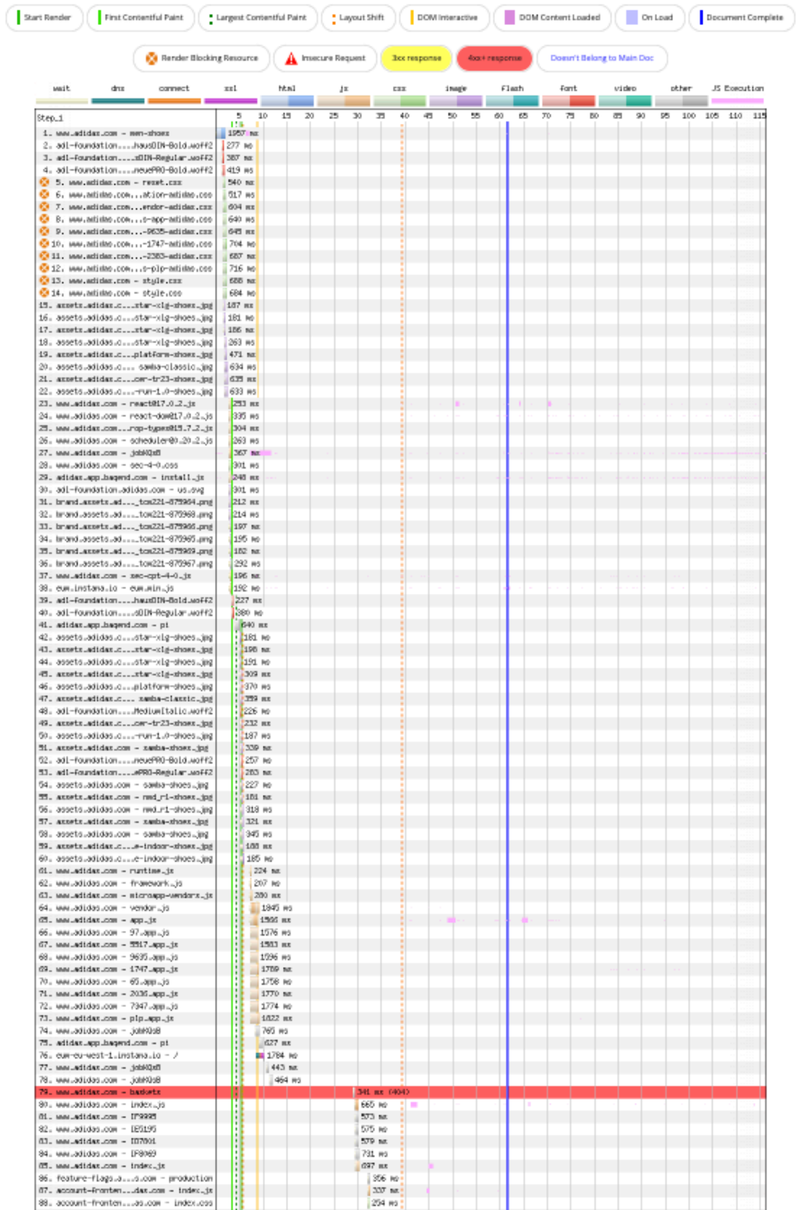
Why We Need a Green Perf Metric

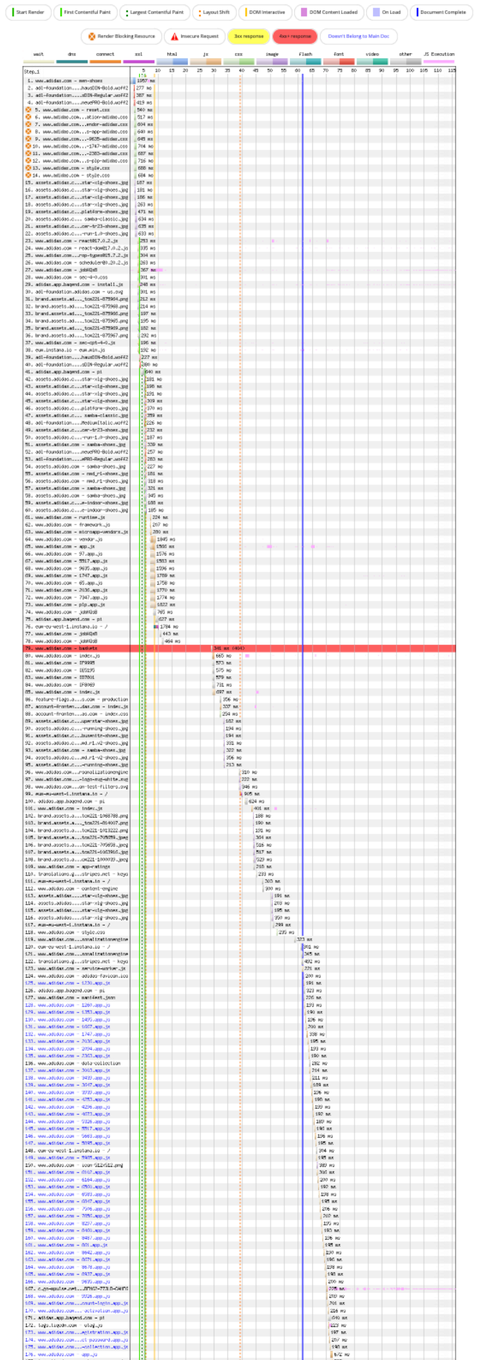
Brian Louis Ramirez
Web Perf Engineer @Speed Kit

Photo: Joyce Goverde, Performance.now() 2022

What do we have in common?

Photo: Joyce Goverde, Performance.now() 2022

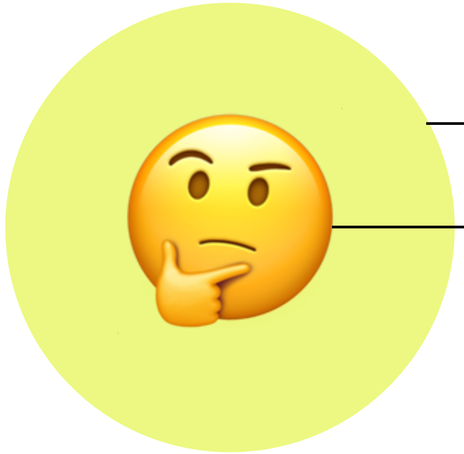

Start Render
First Contentful Paint
Largest Contentful Paint
Layout Shift
DOM Interactive
DOM Content Loaded
On Load
Document Complete
Render Blocking Resource
Insecure Request
3xx response
4xx+ response
Doesn't Belong to Main Doc
wait
dns
connect
ssl
html
js
css
image
Flash
font
video
other
JS Execution
Step_1



Mesure

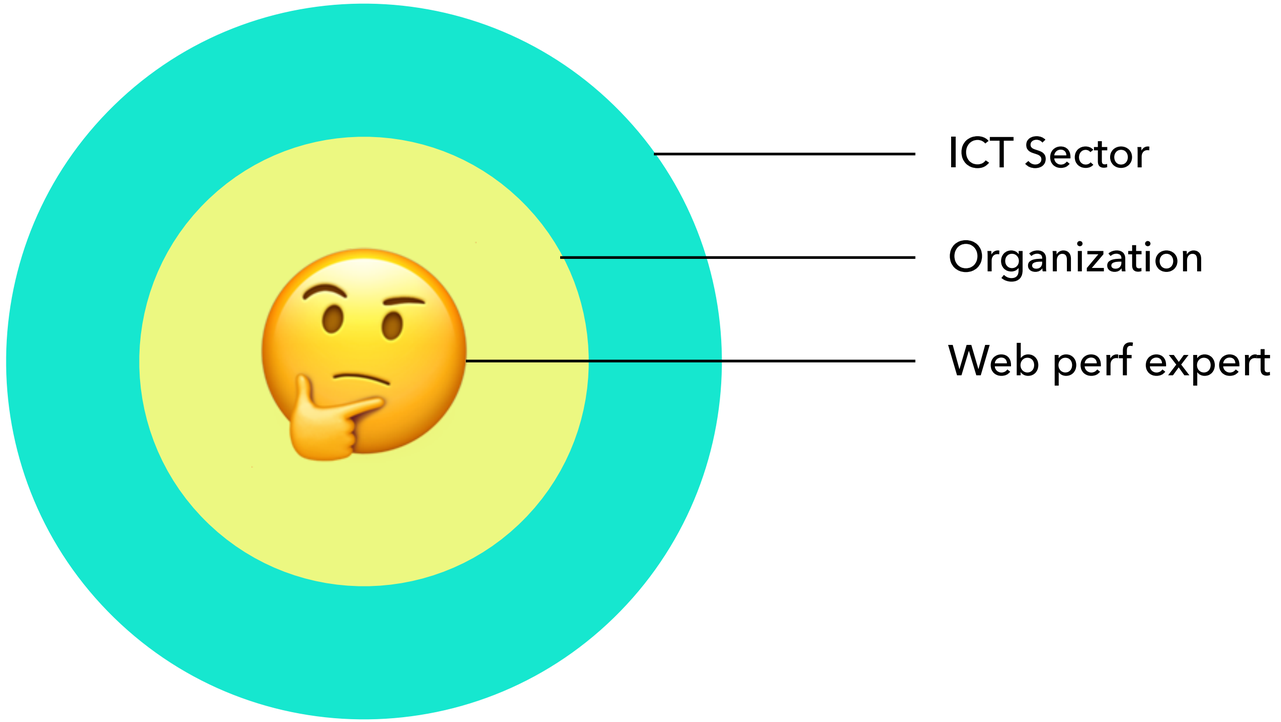
Investigate

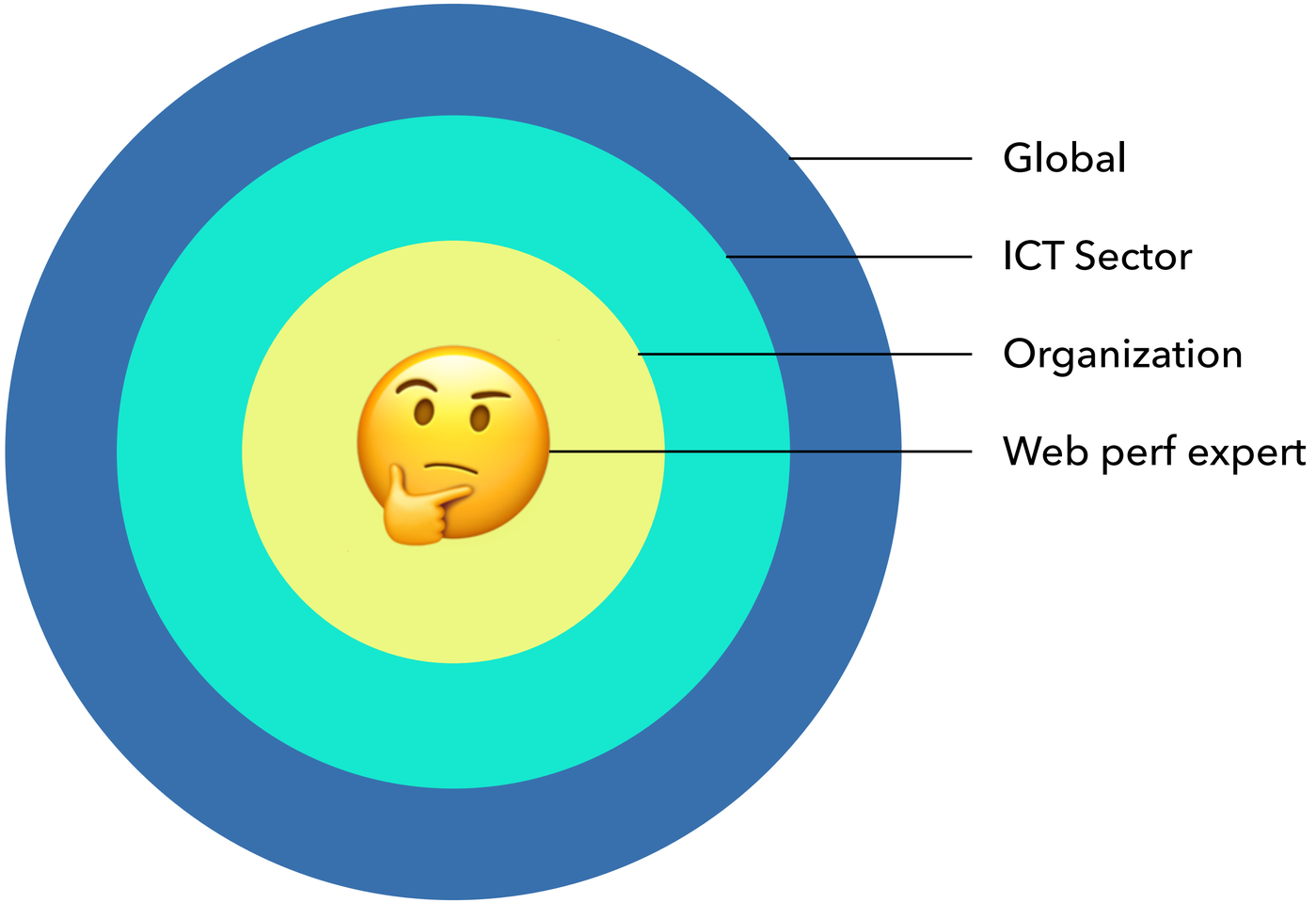
Optimize

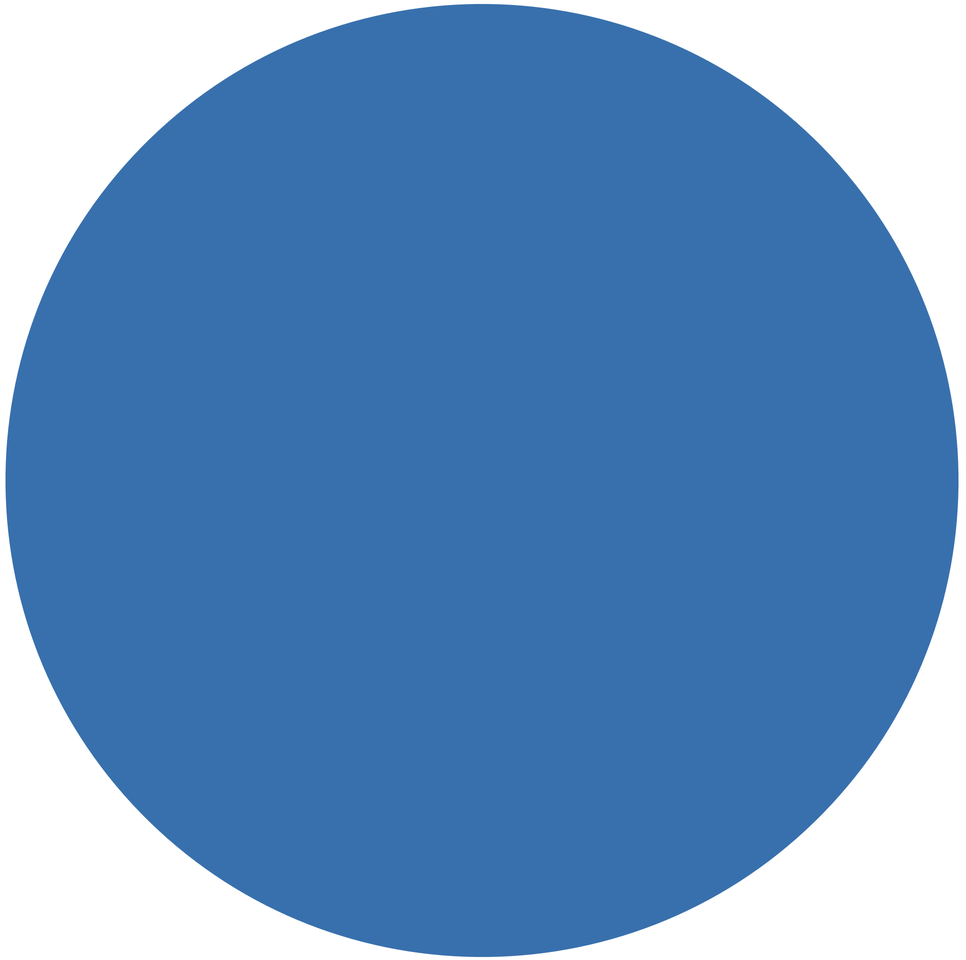


Organization

Web perf expert


ICT Sector
Organization
Web perf expert


Global
ICT Sector
Organization
Web perf expert



We all work on the
largest machine
ever built.

The Internet Machine

Energy,
Land,
Water,
Resources

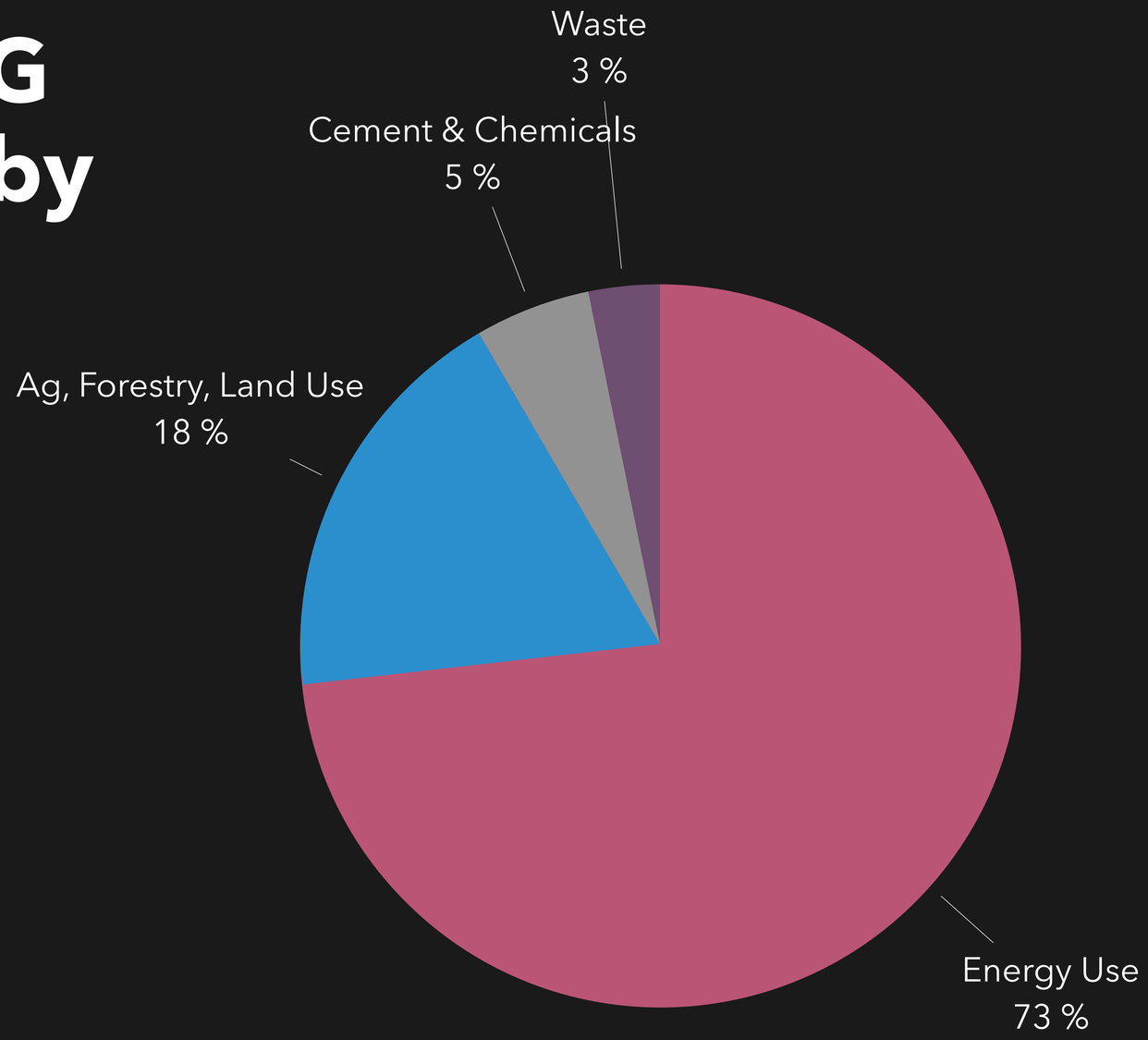
Data Centers

Networks

Devices

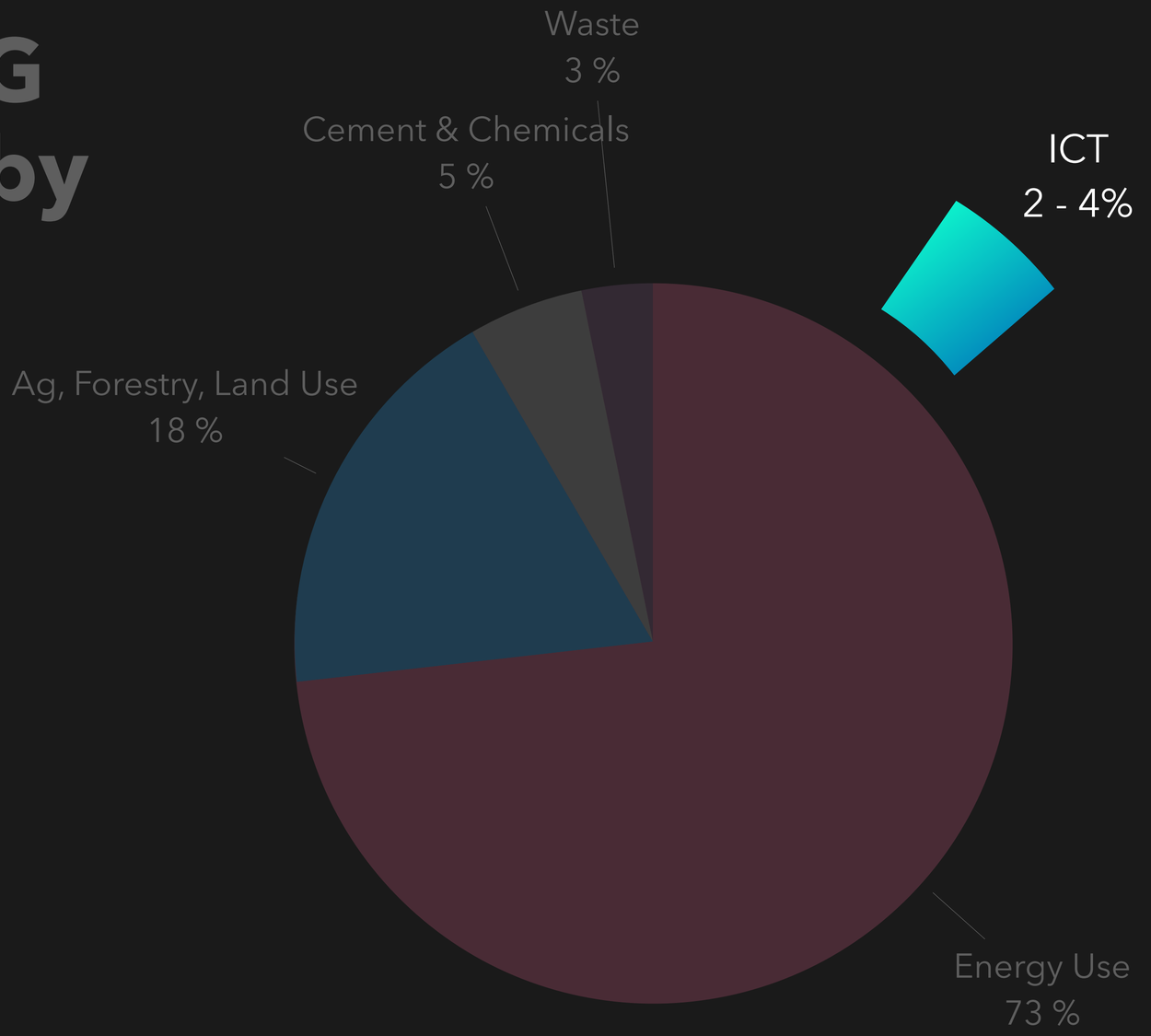
What is our impact?

Global GHG Emissions by Sector



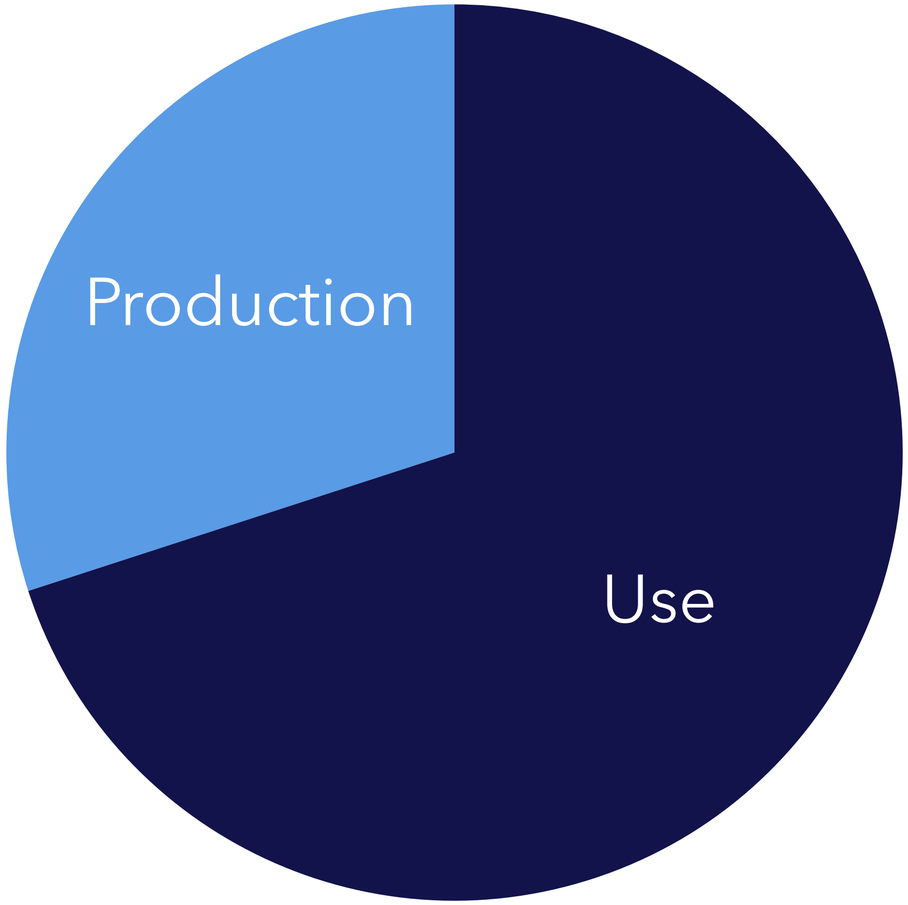
Source: ourworldindata.org/ghg-emissions-by-sector

Global GHG Emissions by Sector



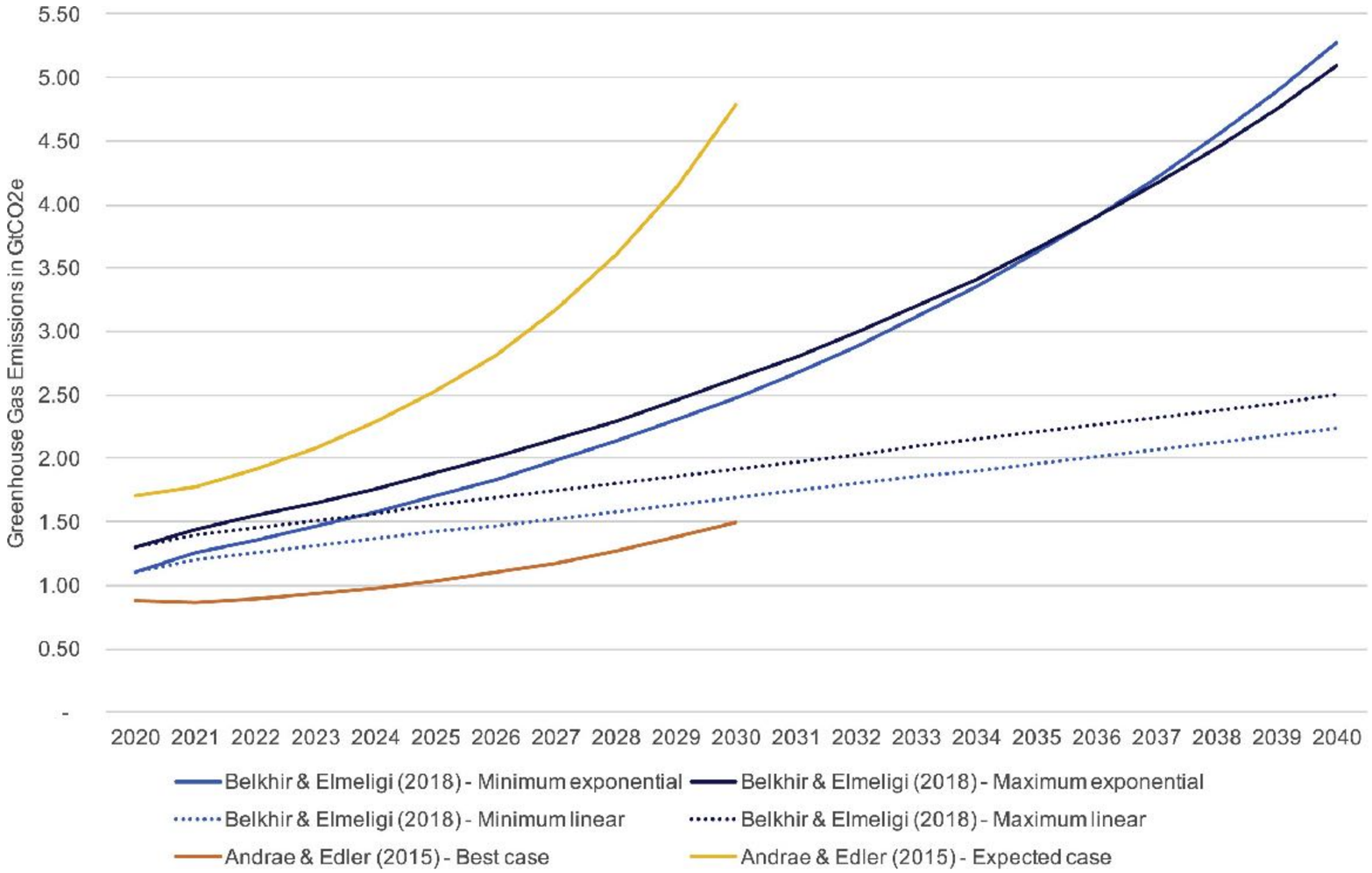
Source: ourworldindata.org/ghg-emissions-by-sector. "The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations" (2021) by Charlotte Freitag, Mike Berners-Lee, et al.

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



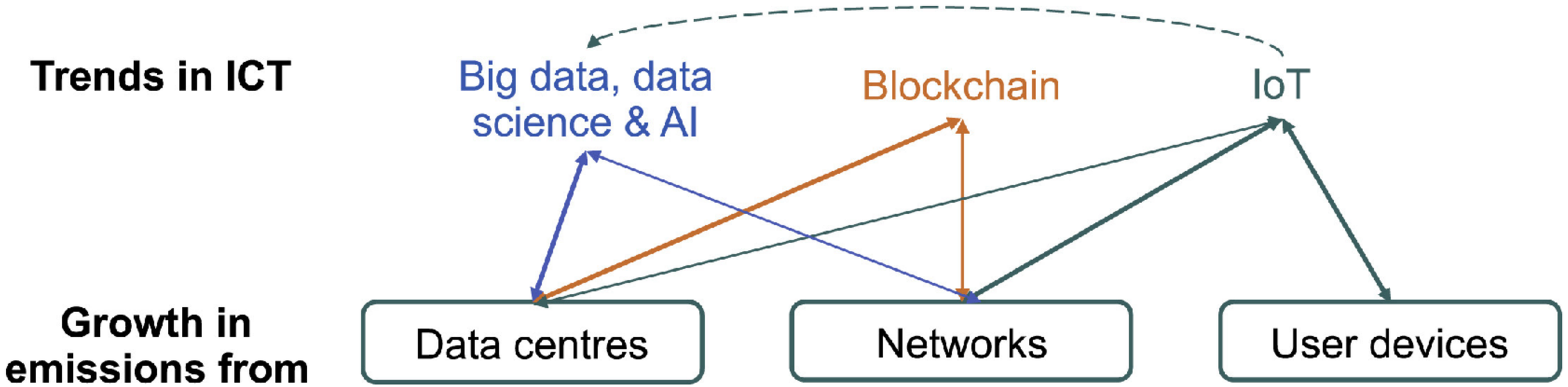
Source: "The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations" (2021) by Charlotte Freitag, Mike Berners-Lee, et al.

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

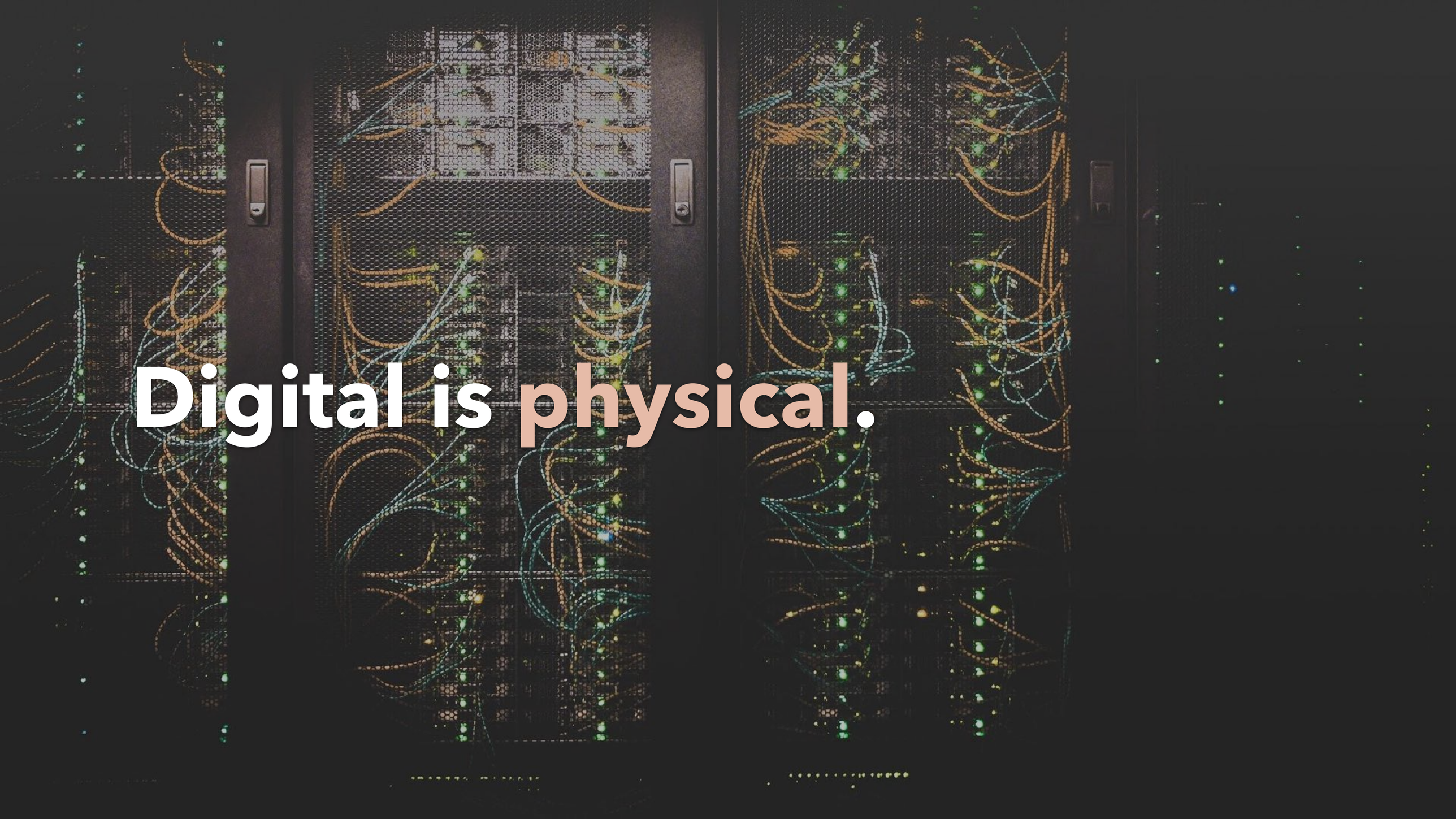


Source: "The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations" (2021) by Charlotte Freitag, Mike Berners-Lee, et al.

We need to shift how we consume on the planet, because we have exceeded the limits.

David Obura, Coral Reef Expert

Source: "The Scientists Watching Their Life's Work Disappear", New York Times, Oct. 26, 2023


Digital is physical.

Digital is social.

https://www.ft.com/content/c6909812-9ce4-11e9-9c06-a4640c9feebb

Our job:

Make the web faster.

Source: formulapedia.com

Our biggest challenges

Too much energy use

Too many devices

Our biggest challenges
What we do already

Too much energy use

- Reduce page weight
- Optimize media
- Audit 3P, use façades
- Compression, minification
- Caching
- Lazy-loading
- Remove unused code
- Perf budgets

Too many devices

- Support legacy, progressively

Our biggest challenges
What we should avoid

Too much energy use

- “Shotgun” preloading
- Too many media formats
- Tracking data without end-of-life

Too many devices

Our biggest challenges
What more we can do

Too much energy use

- Measure green metrics
- Green hosting / cloud
- Carbon awareness
- a11y
- Environmental budgets

Too many devices

- Cloud/ISP carbon data

Our biggest challenges
What more we can do

Too much energy use

Too many devices

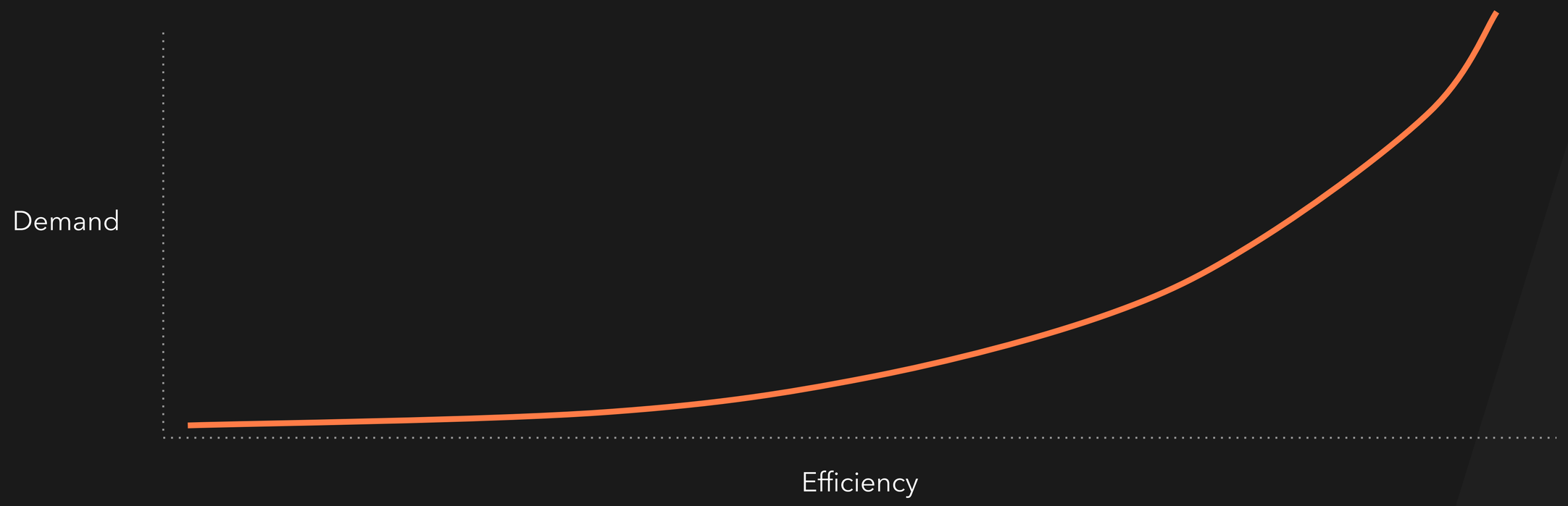
Our biggest challenges
What more we can do

Too much energy use

Too many devices

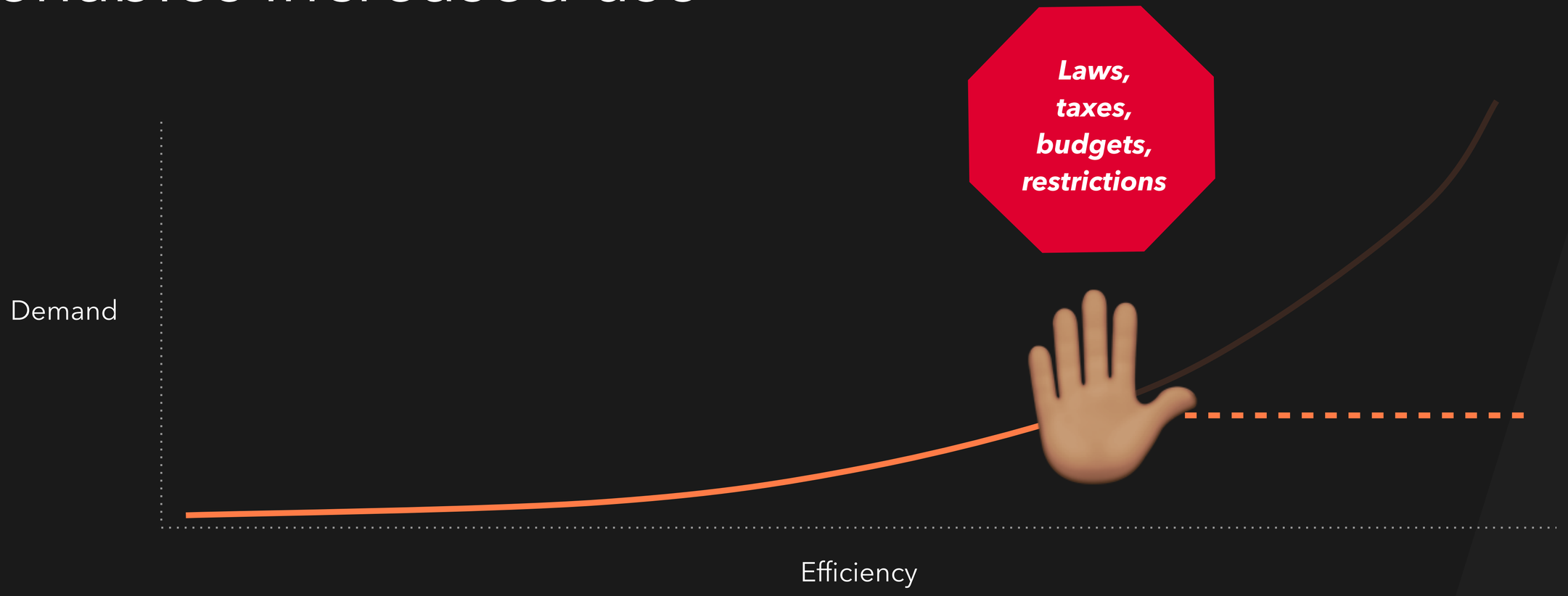
Human behavior

The Jevons Paradox
Increasing efficiency enables increased use



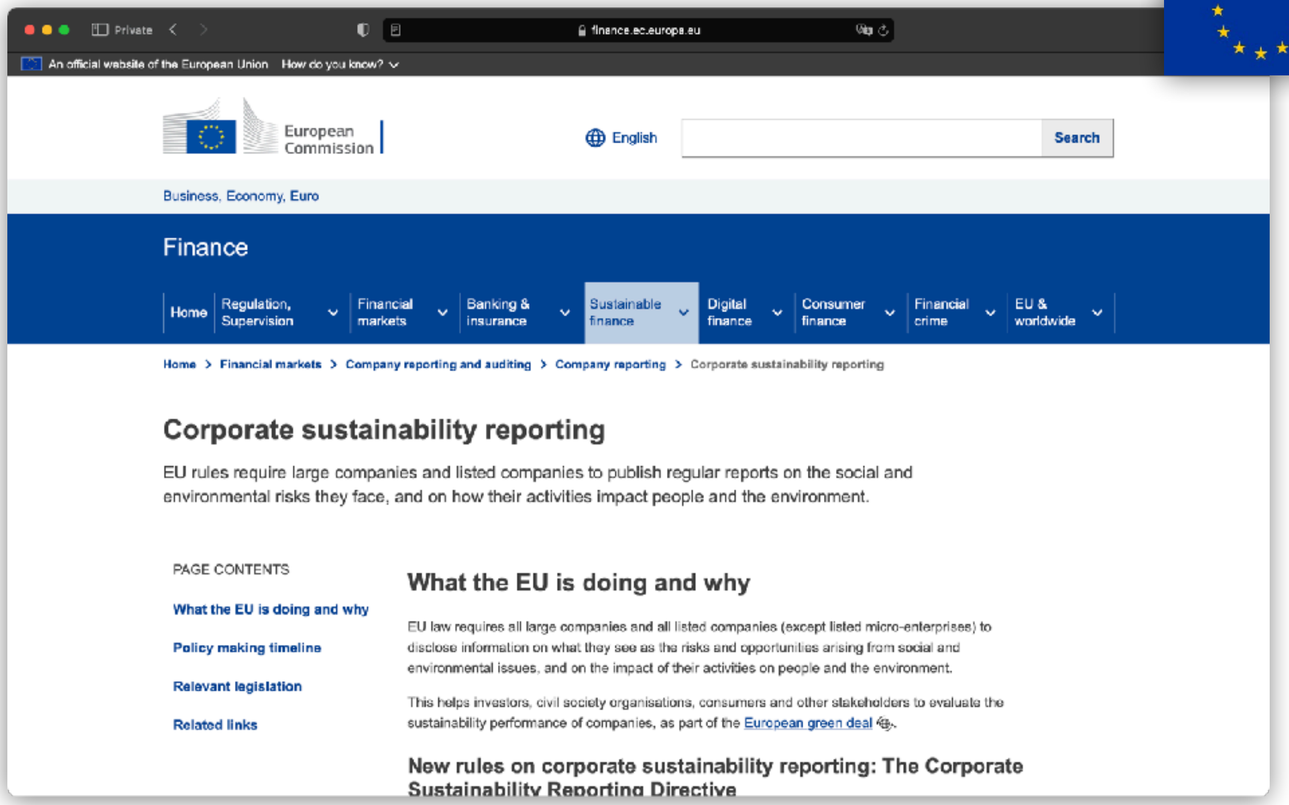
Source: Wikipedia

The Jevons Paradox
Increasing efficiency enables increased use

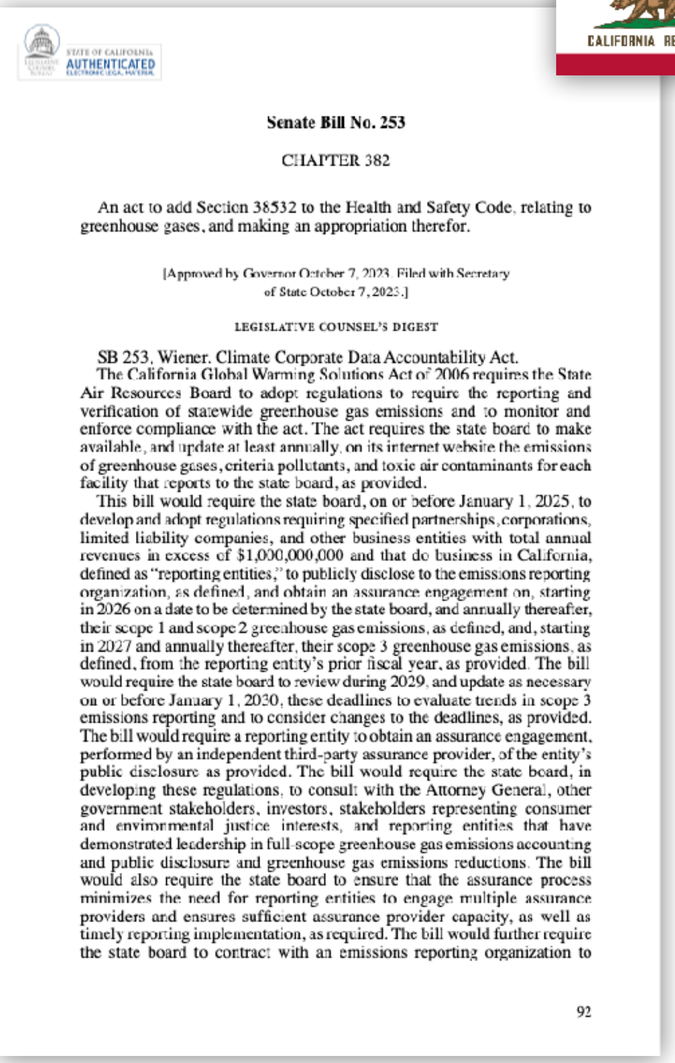


Source: Wikipedia

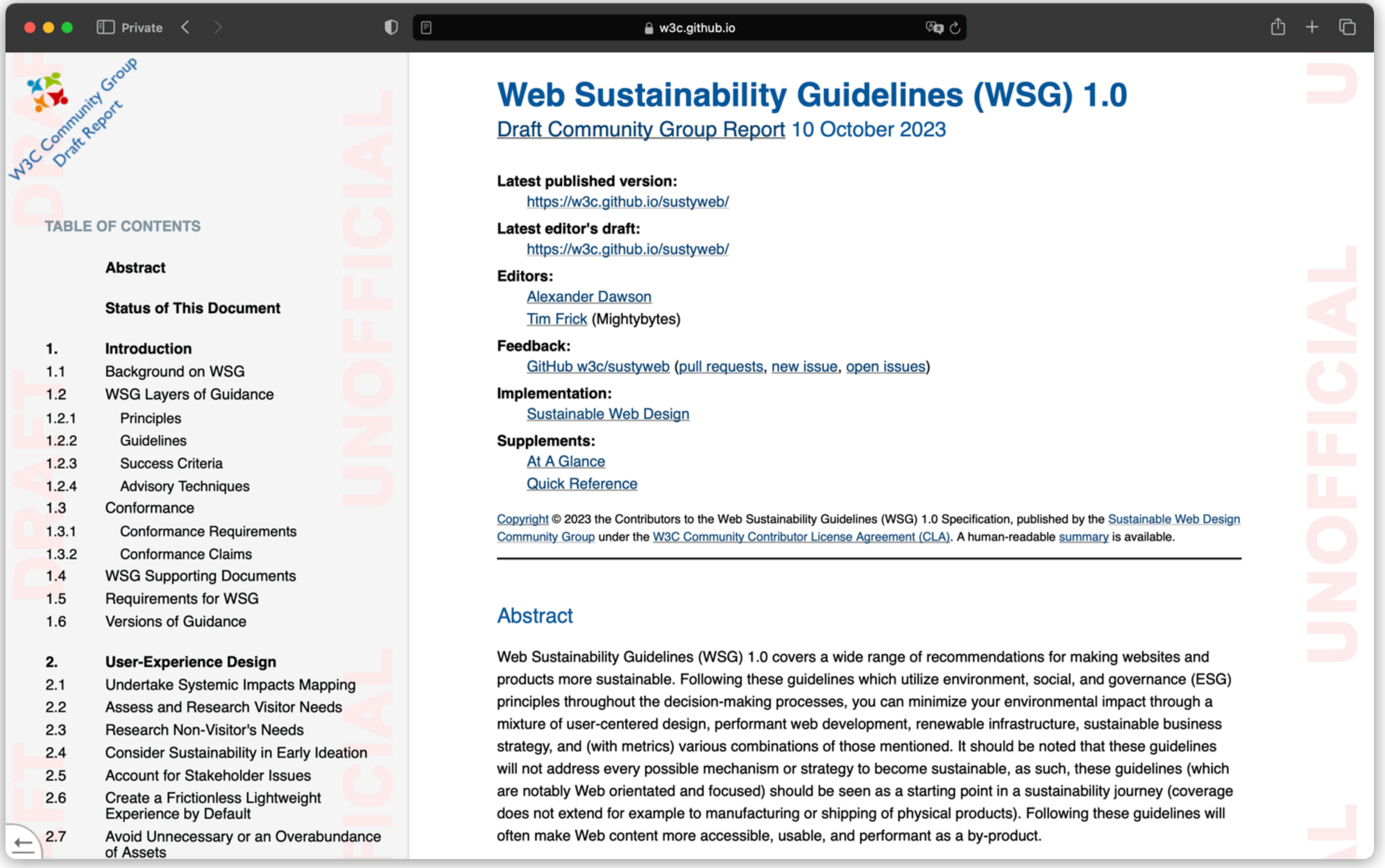
CSRD



CCDAA

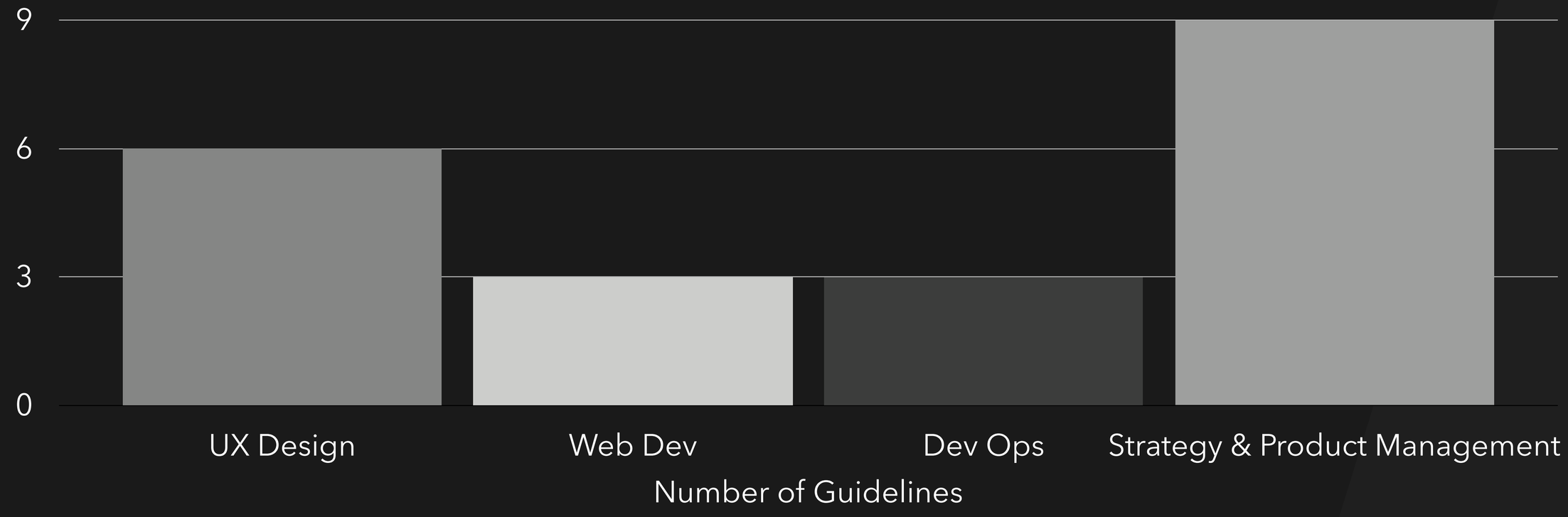


The EU's Corporate Sustainability Reporting Directive (CSRD); California's SB 253, the Climate Corporate Data Accountability Act (CCDAA)



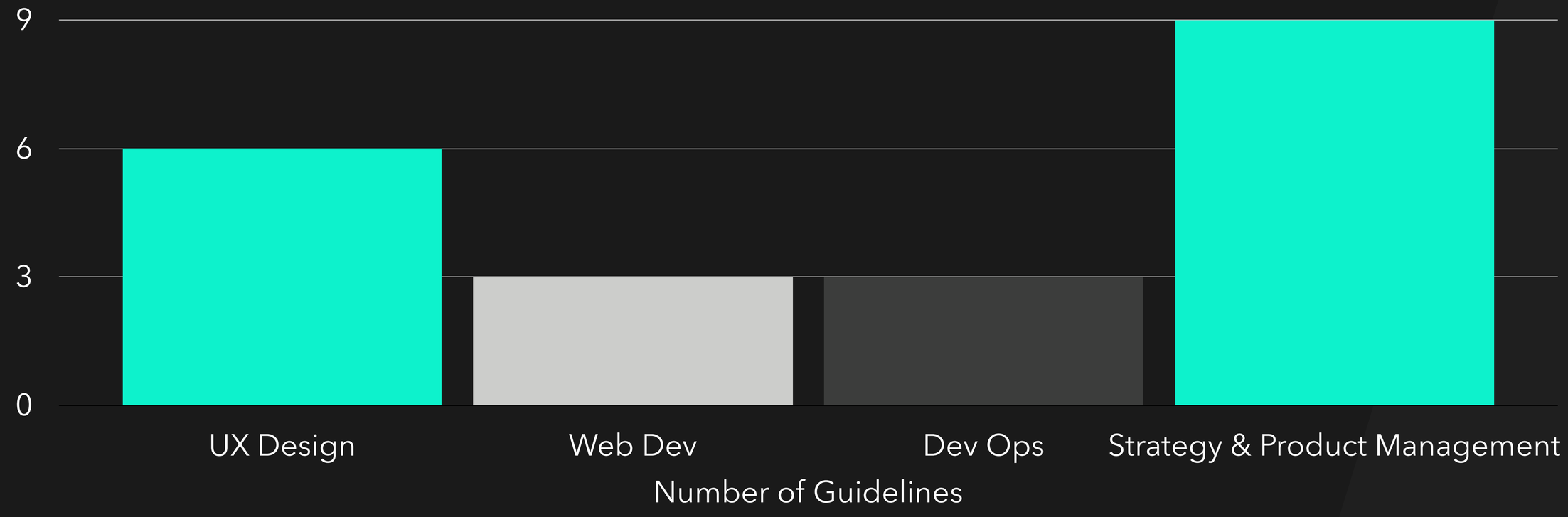
Source: https://w3c.github.io/sustyweb/

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-/Medium Effort



Source: “Web Sustainability Guidelines: Getting Started” by Brian Louis Ramirez, based on Web Sustainability Guidelines, v1, 2023

The biggest problems
What more we can do

Too much energy use

Too many devices

Human behavior

- Green Software Training
- Inform what not to build / what to delete
- Raise awareness
- Help devise sustainability strategy
- Activism

Our job:

Make the web faster.

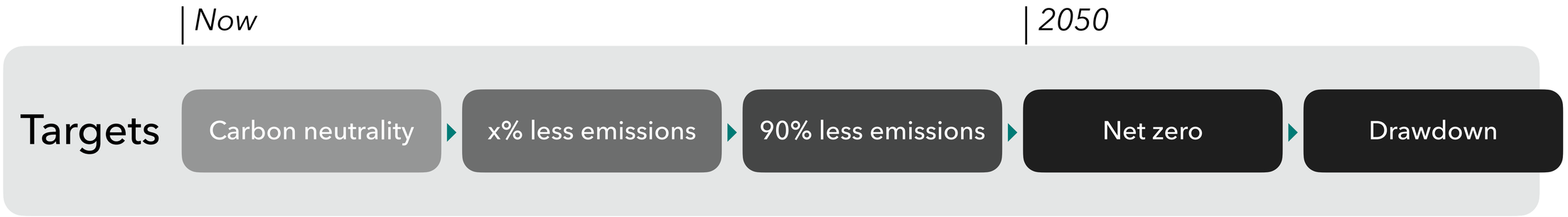
Our job:

Make the web faster *and* greener.

📏 Mesure

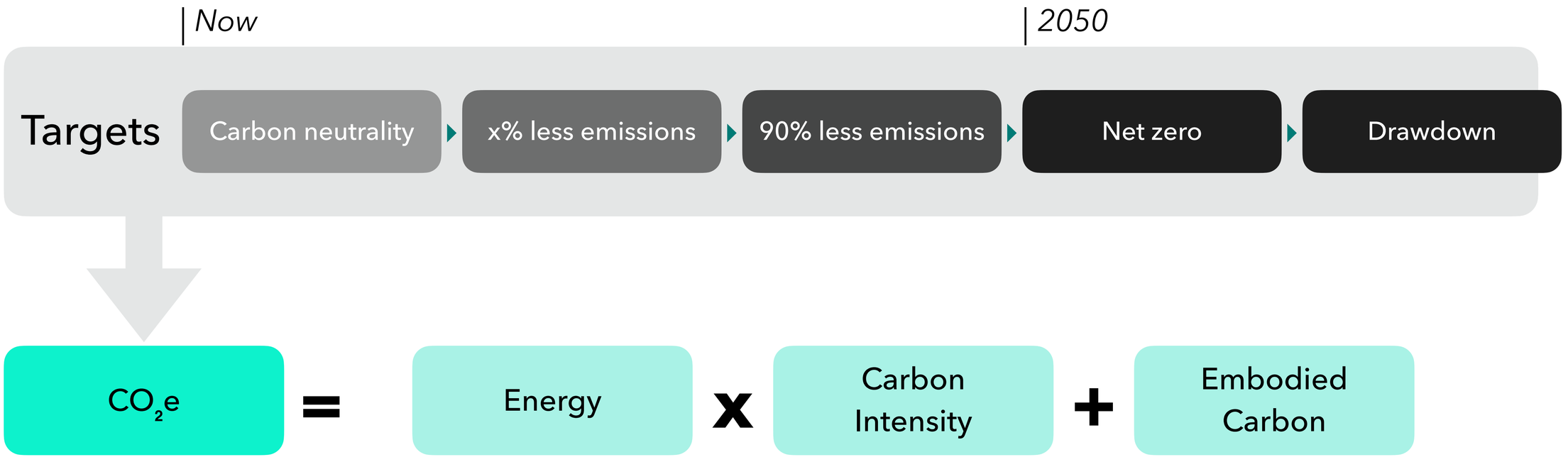
🕵🏾 Investigate

🔧 Optimize



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 perfect green metric



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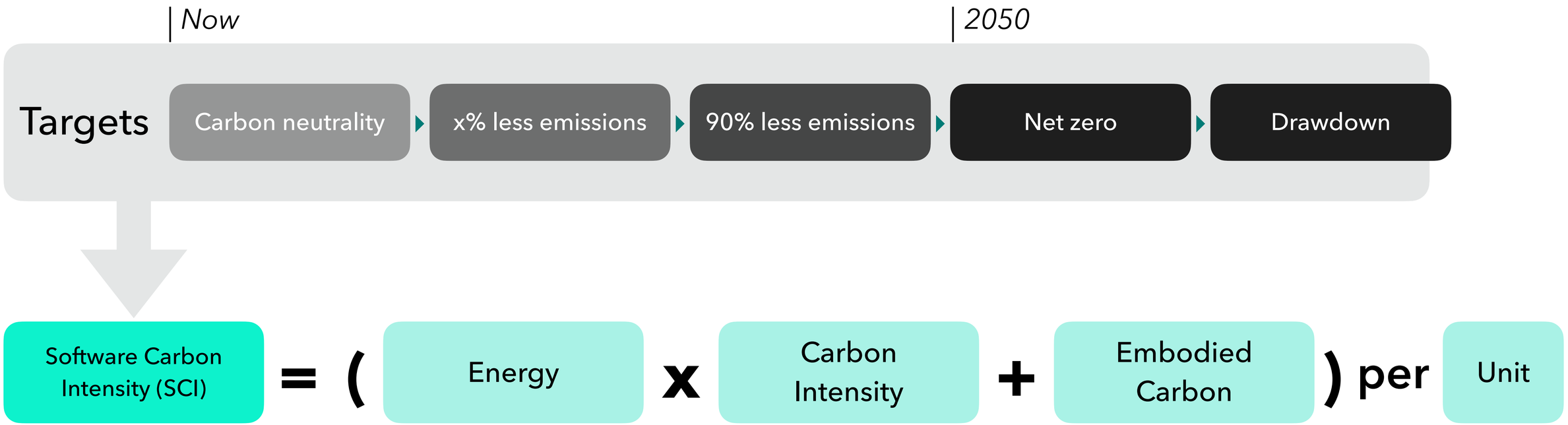
A good-enough green metric



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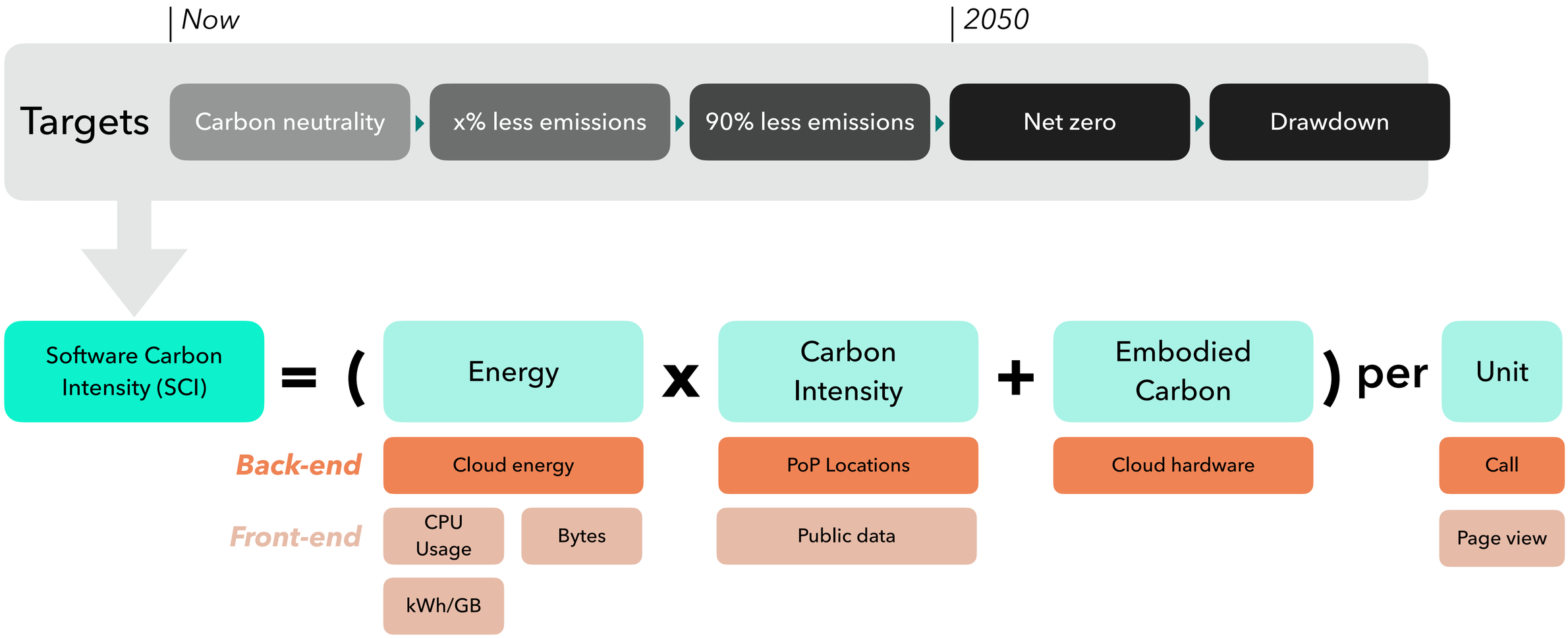

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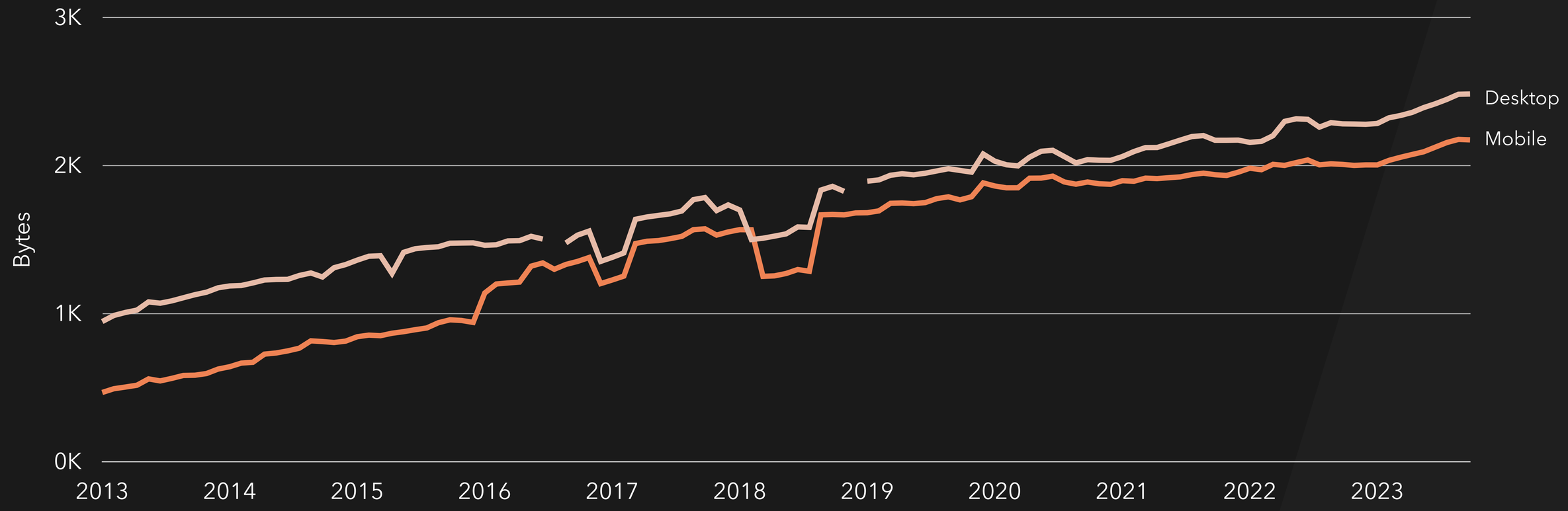
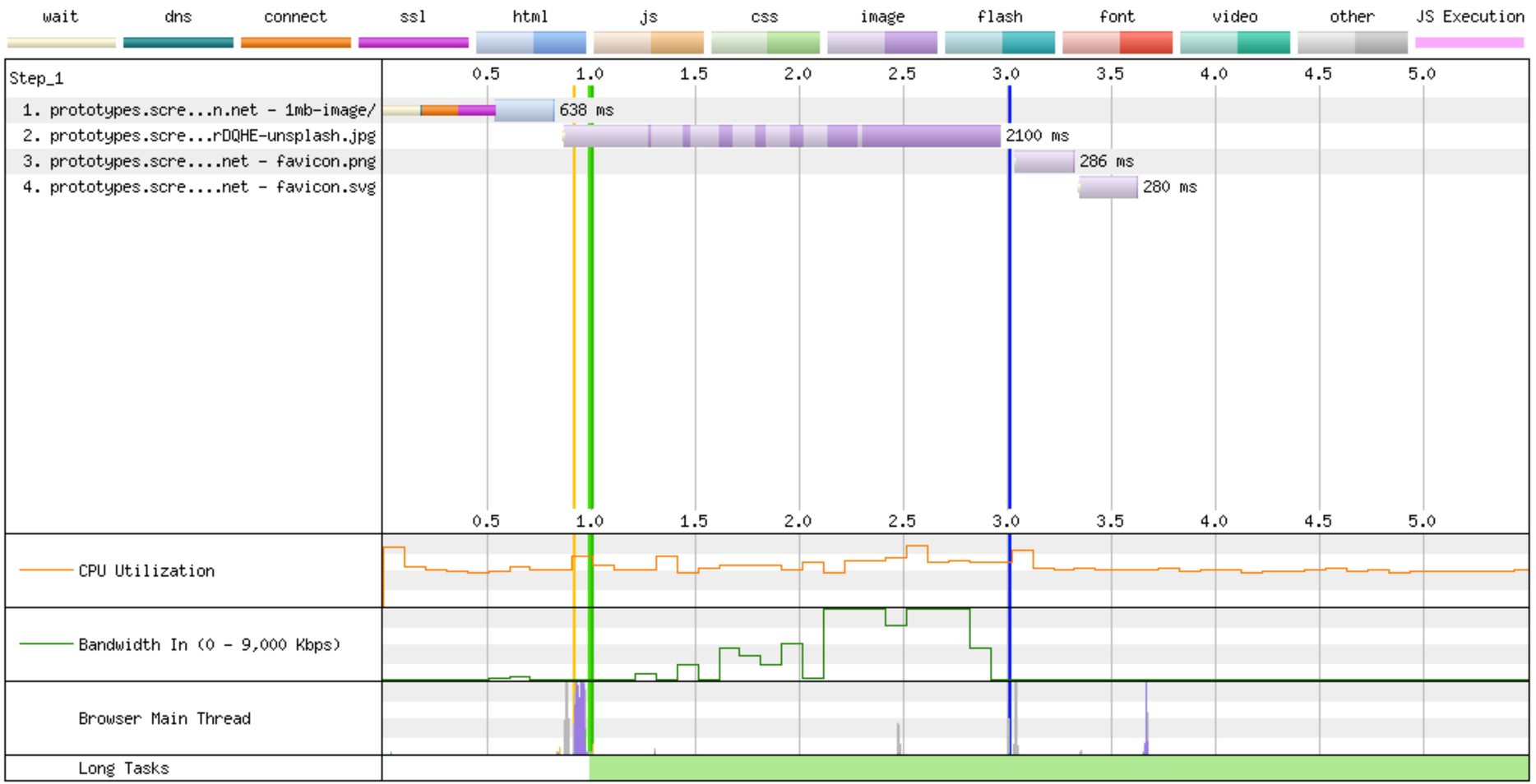
Webpages keep getting heavier



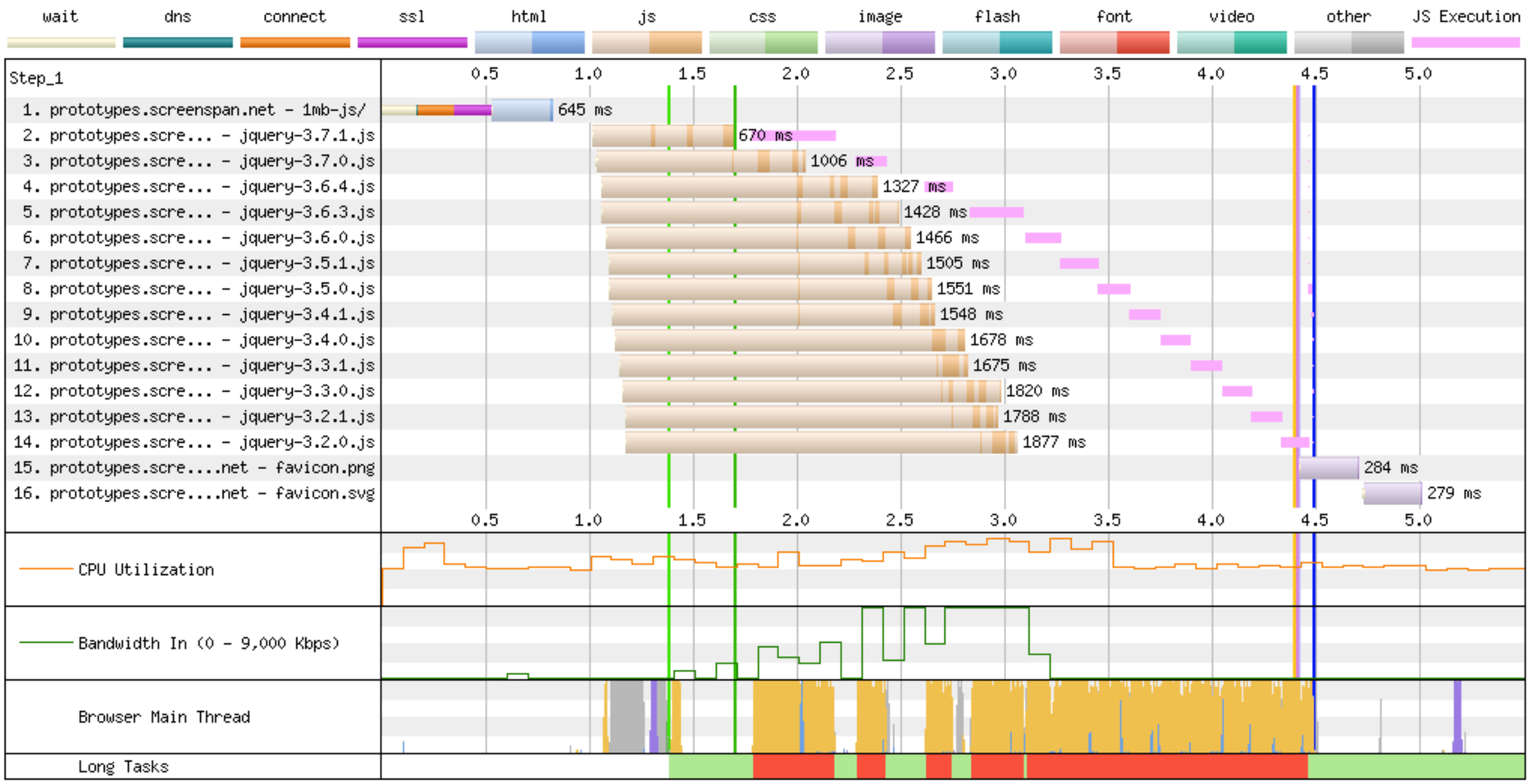
Source: HTTP Archive, Aug 2013 - Sept 2023, no lens

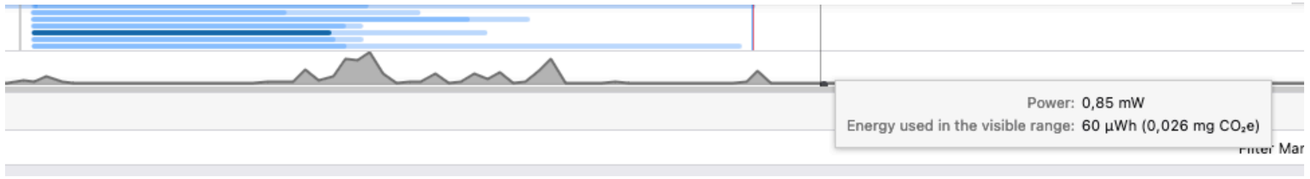
1 MB image file



Source: WebPageTest, Firefox Power Profiler

1 MB of JavaScript





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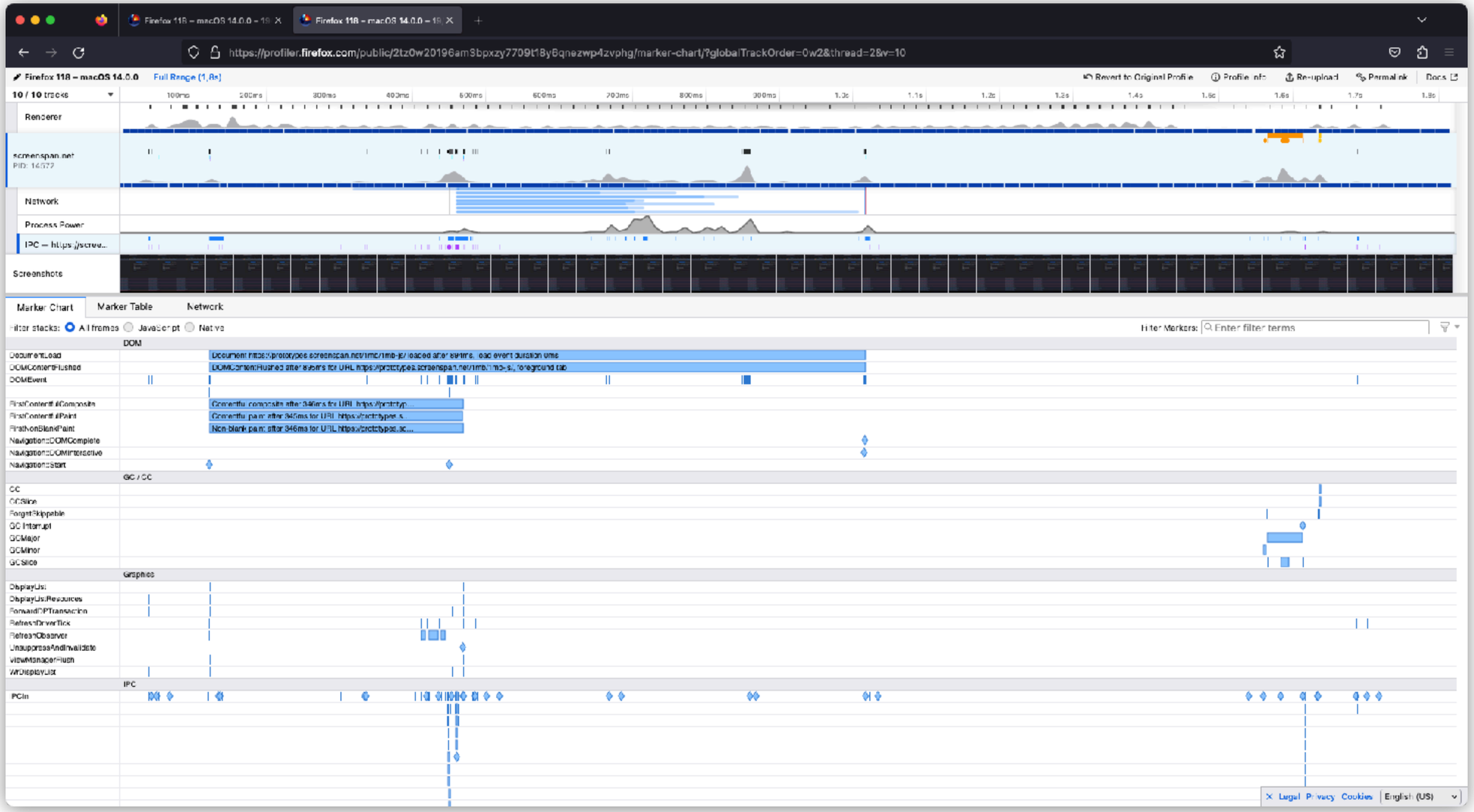
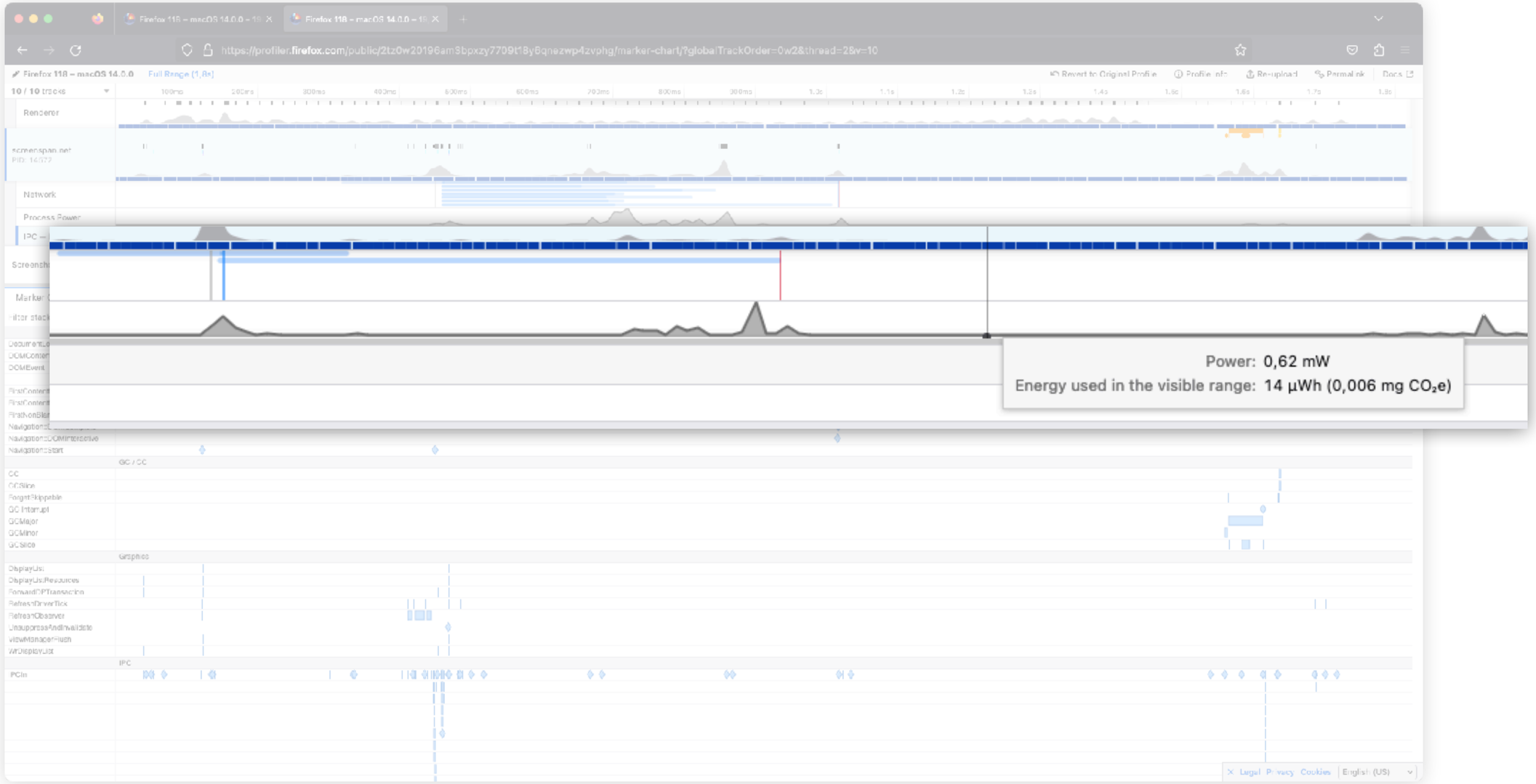
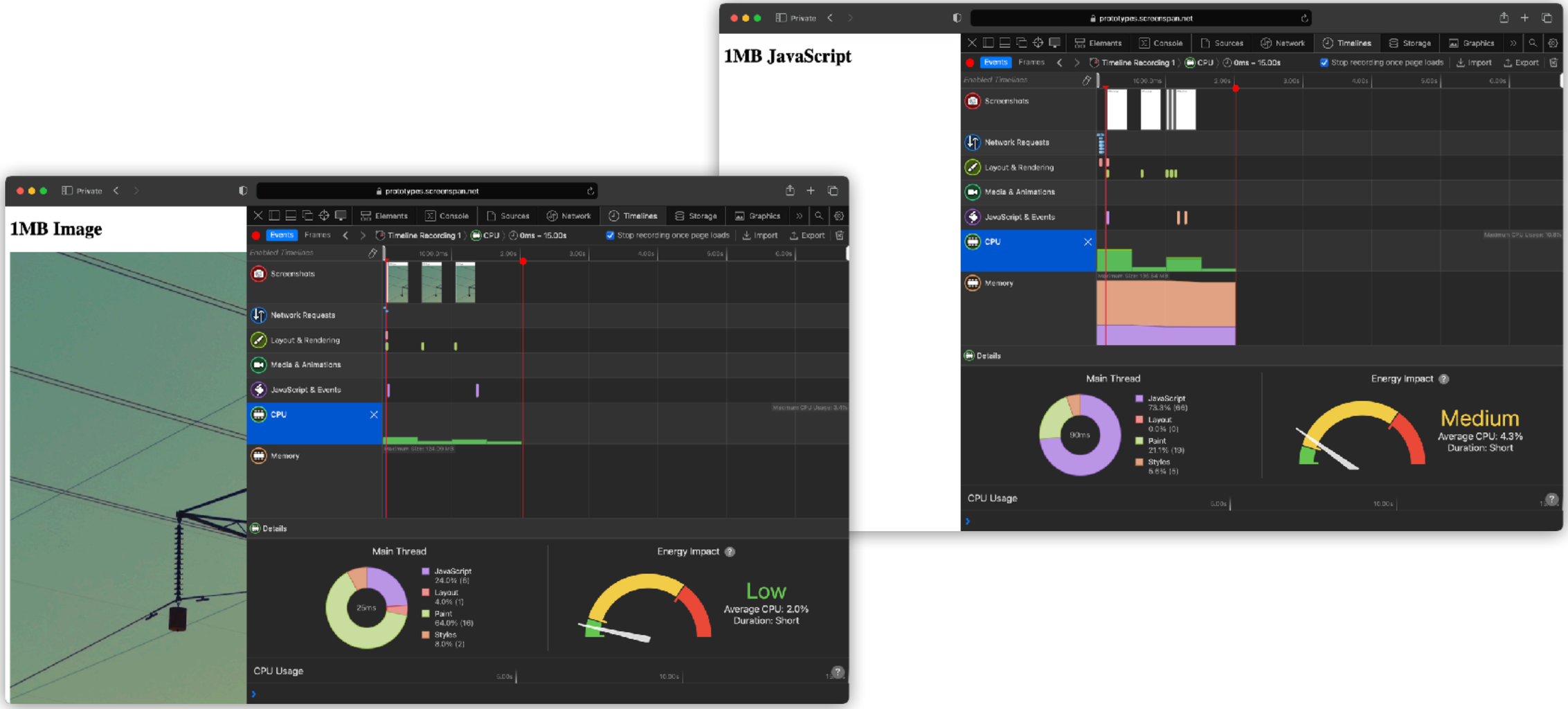
Firefox Power Profiler



Firefox Power Profiler

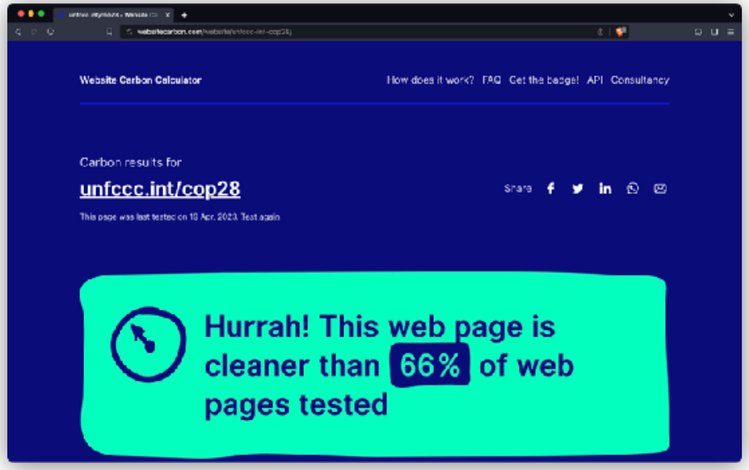


Safari Inspector

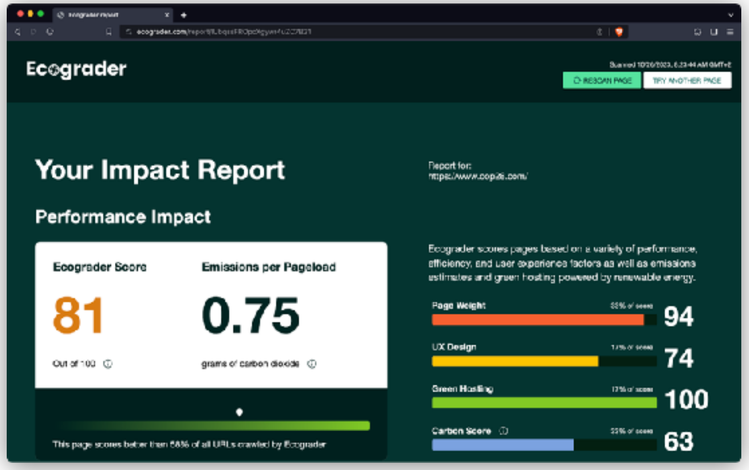


Front-end testing and monitoring

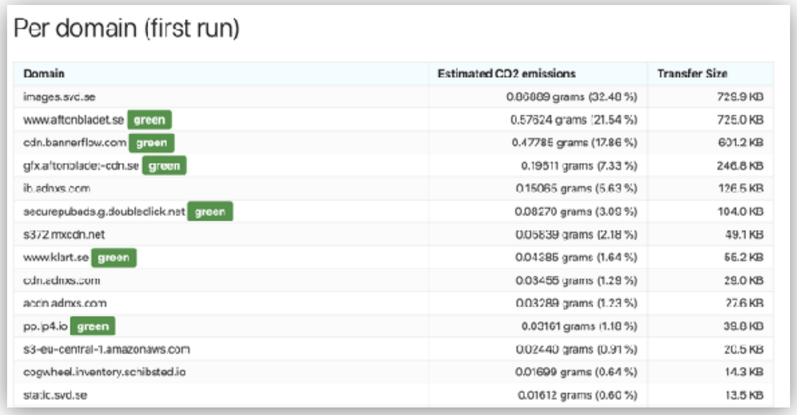
websitecarbon.com



ecograder.com



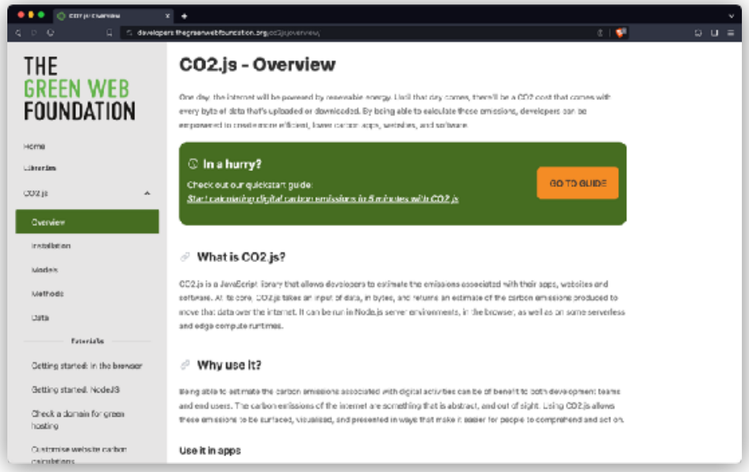
sitespeed.io



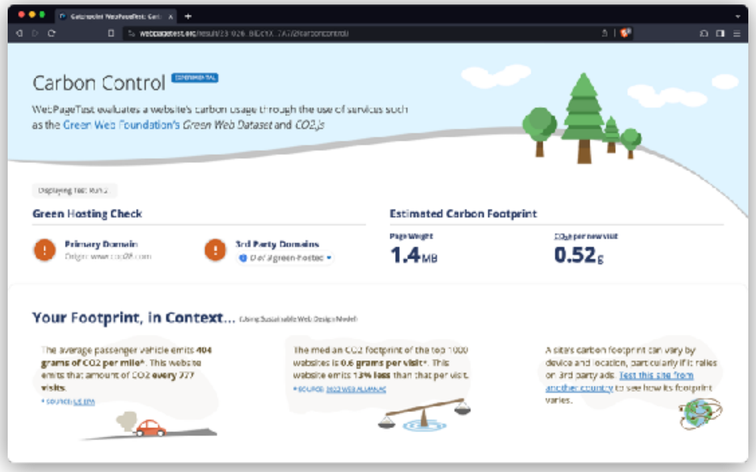
Per domain (first run)

Domain	Estimated CO2 emissions	Transfer Size
images.svc.se	0.06089 grams (32.40 %)	729.9 KB
www.aftonbladet.se green	0.57824 grams (21.54 %)	725.0 KB
cdn.bannerflow.com green	0.47786 grams (17.86 %)	601.2 KB
gfx.aftonbladet-cdn.se green	0.19511 grams (7.33 %)	246.8 KB
ib.adnxs.com	0.15065 grams (5.63 %)	126.5 KB
securepubads.g.doubleclick.net green	0.08270 grams (3.09 %)	104.0 KB
s372.mxcdn.net	0.05839 grams (2.18 %)	49.1 KB
www.klart.se green	0.04385 grams (1.64 %)	55.2 KB
cdn.eduns.com	0.03455 grams (1.29 %)	29.0 KB
acdn.adnxs.com	0.03289 grams (1.23 %)	27.6 KB
pp.p4.io green	0.02161 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



WebPageTest Carbon Control



Speetals

Missing APIs?

```
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
    }
}
```

Photo: Joyce Goverde, Performance.now() 2022