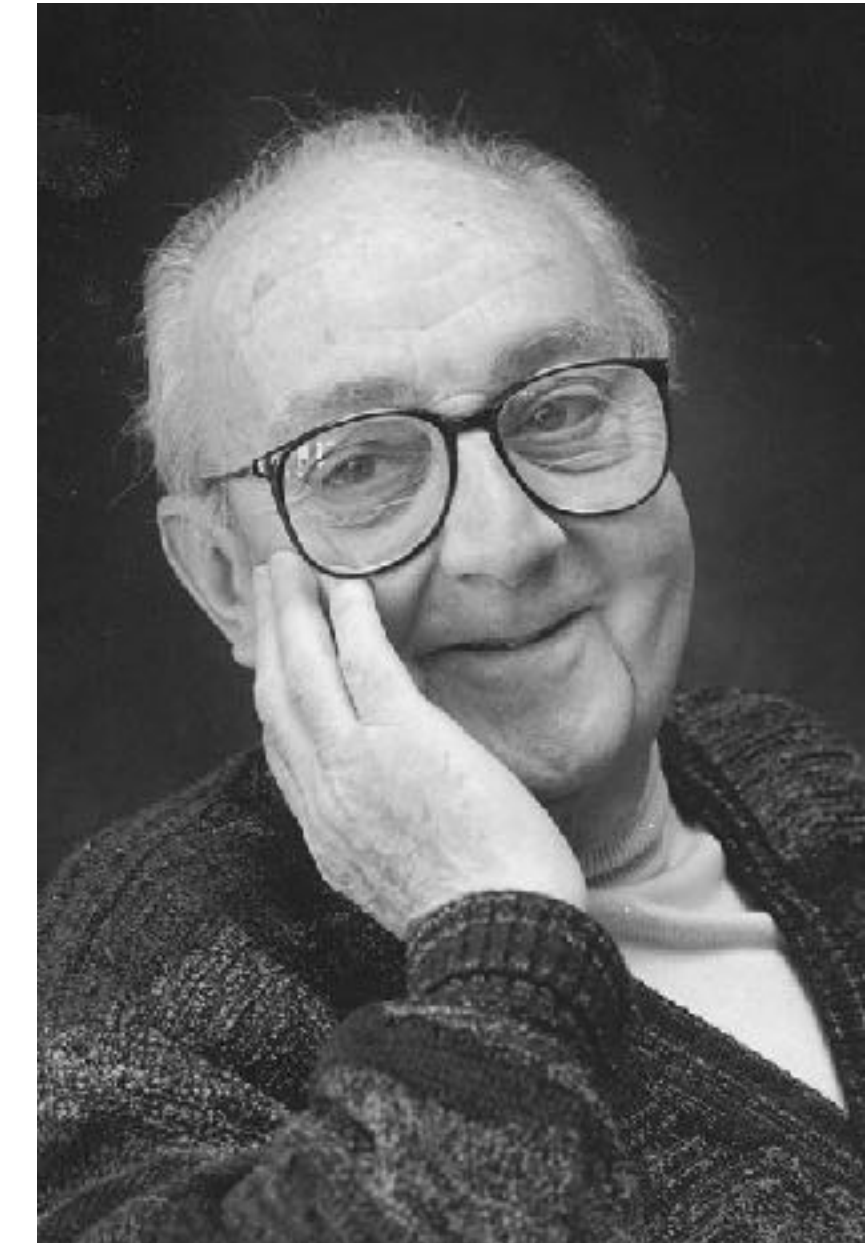
```
Navigator = {
  deviceAge: 2,
  embodiedCarbon: 8,
  // ...
}

PerformanceSessionTiming = {
  totalTransferSize: 2220, // including request and response headers
  totalTransferredJS: 750,
  // ...
}

PerformanceMeasure = {
  detail: {
    cpuTime: 2342,
    gpuTime: 366,
    energyImpact: .66,
    watts: 0.00014
  }
}
```

# On models

All models are wrong  
but some models are useful.



**George Box**  
*Statistician*

# The Impact Framework

The screenshot shows a web browser window with the URL [if.greensoftware.foundation](https://if.greensoftware.foundation). The page features a dark teal header with the title "Impact Framework" and the subtitle "Documentation". A prominent button labeled "Video Walkthrough - 5min" is centered below the header. The main content area is divided into three columns, each with an illustration and a heading: "Measure" (illustration of a factory), "Monitor" (illustration of a laptop with an eye icon), and "Mitigate" (illustration of people working on a mobile device). The footer is dark teal and contains three sections: "Links" (with links to Github and Website), "LEGAL" (with links to Trademark Policy and Terms and Privacy Policy), and "GSF Info" (with links to Green Software Foundation and Twitter).

Impact Framework Docs a Green Software Foundation project

## Impact Framework

Documentation

Video Walkthrough - 5min

### Measure

Measure the energy and carbon impacts of your applications.

### Monitor

Continuous integration allows you to track your impact over time.

### Mitigate

Scenario testing can support your mitigation strategy and quantify its effect.

**Links**  
[Github](#)  
[Website](#)

**LEGAL**  
[Trademark Policy](#)  
[Terms and Privacy Policy](#)

**GSF Info**  
[Green Software Foundation](#)  
[Twitter](#)

Info: <https://if.greensoftware.foundation/>

# Use different models, working with the data you've got

```
name: example
description: a simple example manifest
tags:
initialize:
  models:
    - name: teads-curve
      model: TeadsCurveModel
      path: "@grnsft/if-unofficial-models"
    - name: sci-e
      model: SciEModel
      path: "@grnsft/if-models"
    - name: sci-m
      model: SciMModel
      path: "@grnsft/if-models"
    - name: sci-o
      model: SciOModel
      path: "@grnsft/if-models"
    - name: sci
      model: SciModel
      path: "@grnsft/if-models"
graph:
  children:
    child: # an advanced grouping node
      pipeline:
        - teads-curve
        - sci-e
        - sci-m
        - sci-o
        - sci
      config:
        teads-curve:
          thermal-design-power: 65
```

```
    model: SciModel
    path: "@grnsft/if-models"
graph:
  children:
    child: # an advanced grouping node
      pipeline:
        - teads-curve
        - sci-e
        - sci-m
        - sci-o
        - sci
      config:
        teads-curve:
          thermal-design-power: 65
        sci-m:
          total-embodied-emissions: 251000 # gCO2eq
          time-reserved: 3600 # 1 hour in s
          expected-lifespan: 126144000 # 4 years in seconds
          resources-reserved: 1
          total-resources: 1
        sci-o:
          grid-carbon-intensity: 457 # gCO2/kwh
        sci:
          functional-unit-duration: 1
          functional-duration-time: ''
          functional-unit: requests # factor to convert per tin
      inputs:
        - timestamp: '2023-07-06T00:00'
          duration: 10
          cpu-util: 50
          e-net: 0.000811 #kwh
          requests: 380
```



```
model: SciModel
path: "@grnsft/if-models"
graph:
  children:
    child: # an advanced grouping node
      pipeline:
        - teads-curve
        - sci-e
        - sci-m
        - sci-o
        - sci
      config:
        teads-curve:
          thermal-design-power: 65
        sci-m:
          total-embodied-emissions: 251000 # gCO2eq
          time-reserved: 3600 # 1 hour in s
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        sci:
          functional-unit-duration: 1
          functional-duration-time: ''
          functional-unit: requests # factor to convert per tin
      inputs:
        - timestamp: '2023-07-06T00:00'
          duration: 10
          cpu-util: 50
          e-net: 0.000811 #kwh
          requests: 380
```

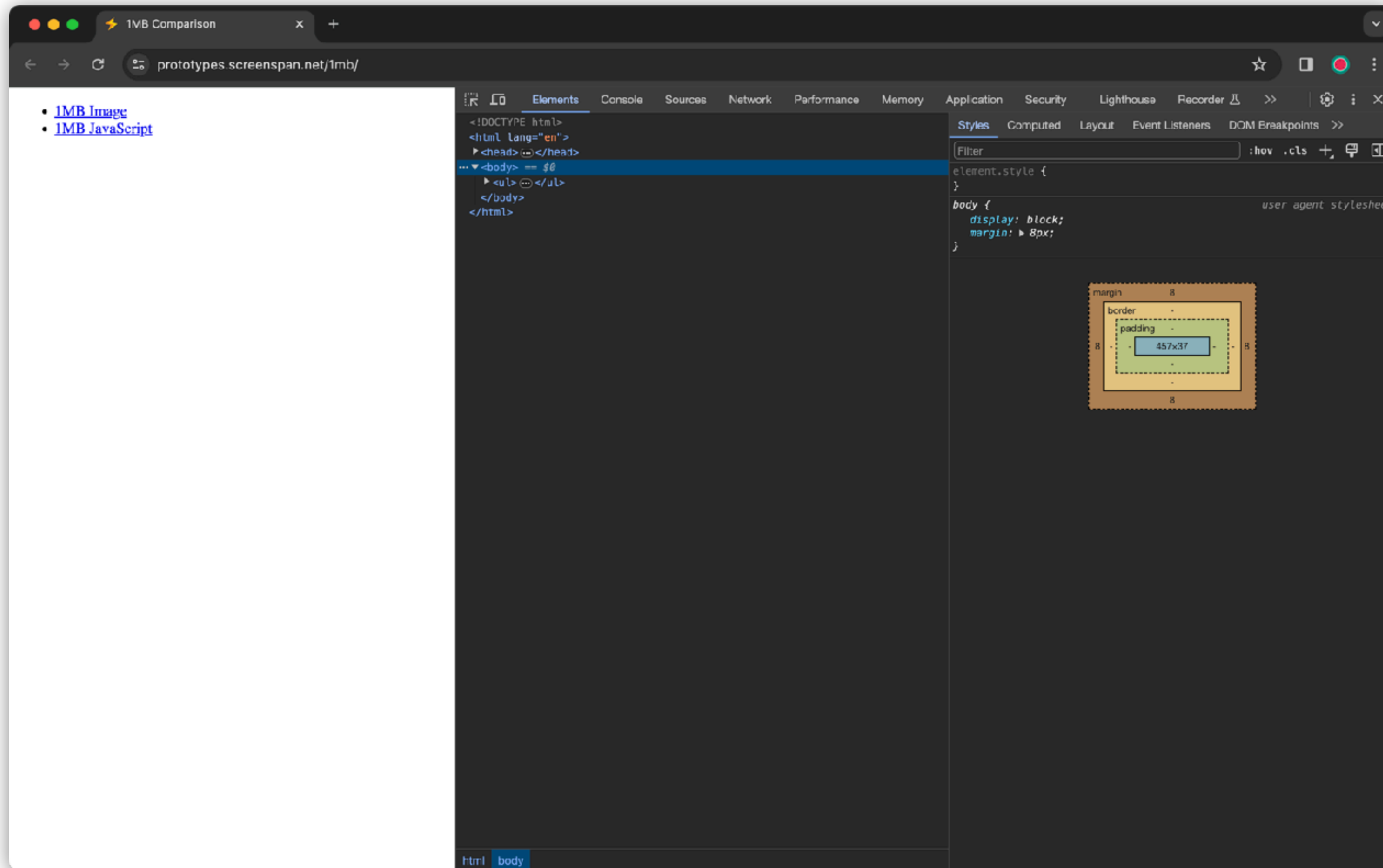
```
functional-duration-time: ''
functional-unit: requests
inputs:
  - timestamp: 2023-07-06T00:00
    duration: 10
    cpu-util: 50
    e-net: 0.000811
    requests: 380
outputs:
  - timestamp: 2023-07-06T00:00
    duration: 10
    cpu-util: 50
    e-net: 0.000811
    requests: 380
    thermal-design-power: 65
    total-embodied-emissions: 251000
    time-reserved: 3600
    expected-lifespan: 126144000
    resources-reserved: 1
    total-resources: 1
    grid-carbon-intensity: 457
    functional-unit-duration: 1
    functional-duration-time: ''
    functional-unit: requests
    energy-cpu: 0.00013541666666666666
    energy: 0.00013541666666666666
    embodied-carbon: 7.16324200913242
    operational-carbon: 0.061885416666666665
    carbon: 0.7225127425799086
    sci: 0.001901349322578707
```

# Start with the basics, focus on high-impact, add more granular data where possible

<i>Fill in columns A, B and F only</i>		<i>Using energy factor of 1.8kWh/GB. Can be easily adjusted with data from new studies.</i>	<i>Using gloval IEA figure of 475g/kWh. Adjust for relevant region or country</i>	<i>Adjusted to only power data centre by renewables (33.4g/kWh)</i>			
<b>Website</b>	<b>Page transfer size (MB)</b>	<b>Energy consumption per page view (kWh)</b>	<b>CO2 per page view from standard grid energy (kg)</b>	<b>CO2 per page view with 100% renewable hosting (kg)</b>	<b>Annual page views</b>	<b>Annual CO2 from standard grid energy (kg)</b>	<b>Annual CO2 with 100% renewable hosting (kg)</b>
Average website 2020	3.17	0.00571	0.00271	<b>0.00160</b>	120000	325.24	191.62
		0.00000	0.00000	<b>0.00000</b>		0.00	0.00

**How to optimize?**


# Chrome Developer Tools




More info: "[Analyze runtime performance](#)" at Chrome for Developers

- [1MB Image](#)
- [1MB JavaScript](#)

- [1MB Image](#)
- [1MB JavaScript](#)

Click the record button  or hit **⌘ E** to start a new recording.

Click the reload button  or hit **⌘ ⇧ E** to record the page load.

After recording, select an area of interest in the overview by dragging. Then, zoom and pan the timeline with the mousewheel or **WASD** keys. [Learn more](#)

# Firefox Power Profiler

The screenshot shows the Firefox Profiler web application in a browser window. The browser's address bar displays the URL <https://profiler.firefox.com>. The page title is "Firefox Profiler — Web app for Firefox performance analysis". Below the title, a tagline reads "Capture a performance profile. Analyze it. Share it. Make the web faster." To the left, there is a thumbnail image of the Firefox Profiler interface, showing various performance charts and a callout box. To the right of the thumbnail, there are two prominent blue buttons: "+ Enable Firefox Profiler Menu Button" and "? Documentation". Below these buttons, a paragraph explains that users can enable the profiler menu button to start recording performance profiles in Firefox, analyze them, and share them. Another paragraph mentions that users can also profile Firefox for Android, with a link to "Profiling Firefox for Android directly on device".

**Firefox Profiler — Web app for Firefox performance analysis**

Capture a performance profile. Analyze it. Share it. Make the web faster.

[+ Enable Firefox Profiler Menu Button](#)

[? Documentation](#)

Enable the profiler menu button to start recording a performance profile in Firefox, then analyze it and share it with profiler.firefox.com.

You can also profile Firefox for Android. For more information, please consult this documentation: [Profiling Firefox for Android directly on device](#).

**Load existing profiles**

You can **drag and drop** a profile file here to load it, or:

[Load a profile from file](#) [Load a profile from a URL](#)

The Firefox Profiler can also import profiles from other profilers, such as [Linux perf](#), [Android SimplePerf](#), the Chrome performance panel, [Android Studio](#), or any file using the [dhat format](#) or [Google's Trace Event Format](#). [Learn how to write your own importer](#).

You can also compare recordings. [Open the comparing interface](#).

**Your recent uploaded recordings**

No profile has been uploaded yet!

[Legal](#) [Privacy](#) [Cookies](#) English (US)

Info: <https://profiler.firefox.com/>

UA: Mozilla/5.0 (Linux; Android 11; SAMSUNG SM-G973U) Ap

The image shows the YouTube mobile interface. At the top, there's a navigation bar with 'All', 'Gaming', 'Music', and 'Live' buttons. Below that is a video player showing a construction site with a wooden frame. The video title is 'Man Builds Amazing House on Steep Mountain in 8 Months | Start to Finish...'. Below the video player is a 'Shorts' section with three video thumbnails. The first thumbnail shows a man with dice and the text 'Kobe Bryant made from 10,000 dice. #diceart'. The second thumbnail shows a woman and the text 'Eine echte Prinzessin bleibt immer treu...'. The bottom navigation bar has 'Home', 'Shorts', and 'Library' icons.

Search HTML

```

<!DOCTYPE html>
<html darker-dark-theme="">
  <head>
  </head>
  <body class="" lang="en" dir="ltr" has-pivot-bar="true" has-safe-area-in-max="false" has-player-custom-control="true" shorts-player="false">
    <style nonce="rW0yBlpxPEd17HvSi2m51g">
    </style>
    <div id="player-container-id" class="player-container sticky-player">
    </div>
    <ytm-app id="app" class="sticky-player">
    </ytm-app>
    <script nonce="C-Lrd-aftboknrowuWw_gA">
    </script>
    <script nonce="C-Lrd-aftboknrowuWw_gA">
    </script>
    <script nonce="C-Lrd-aftboknrowuWw_gA">
    </script>
    <script src="https://m.youtube.com/static/r/1a91cbe7/fetch_polyfill.vflset/fetch_polyfill.js" nonce="C-Lrd-aftboknrowuWw_gA">
    </script>
    <script nonce="C-Lrd-aftboknrowuWw_gA">
      var ytInitialPlayerResponse = null;
    </script>
    <script nonce="C-Lrd-aftboknrowuWw_gA">
    </script>
    <script name="www-roboto" nonce="C-Lrd-aftboknrowuWw_gA">
    </script>
    <script nonce="C-Lrd-aftboknrowuWw_gA">
    </script>
    <script id="base-js" fetchpriority="high" name="mobile-c3" src="https://m.youtube.com/s/_/ytmweb/_/js/k=ytmweb.c3_base.en_US...g_0/d=1/br=1/rs=ABnK5FKiM04aEAtiVX3HumN4rzbGcjUM6g/m=c3_base" nonce="C-Lrd-aftboknrowuWw_gA">
    </script>
    <script nonce="C-Lrd-aftboknrowuWw_gA">
    </script>
    <link id="c3-css" href="https://m.youtube.com/s/_/ytmweb/_/ss/k=ytmweb.c3_base.7fXA1...L.W.0/am=AELA/d=0/br=1/rs=ABnK5FKsHB91P3veSjrSK0s4X5FJnW_1Yg" rel="stylesheet" nonce="rW0yBlpxPEd17HvSi2m51g">
    <!--Welcome to the end of the first chunk-->
    <script nonce="C-Lrd-aftboknrowuWw_gA">
    </script>
    <script nonce="C-Lrd-aftboknrowuWw_gA">
    </script>
    <script nonce="C-Lrd-aftboknrowuWw_gA">
    </script>
    <script nonce="C-Lrd-aftboknrowuWw_gA">
    </script>
    <script nonce="C-Lrd-aftboknrowuWw_gA">
    </script>
  </body>
</html>

```

Filter Styles

```

element :: {
}
body :: {
  margin: 0;
  padding: 0;
  padding: 0 env(safe-area-inset-right) env(safe-area-inset-bottom) env(safe-area-inset-left);
  font-size: 1.2rem;
  overflow-x: hidden;
}
body :: {
  margin: 0;
  padding: 0;
  padding: 0 env(safe-area-inset-right) env(safe-area-inset-bottom) env(safe-area-inset-left);
  font-size: 1.2rem;
  overflow-x: hidden;
}
* :: {
  -ms-flex: 0 1 auto;
}
Inherited from html
html :: {
  word-wrap: break-word;
  color: #f1f1f1;
  -webkit-text-size-adjust: 100%;
}
html :: {
  color: #f1f1f1;
  font-size: 10px;
  font-family: Roboto, Arial, sans-serif;
}
html :: {
  color: #f1f1f1;
  font-size: 10px;
  font-family: Roboto, Arial, sans-serif;
}

```

Layout Computed Changes

Flexbox

Select a Flex container or item to continue.

Grid

CSS Grid is not in use on this page

Box Model

The diagram shows a purple content box with a blue border and a green margin. The dimensions are 360x1780.5. The margin is 0, border is 0, and padding is 0.

360x1780.5 static

Box Model Properties

box-sizing	content-box
display	block
float	none
line-height	normal
position	static
z-index	auto



# Safari Web Inspector

This screenshot shows the Safari Web Inspector interface for a page titled "1MB Image". The "CPU" timeline is selected, showing a single event with a duration of 25ms. The "Main Thread" pie chart indicates the following breakdown: JavaScript (24.0%, 6), Layout (4.0%, 1), Paint (64.0%, 16), and Styles (8.0%, 2). The "Energy Impact" gauge shows a "Low" rating with an average CPU usage of 2.0% and a short duration. The "CPU Usage" graph at the bottom shows a single spike corresponding to the event.

This screenshot shows the Safari Web Inspector interface for a page titled "1MB JavaScript". The "CPU" timeline is selected, showing a single event with a duration of 90ms. The "Main Thread" pie chart indicates the following breakdown: JavaScript (73.3%, 88), Layout (0.0%, 0), Paint (21.1%, 19), and Styles (5.6%, 5). The "Energy Impact" gauge shows a "Medium" rating with an average CPU usage of 4.3% and a short duration. The "CPU Usage" graph at the bottom shows a single spike corresponding to the event.

Debug

Zustimmung Details Anzeigeneinstellungen

**Verantwortungsvoller Umgang mit Ihren Daten**

Wir und **unsere 835 Partner** verarbeiten Ihre persönlichen Daten, wie z. B. Ihre IP-Adresse, mithilfe von Technologien wie Cookies, um Informationen auf Ihrem Gerät zu speichern und darauf zuzugreifen und so personalisierte Werbung und Inhalte, Messungen von Werbung und Inhalten, Einsichten in Zielgruppen und Produktentwicklung zu ermöglichen. Sie entscheiden darüber, wer Ihre Daten für welche

Notwendig

Präferenzen

Statistiken

Marketing/Gewinnspiele

**Cookies zulassen**

Auswahl erlauben

Powered by **Cookiebot by Usercentrics**

noen.at

Elements Console Sources Network Timelines Storage Graphics Layers Audit

```

<!DOCTYPE html>
<html lang="de">
  <head>
  </head>
  <body class="noen frontend-noen channel-frontpage channel-961" data-channel="961">
  </body>
</html>

```

Style Attribute {

```

html {
  background-color: #fff;
  width: 100vw;
  height: 100vh;
}
html {
  display: flex;
  align-items: center;
  justify-content: center;
  overflow-x: hidden;
  line-height: 1.7em;
  font-size: 18px;
  background-color: #fff;
  scroll-padding-top: 60px;
}
html, body, div, span, applet, object, iframe, h1, h2, h3, h4, h5, h6, p, blockquote, pre, a, abbr, acronym, address, big, cite, code, del, dfn, em, img, ins, kbd, q, s, samp, small, strike, strong, sub, sup, tt, var, b, u, i, center, dl, dt, dd, ol, ul, li, fieldset, form, label, legend, table, caption, tbody, tfoot, thead, tr, th, td, article, aside, canvas, details, embed, figure, figcaption, footer, header, hgroup, menu, nav, output, ruby, section, summary, time, mark, audio, video {
  margin: 0;
  padding: 0;
  border: 0;
  font-size: 100%;
  font: inherit;
  vertical-align: baseline;
}
html, body, div, span, applet, object, iframe, h1, h2, h3, h4, h5, h6, p, blockquote, pre, a, abbr, acronym, address, big, cite, code, del, dfn, em, img, ins, kbd, q, s, samp, small, strike, strong, sub, sup, tt, var, b, u, i, center, dl, dt, dd, ol, ul, li, fieldset, form, label, legend, table, caption, tbody, tfoot, thead, tr, th, td, article, aside, canvas, details, embed, figure, figcaption, footer, header, hgroup, menu, nav, output, ruby, section, summary, time, mark, audio, video {
  margin: 0;
  padding: 0;
  border: 0;
  font-size: 100%;
  font: inherit;
  vertical-align: baseline;
}

```

Computed

Box Model

Properties

- align-items: center
- background-attachment: scroll
- background-clip: border-box
- background-color: rgb(255, 255, 255)
- background-image: none
- background-origin: padding-box
- background-position-x: 0%
- background-position-y: 0%
- background-repeat: repeat
- background-size: auto
- border-bottom-color: rgb(0, 0, 0)
- border-bottom-style: none
- border-bottom-width: 0px
- border-image-outset: 0
- border-image-repeat: stretch
- border-image-slice: 100%
- border-image-source: none
- border-image-width: 1
- border-left-color: rgb(0, 0, 0)
- border-left-style: none
- border-left-width: 0px
- border-right-color: rgb(0, 0, 0)
- border-right-style: none
- border-right-width: 0px
- border-top-color: rgb(0, 0, 0)
- border-top-style: none
- border-top-width: 0px
- color: rgb(0, 0, 0)
- display: flex
- font-family: -webkit-standard
- font-feature-settings: normal
- font-kerning: auto

Classes Pseudo

Auto — m.noen.at

Debug

Zustimmung Details Anzeigeneinstellungen

**Verantwortungsvoller Umgang mit Ihren Daten**

Wir und **unsere 835 Partner** verarbeiten Ihre persönlichen Daten, wie z. B. Ihre IP-Adresse, mithilfe von Technologien wie Cookies, um Informationen auf Ihrem Gerät zu speichern und darauf zuzugreifen und so personalisierte Werbung und Inhalte, Messungen von Werbung und Inhalten, Einsichten in Zielgruppen und Produktentwicklung zu ermöglichen. Sie entscheiden darüber, wer Ihre Daten für welche

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<html lang="de">
  <head>
  </head>
  <body class="noen frontend-noen channel-frontpage channel-961" data-channel="961">
  </body>
</html>

```

Style Attribute {

```

html {
  background-color: #fff;
  width: 100vw;
  height: 100vh;
}
html {
  display: flex;
  align-items: center;
  justify-content: center;
  overflow-x: hidden;
  line-height: 1.7em;
  font-size: 18px;
  background-color: #fff;
  scroll-padding-top: 60px;
}
html, body, div, span, applet, object, iframe, h1, h2, h3, h4, h5, h6, p, blockquote, pre, a, abbr, acronym, address, big, cite, code, del, dfn, em, img, ins, kbd, q, s, samp, small, strike, strong, sub, sup, tt, var, b, u, i, center, dl, dt, dd, ol, ul, li, fieldset, form, label, legend, table, caption, tbody, tfoot, thead, tr, th, td, article, aside, canvas, details, embed, figure, figcaption, footer, header, hgroup, menu, nav, output, ruby, section, summary, time, mark, audio, video {
  margin: 0;
  padding: 0;
  border: 0;
  font-size: 100%;
  font: inherit;
  vertical-align: baseline;
}
html, body, div, span, applet, object, iframe, h1, h2, h3, h4, h5, h6, p, blockquote, pre, a, abbr, acronym, address, big, cite, code, del, dfn, em, img, ins, kbd, q, s, samp, small, strike, strong, sub, sup, tt, var, b, u, i, center, dl, dt, dd, ol, ul, li, fieldset, form, label, legend, table, caption, tbody, tfoot, thead, tr, th, td, article, aside, canvas, details, embed, figure, figcaption, footer, header, hgroup, menu, nav, output, ruby, section, summary, time, mark, audio, video {
  :active
  :focus
  :focus-visible
  :focus-within
  :hover
  :target
  :visited
}

```

Computed

Box Model

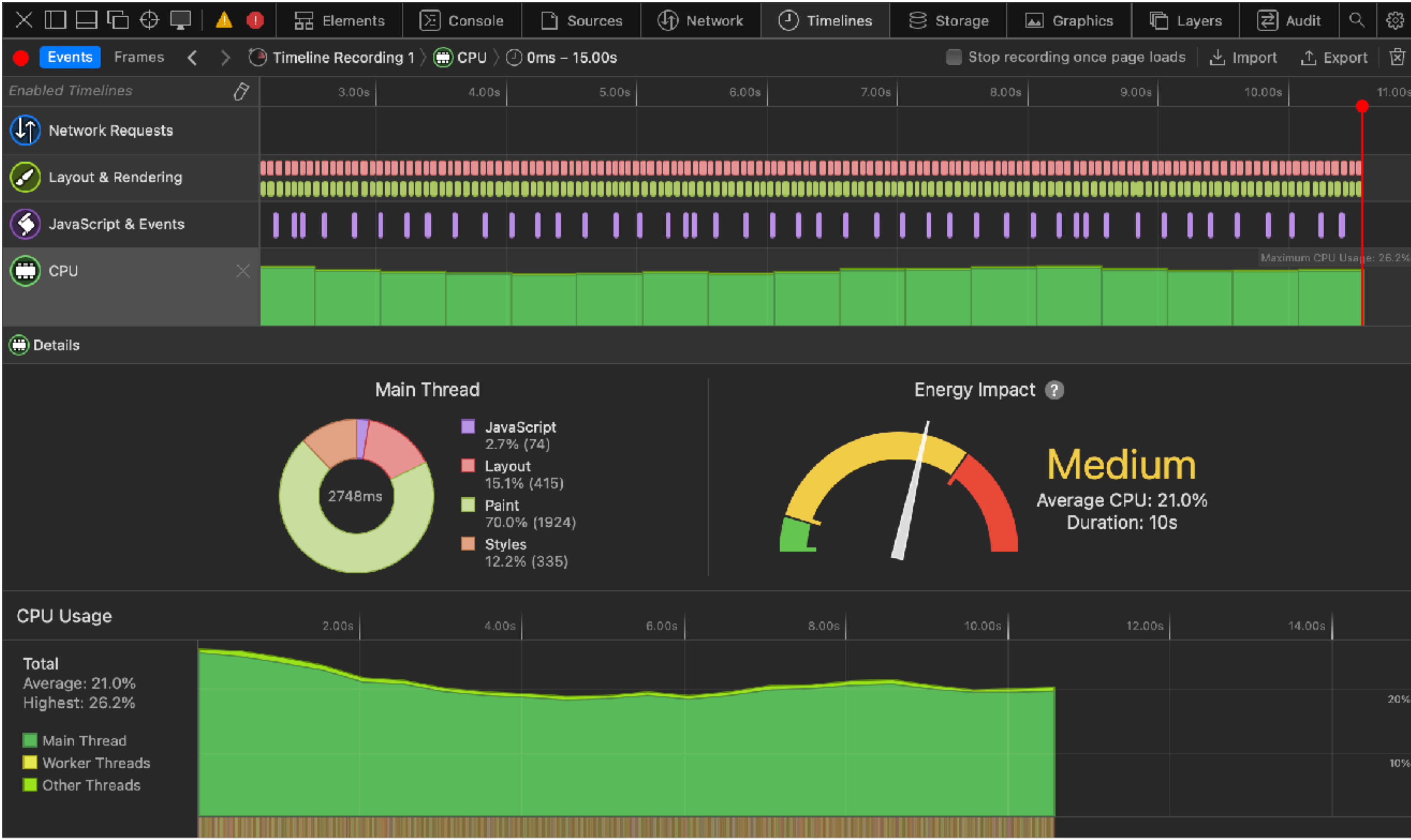
Properties

- align-items: center
- background-attachment: scroll
- background-clip: border-box
- background-color: rgb(255, 255, 255)
- background-image: none
- background-origin: padding-box
- background-position-x: 0%
- background-position-y: 0%
- background-repeat: repeat
- background-size: auto
- border-bottom-color: rgb(0, 0, 0)
- border-bottom-style: none
- border-bottom-width: 0px
- border-image-outset: 0
- border-image-repeat: stretch
- border-image-slice: 100%
- border-image-source: none
- border-image-width: 1
- border-left-color: rgb(0, 0, 0)
- border-left-style: none
- border-left-width: 0px
- border-right-color: rgb(0, 0, 0)
- border-right-style: none
- border-right-width: 0px
- border-top-color: rgb(0, 0, 0)
- border-top-style: none
- border-top-width: 0px
- color: rgb(0, 0, 0)
- display: flex
- font-family: -webkit-standard
- font-feature-settings: normal
- font-kerning: auto

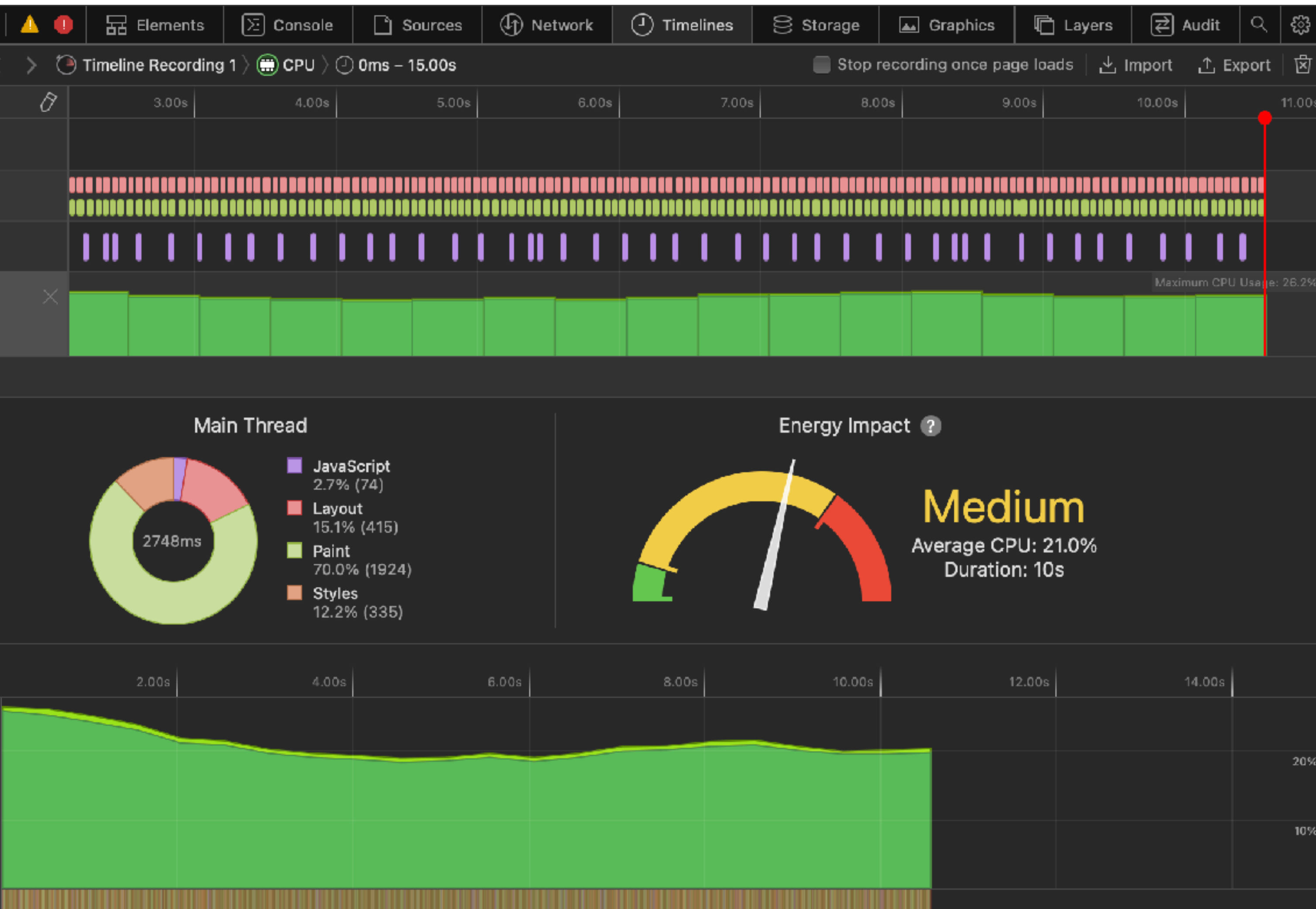
Filter Classes Pseudo

Auto — m.noen.at

# Watch out for infinite animations!

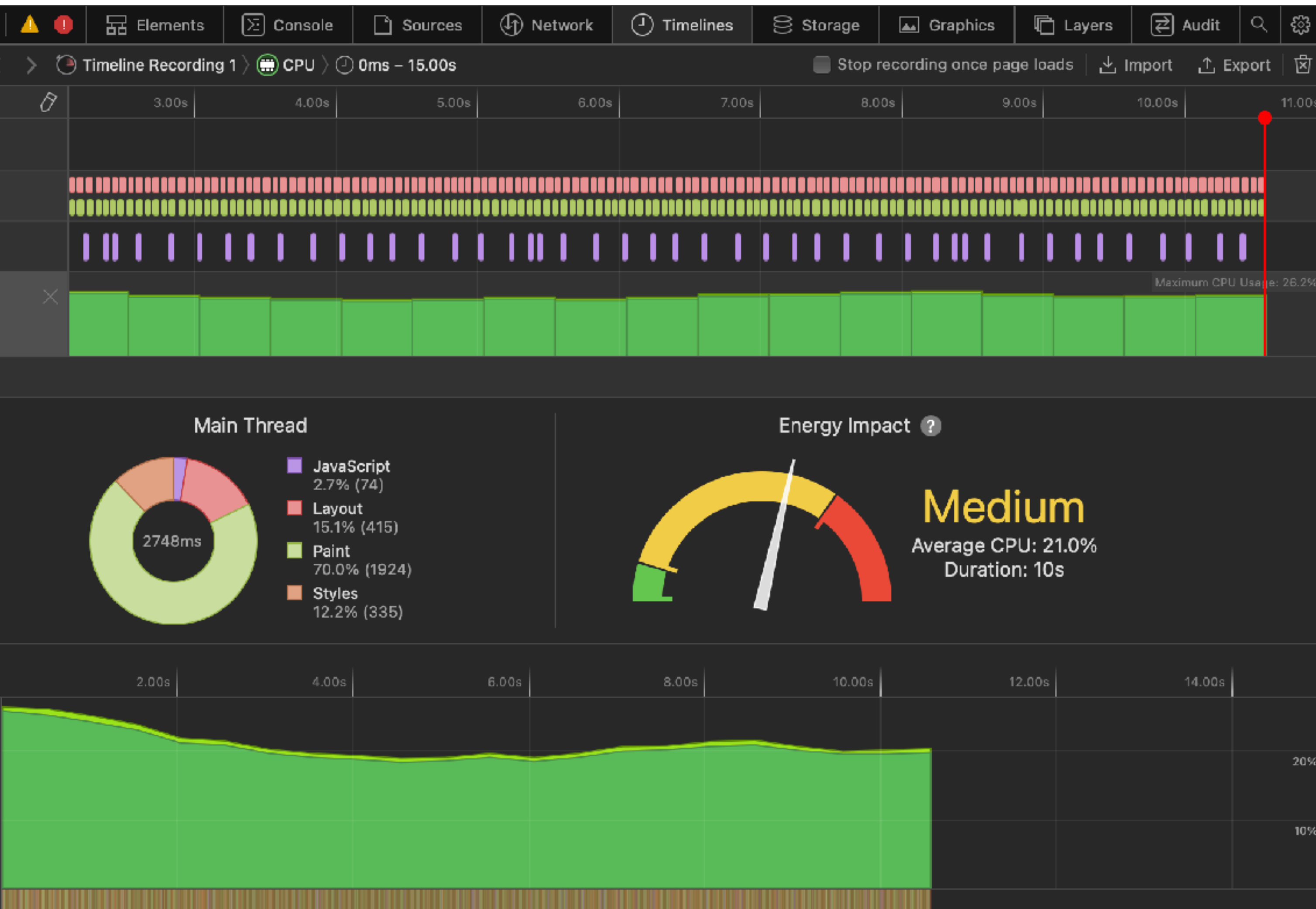


# Watch out for infinite animations!



```
Pseudo-Element ::after
P .product-grid-slider      product-grid.css:736
.preloader:after {
  animation: shine 2s linear infinite;
  background: linear-gradient(110deg, #eaeaea 8%, #f5f5f5 18%, #eaeaea 33%);
  background-size: 300% 100%;
  content: "";
  display: block;
  height: 100%;
  left: 0;
  position: absolute;
  top: 0;
  width: 100%;
}
```

# Watch out for infinite animations!



```
Pseudo-Element ::after
P .product-grid-slider      product-grid.css:736
.preloader:after {
  /* animation: shine 2s linear infinite;
  */
  background: linear-
    gradient(110deg,#eaeaea 8%,#f5f5f5
    18%,#eaeaea 33%);
  background-size: 300% 100%;
  content: "";
  display: block;
  height: 100%;
  left: 0;
  position: absolute;
  top: 0;
  width: 100%;
}
```

# Watch out for infinite animations!

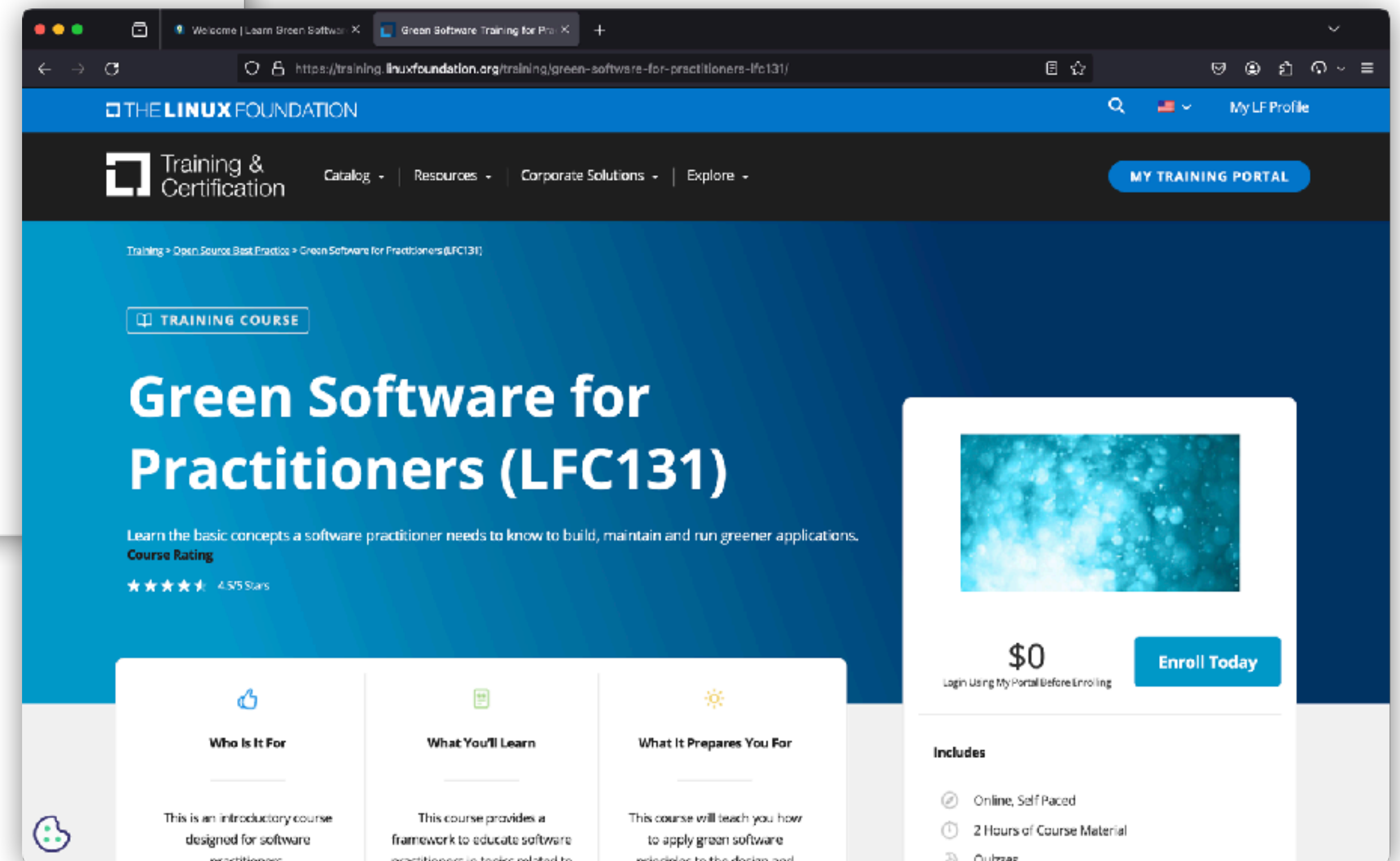
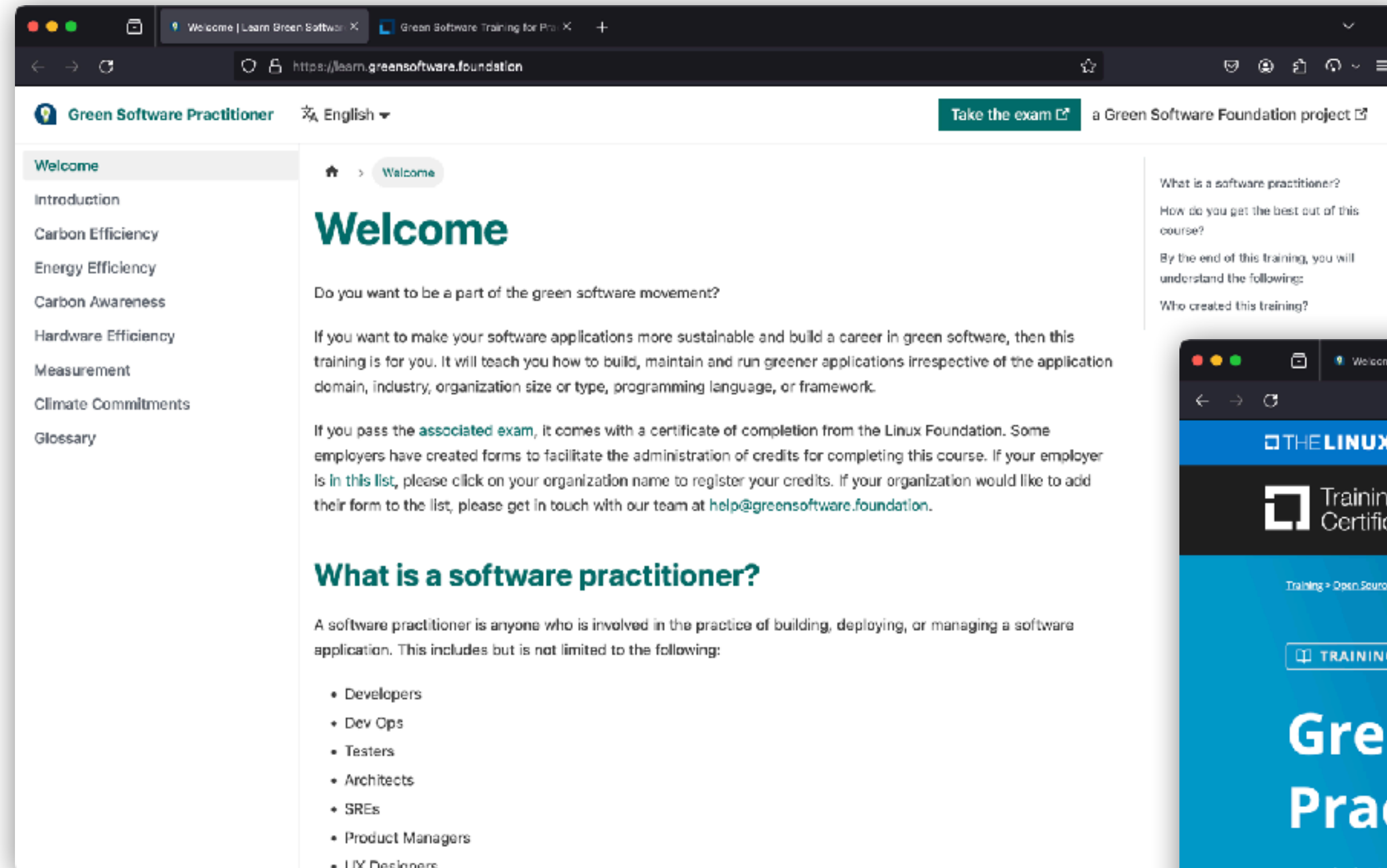
```
element ::after  
product-grid-slider  
er:after {  
animation: shine 2s linear infinite;  
@keyframes shine {  
0% { transform: rotate(110deg); background-color: #eaeaea 8%, #f5f5f5 8%, #eaeaea 33%; }  
100% { transform: rotate(-110deg); background-color: #eaeaea 8%, #f5f5f5 8%, #eaeaea 33%; }  
}  
border-radius: 300% 100%;  
font-size: 100%;  
text-align: center;  
width: 100%;  
position: absolute;  
top: 0;  
left: 0;  
right: 0;  
bottom: 0;  
z-index: 1000;  
}
```



**Where to go from here?**

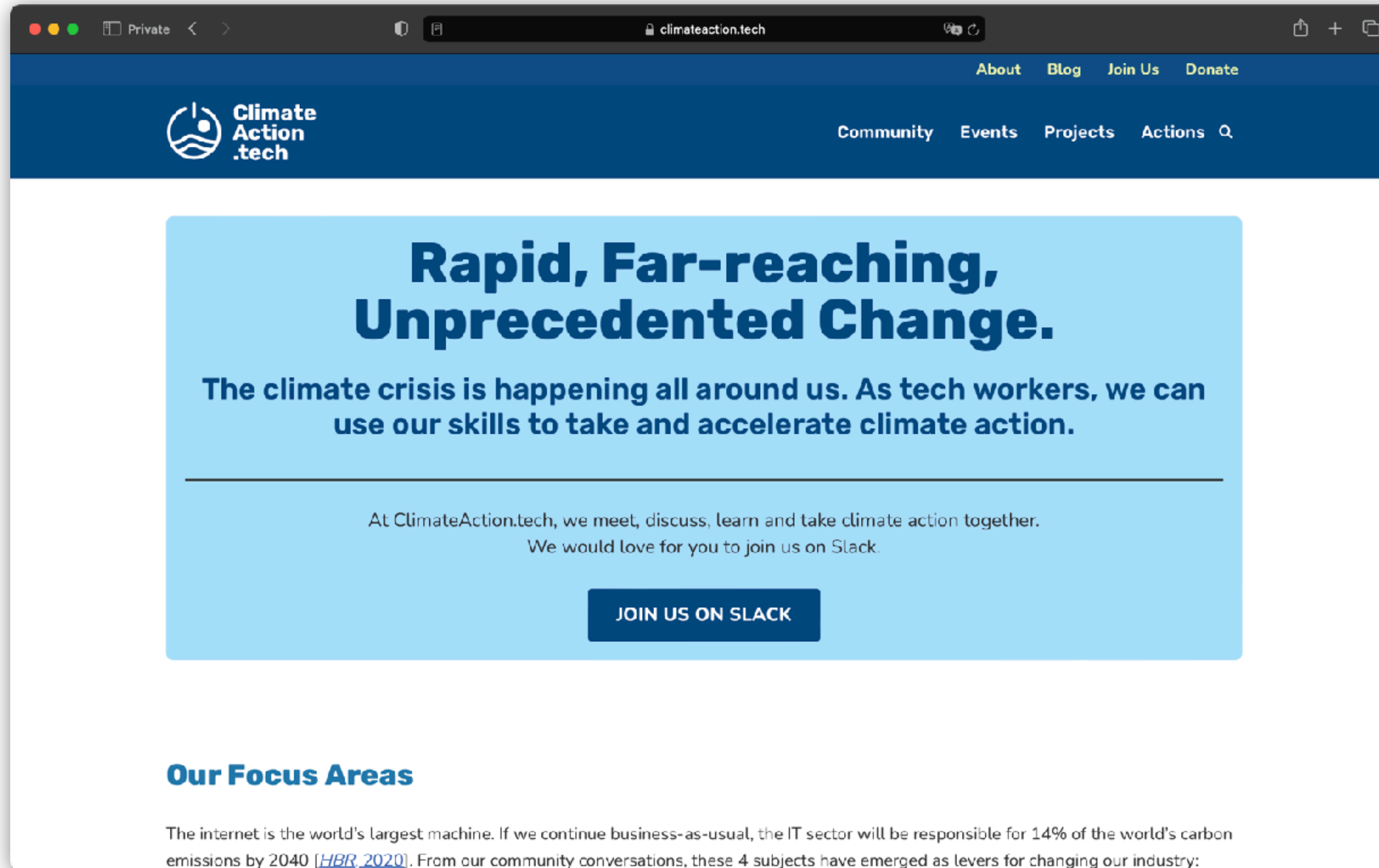


# Online Training



Green Software Practitioner courses by the [Green Software Foundation](https://learn.greensoftware.foundation) and [The Linux Foundation](https://training.linuxfoundation.org/training/green-software-for-practitioners-lfc131/)

# Online Community



The screenshot shows a web browser window with the URL `climateaction.tech`. The page features a dark blue header with the ClimateAction.tech logo on the left and navigation links for 'About', 'Blog', 'Join Us', and 'Donate' on the right. Below the header, there are additional navigation links for 'Community', 'Events', 'Projects', and 'Actions' with a search icon. The main content area is a light blue box with the following text:

## Rapid, Far-reaching, Unprecedented Change.

The climate crisis is happening all around us. As tech workers, we can use our skills to take and accelerate climate action.

---

At ClimateAction.tech, we meet, discuss, learn and take climate action together.  
We would love for you to join us on Slack.

[JOIN US ON SLACK](#)

### Our Focus Areas

The internet is the world's largest machine. If we continue business-as-usual, the IT sector will be responsible for 14% of the world's carbon emissions by 2040 [HBR, 2020]. From our community conversations, these 4 subjects have emerged as levers for changing our industry:

# Podcasts



# Follow on Social



SUSTAINABLE DIGITAL  
INFRASTRUCTURE ALLIANCE



Green  
Software  
Foundation



GREEN WEB  
FOUNDATION

**Let's wrap it up...**

# Key Points

## **AWARENESS**

ICT has an environmental cost

Software enables savings in other sectors, but it needs to do so sustainably

Talk to others about digital sustainability

## **BUILD SUSTAINABLY**

Only build what's needed and delete what's no longer needed

Use green hosts & cloud

Ship less code, cache, compress, minify

Focus on performance and accessibility

Lazy-load and use façades for what's not immediately needed

Optimize media and images

Rely on HTML standards instead of JavaScript frameworks and libraries

## **MEASURE**

Establish performance budgets

Measure and monitor performance

Try out the Impact Framework

## **OPTIMIZE**

Debug memory leaks, JavaScript performance and excessive rendering work and animations

# Thanks!

Notes, Links, Slides:

**[screenspan.net/talks/digital-sustainability/](https://screenspan.net/talks/digital-sustainability/)**