THE FUTURE OF DIGITAL GOVERNMENT IS green

HIDDE DE VRIES - USER NEEDS FIRST, AMSTERDAM - MAY 2025

developer, accessibility specialist, blogger

not alone in worrying about the climate crisis


NOKIA

hdv | Ecologi

https://ecologi.com/devries

hdv 👋

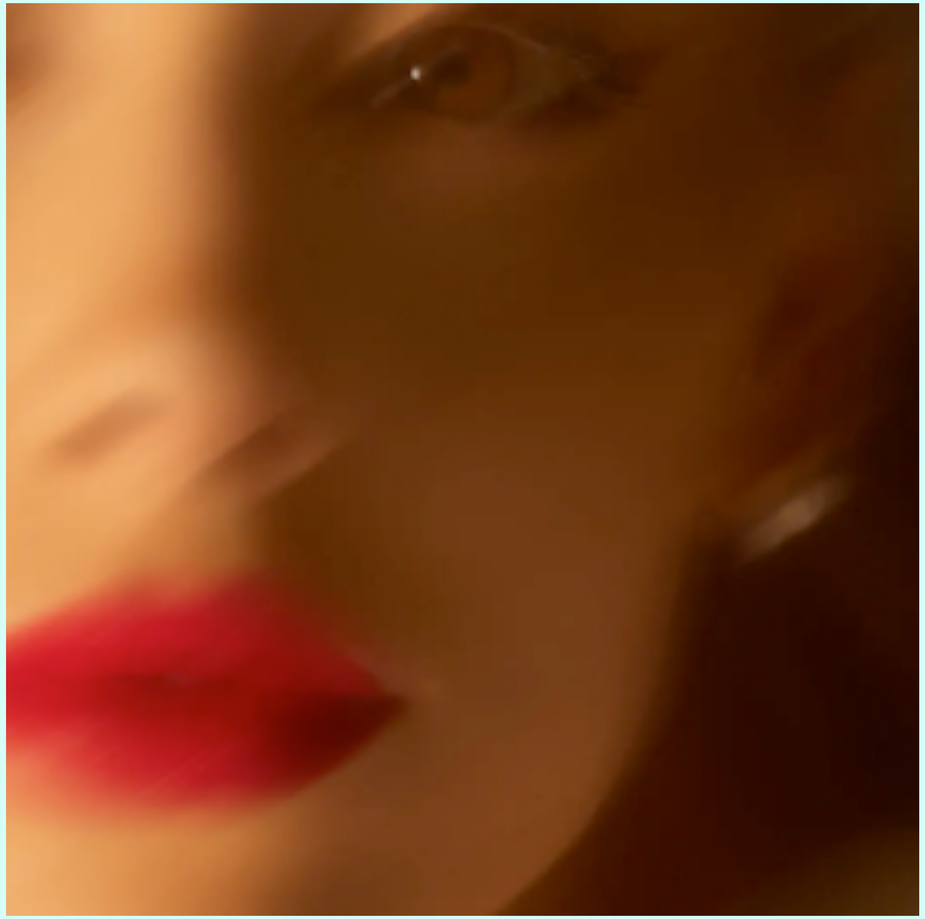
- Your profile
- Dashboard
- Project insights
- Impact shop
- Badges
- Account

Help centre

Logout

Hidde's forest

Buy more impact



Cover of Ariana Grande's single “Yes, And?”

Yes, we're all somewhat hypocritical.

And...

We can make
the world
greener faster
at work

PARIS AGREEMENT

The Parties to this Agreement,

Being Parties to the United Nations Framework Conve
Change, hereinafter referred to as "the Convention",

Pursuant to the Durban Platform for Enhanced Actio
decision 1/CP.17 of the Conference of the Parties to the
seventeenth session,

In pursuit of the objective of the Convention, and bei
principles, including the principle of equity and common
responsibilities and respective capabilities, in the light of

2015 Paris Agreement

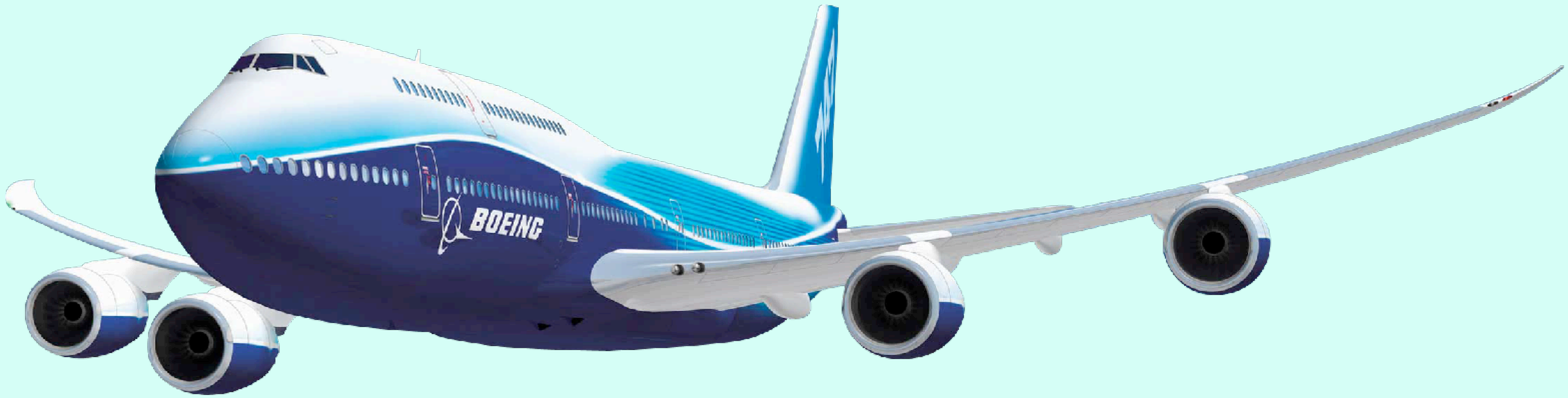
EC Digital Strategy 2030

Hidde

@hdv@front-end.social

Joined the first meeting of the new Web Sustainability Interest Group today, very excited to see this work progressing at W3C, hope to make time to contribute.

December 5, 2024 at 4:30:40 PM · · Ivory for iOS


BOEING

ICT emissions > aviation emissions

“If the internet was a country it would be the 13th largest emitter between Mexico and Brazil”

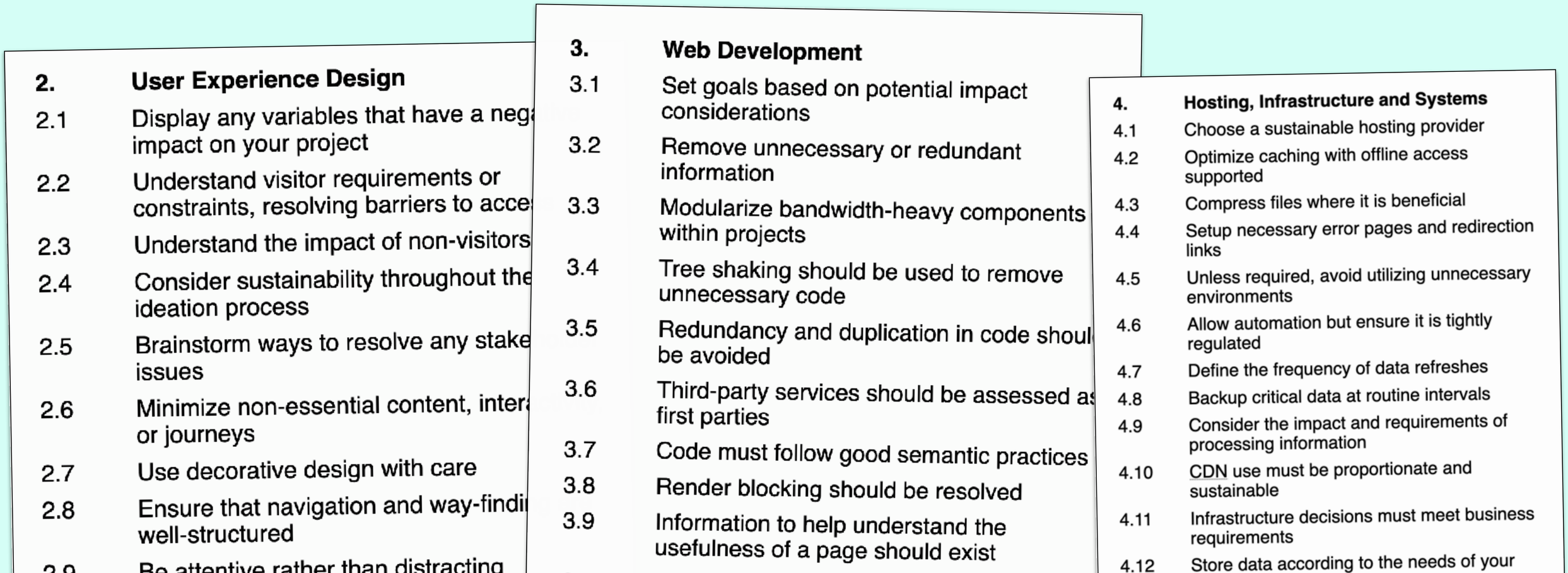
- Sustainable Web Manifesto
(based on CO^2 emissions in Our World in Data vs IT emissions data from Green Web Foundation)

“There is no magic button you can press”

– Hannah Smith (The Green Web Foundation)
at Pixel Pioneers 2022

youtube.com/watch?v=QZE2FuSDIoQ

Web Sustainability Guidelines



2. User Experience Design

2.1 Display any variables that have a nega… impact on your project

2.2 Understand visitor requirements or constraints, resolving barriers to acce…

2.3 Understand the impact of non-visitors…

2.4 Consider sustainability throughout the… ideation process

2.5 Brainstorm ways to resolve any stake… issues

2.6 Minimize non-essential content, intera… or journeys

2.7 Use decorative design with care

2.8 Ensure that navigation and way-findi… well-structured

2.9 Be attentive rather than distracting

3. Web Development

3.1 Set goals based on potential impact considerations

3.2 Remove unnecessary or redundant information

3.3 Modularize bandwidth-heavy components within projects

3.4 Tree shaking should be used to remove unnecessary code

3.5 Redundancy and duplication in code shoul… be avoided

3.6 Third-party services should be assessed as… first parties

3.7 Code must follow good semantic practices

3.8 Render blocking should be resolved

3.9 Information to help understand the usefulness of a page should exist

4. Hosting, Infrastructure and Systems

4.1 Choose a sustainable hosting provider

4.2 Optimize caching with offline access supported

4.3 Compress files where it is beneficial

4.4 Setup necessary error pages and redirection links

4.5 Unless required, avoid utilizing unnecessary environments

4.6 Allow automation but ensure it is tightly regulated

4.7 Define the frequency of data refreshes

4.8 Backup critical data at routine intervals

4.9 Consider the impact and requirements of processing information

4.10 CDN use must be proportionate and sustainable

4.11 Infrastructure decisions must meet business requirements

4.12 Store data according to the needs of your

6 principles

92 guidelines

253 success criteria

100+ contributors

User Experience Design

Hosting, Infrastructure & Systems

Web Development

Business Strategy & Product Management

Impact

Low
Quick wins

Medium
Noticeable sustainable impact

High
Significant long-term benefit

Effort

Low
Minimal implementation

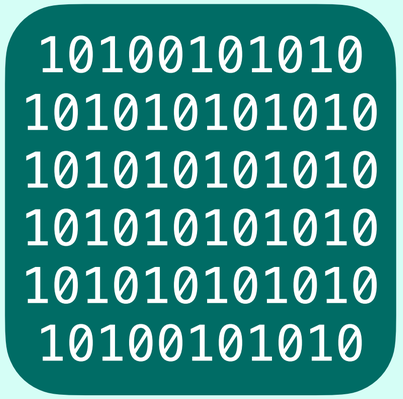
Medium
Some changes are needed

High
Heavy refactoring required

Progress over perfection

What adds to the footpint of our services?

Data centres
Emissions of server hardware (making and running)



Networks
Data downloads/ uploads

Consumer devices
Manufacturing laptops, phones, tablets that access the web

QUIZ TIME

When does a phone cause most carbon emission?

a. before it is in your hands (production)

b. during usage

c. after you own it

Product Environmental Report

iPhone 14 Pro

Date introduced
September 7, 2022

Made with better materials

100%
recycled gold in the wire of all cameras

100%
recycled rare earth elements in all magnets

Tackling climate change

100%
We're committed to transitioning our entire manufacturing supply chain to 100 percent renewable electricity by 2030.

by focusing
renewable
ram helped
ration.[4] Apple
e down

iPhone 14 Pro
life cycle carbon emissions

81%	Production
3%	Transport
15%	Use
<1%	End-of-life processing

by focusing
renewable
ram helped
ration.[4] Apple
e down

iPhone 14 Pro
life cycle carbon emissions

81%	Production
3%	Transport
15%	Use
<1%	End-of-life processing

Elimination vs offsetting

Elimination vs offsetting

1.

Make smaller web pages

Median website size is growing and growing...

Data: HTTPArchive

2011
467 kB

2025
2678 kB

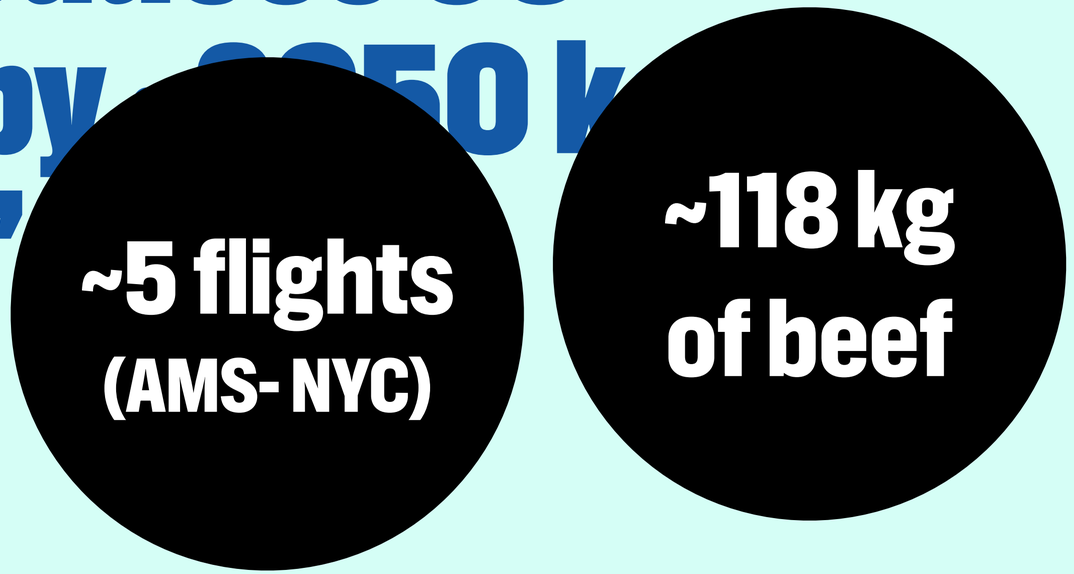
“Shaving off 1kB in a file that is loaded on 2 million websites reduces CO^2 emissions by ~2950 kg per month.”

- Danny van Kooten

dannyvankooten.com/blog/2020/website-carbon-emissions

“Shaving off 1kB in a file that is loaded on 2 million websites reduces CO^2 emissions by ~250 k per month.”

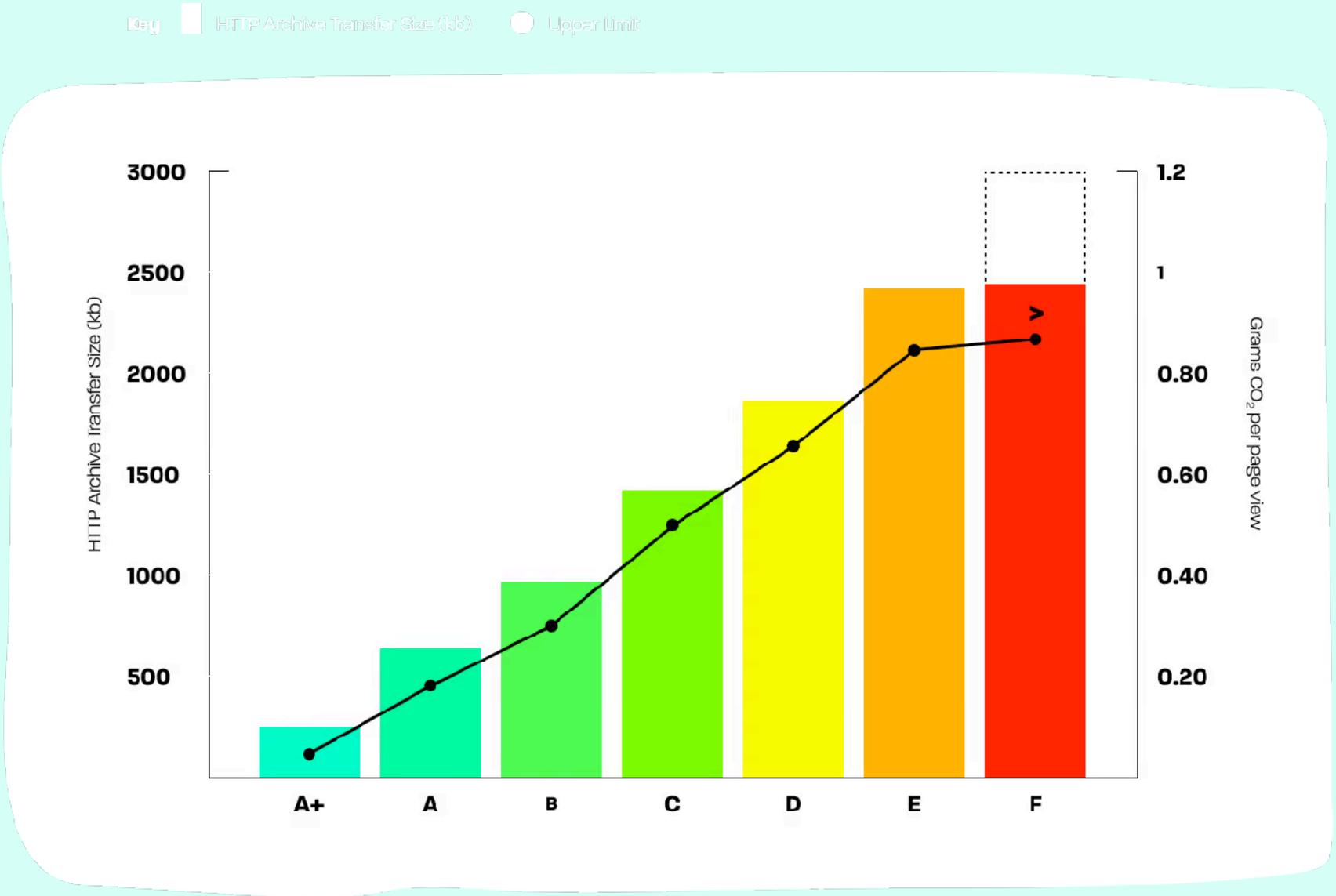
- Danny van Kooten



dannyvankooten.com/blog/2020/website-carbon-emissions

Website Carbon Rating Scale

based on Grams CO2e per pageview



websitecarbon.com/introducing-the-website-carbon-rating-system

websitecarbon.com

1 tree

This web page emits the amount of carbon that 1 tree absorbs in a year.

5kWh of energy

That's enough electricity to drive an electric car 33km.

Over a year, with 10,000 monthly page views, hidde.blog produces

1.99kg of CO2 equivalent.

As much CO2 as boiling water for 270 cups of tea

Note on the numbers

EASIER TO MEASURE

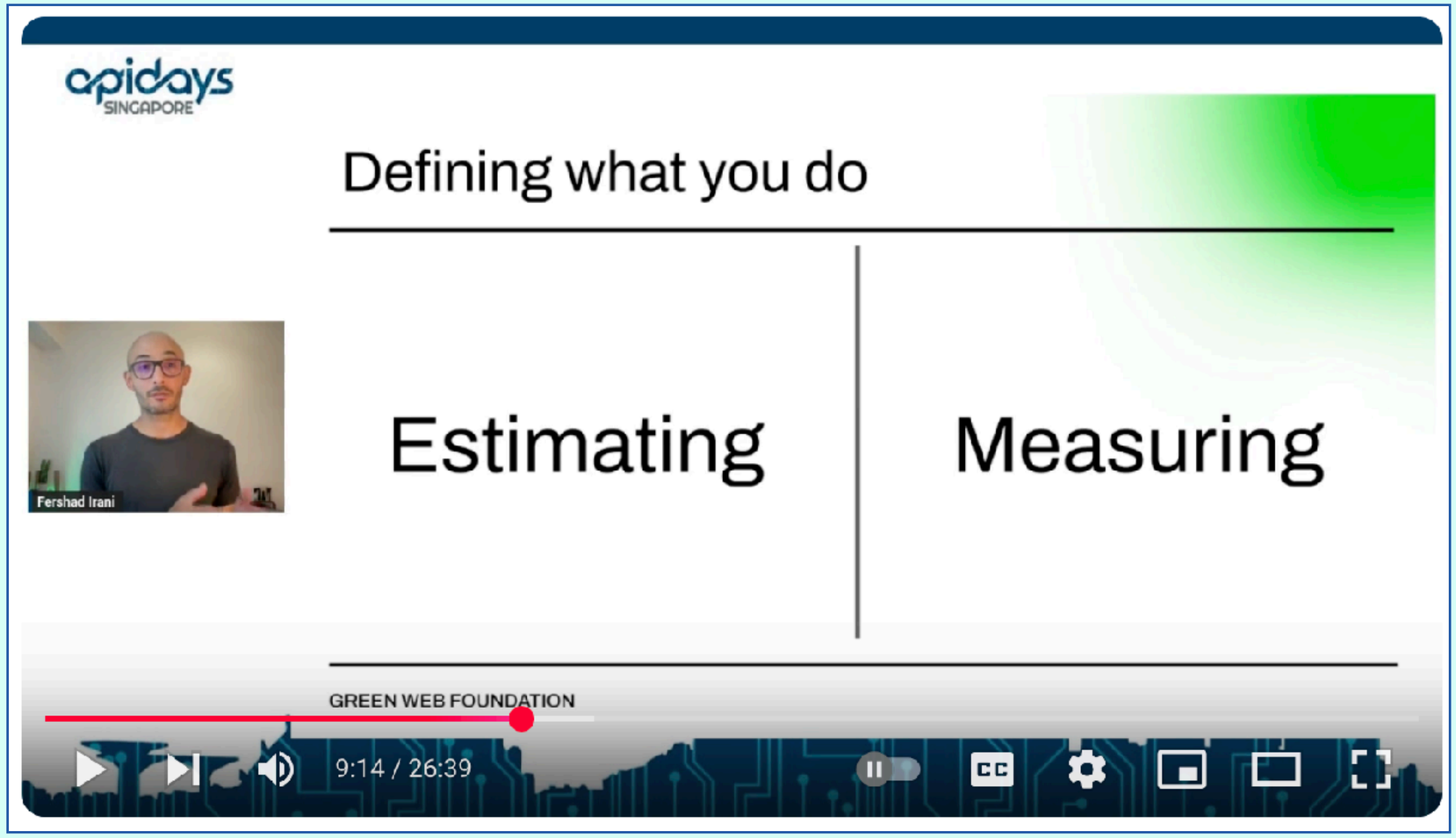
transferred data, number of HTTP requests, and DOM size

SOMETIMES MISSED

calculations in JS. CPU/GPU, memory. Real user journeys.

– HTTP Archive Web Almanac, Sustainability.

Sometimes measured, sometimes estimated



- Fershad Irani, The Nuance of Quantifying Digital Carbon Emissions at Green I/O Singapore, 2024.

SWDM

Data transfer
Amount of GB transferred when using a service

Average Emissions per Page View (gCO2e) = ([(OP_{DC} × (1 - Green Hosting Factor) + EM_{DC}) + (OP_N + EM_N) + (OP_{UD} + EM_{UD})] × New Visitor Ratio) + ([(OP_{DC} × (1 - Green Hosting Factor) + EM_{DC}) + (OP_N + EM_N) + (OP_{UD} + EM_{UD})] × Return Visitor Ratio × (1 - Data Cache Ratio))

Carbon intensity
Grams of carbon emitted per kWh at a given time.

sustainablewebdesign.org/estimating-digital-emissions

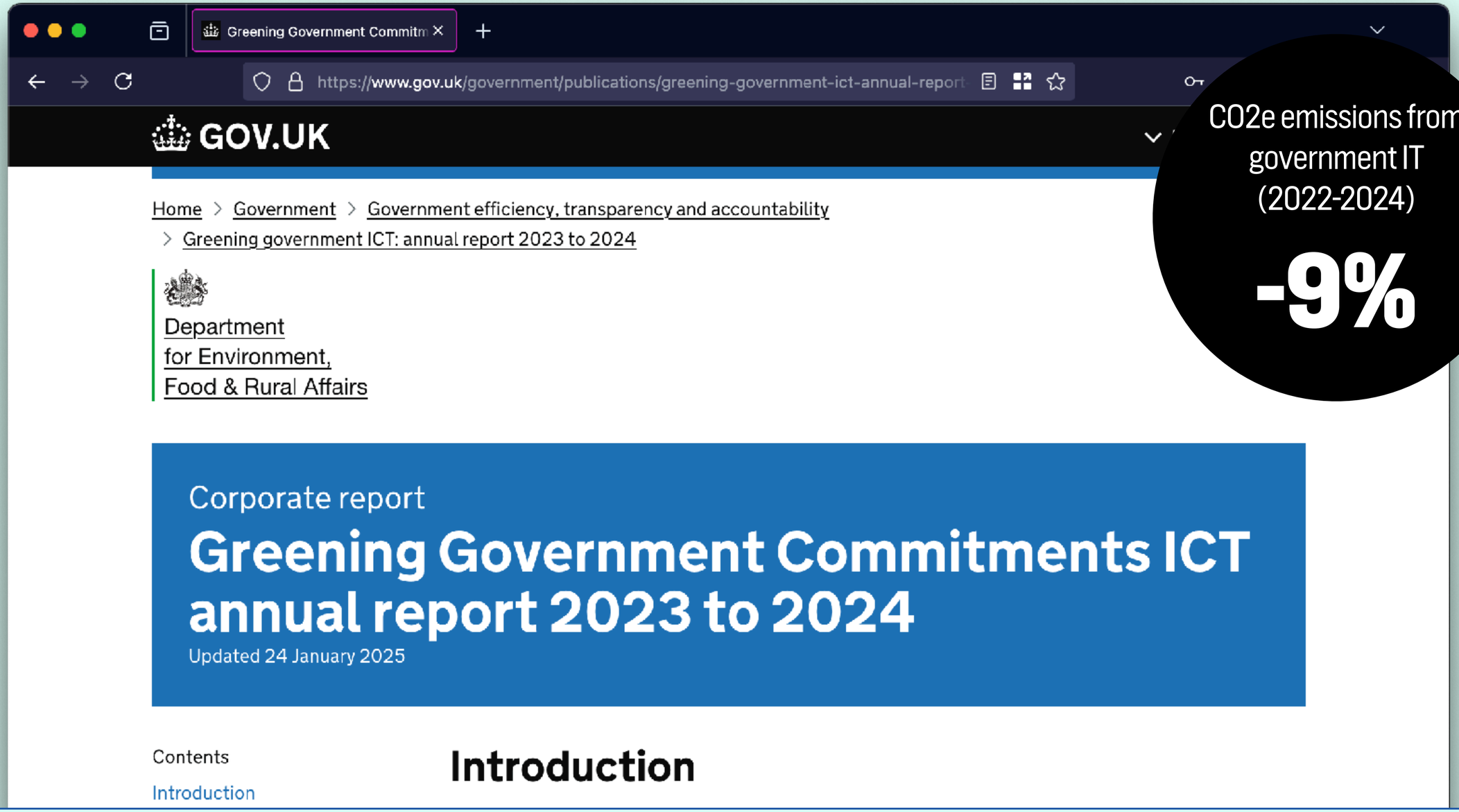
CO2.js

- **Estimate carbon emissions** produced by transferring data on the internet.
- Get different forms of **grid intensity data**, like annual average and marginal data by country.
- Check if a website uses a known **green web host**.

thegreenwebfoundation.org/co2-js

WSG

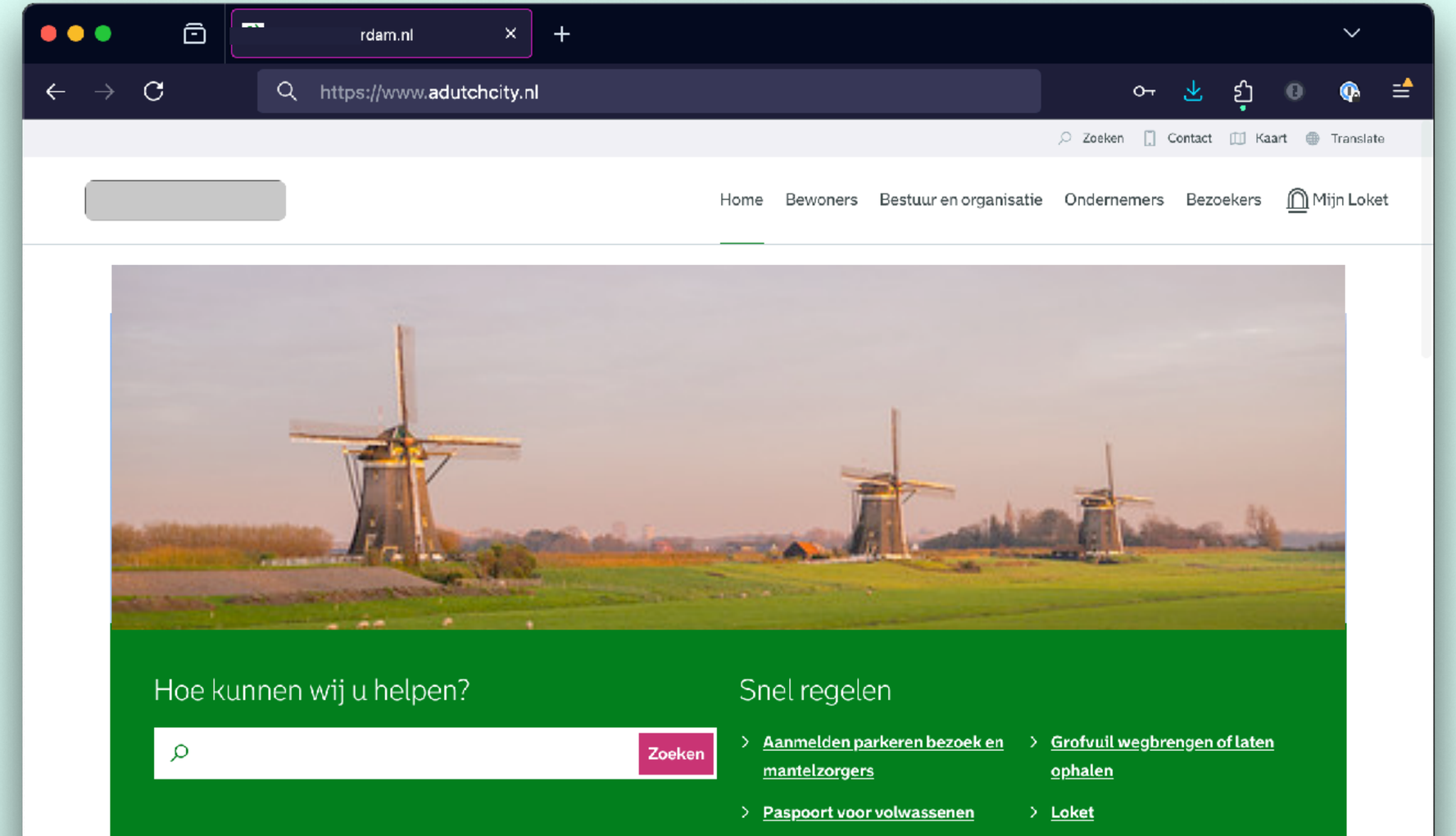
3.1. Set goals based on potential impact considerations



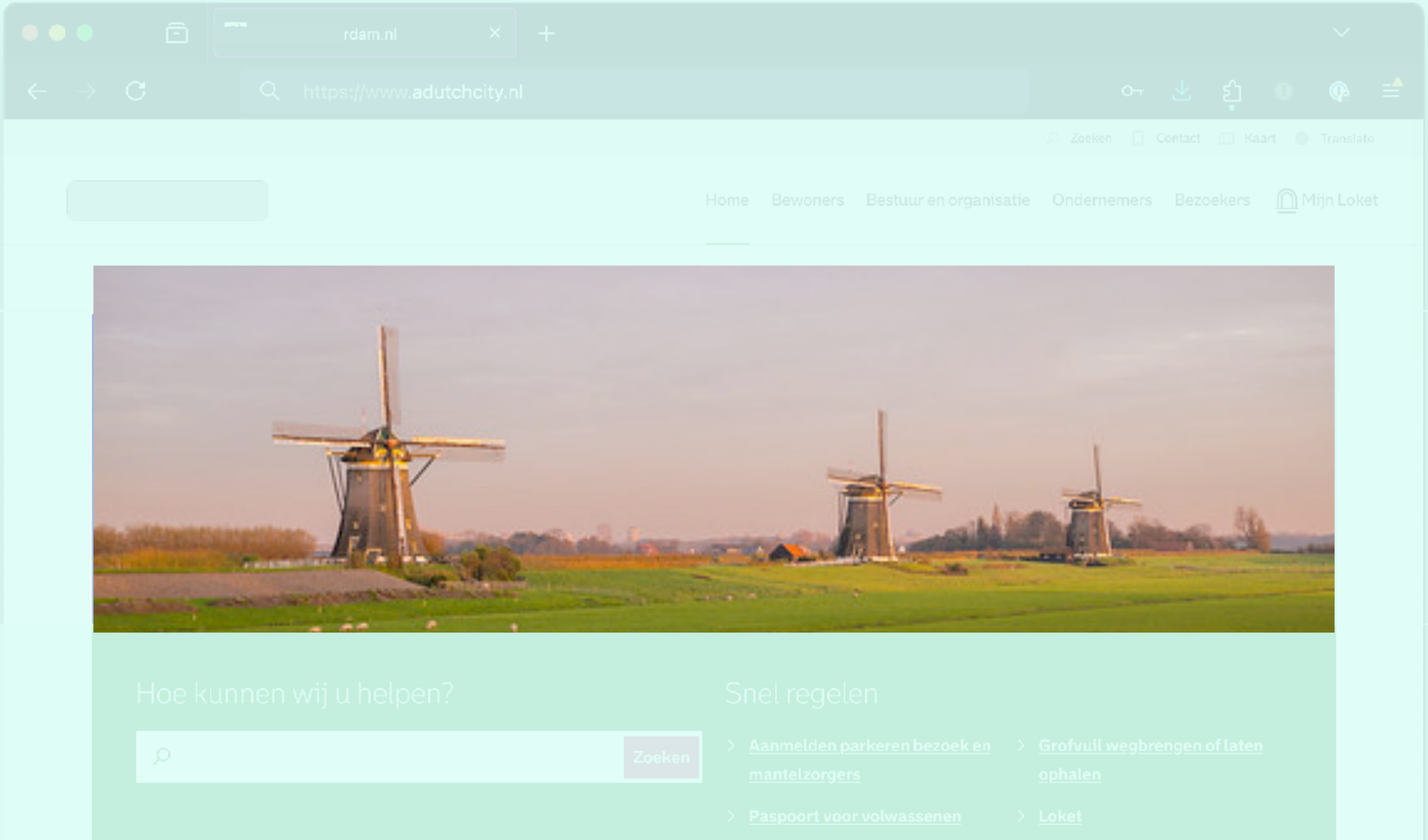
gov.uk/government/publications/greening-government-ict-annual-report-2023-to-2024

Minimise images and videos

A Dutch City Total page size: 1,2 MB



A Dutch City Hero image: 367 KB (32%)



“Detail is data”

– Emily Trotter (Nomensa) on images in Planet Centred Design

youtube.com/watch?v=znz-f_QEGnQ

Ways to save images

Blur or blur parts

Remove some background

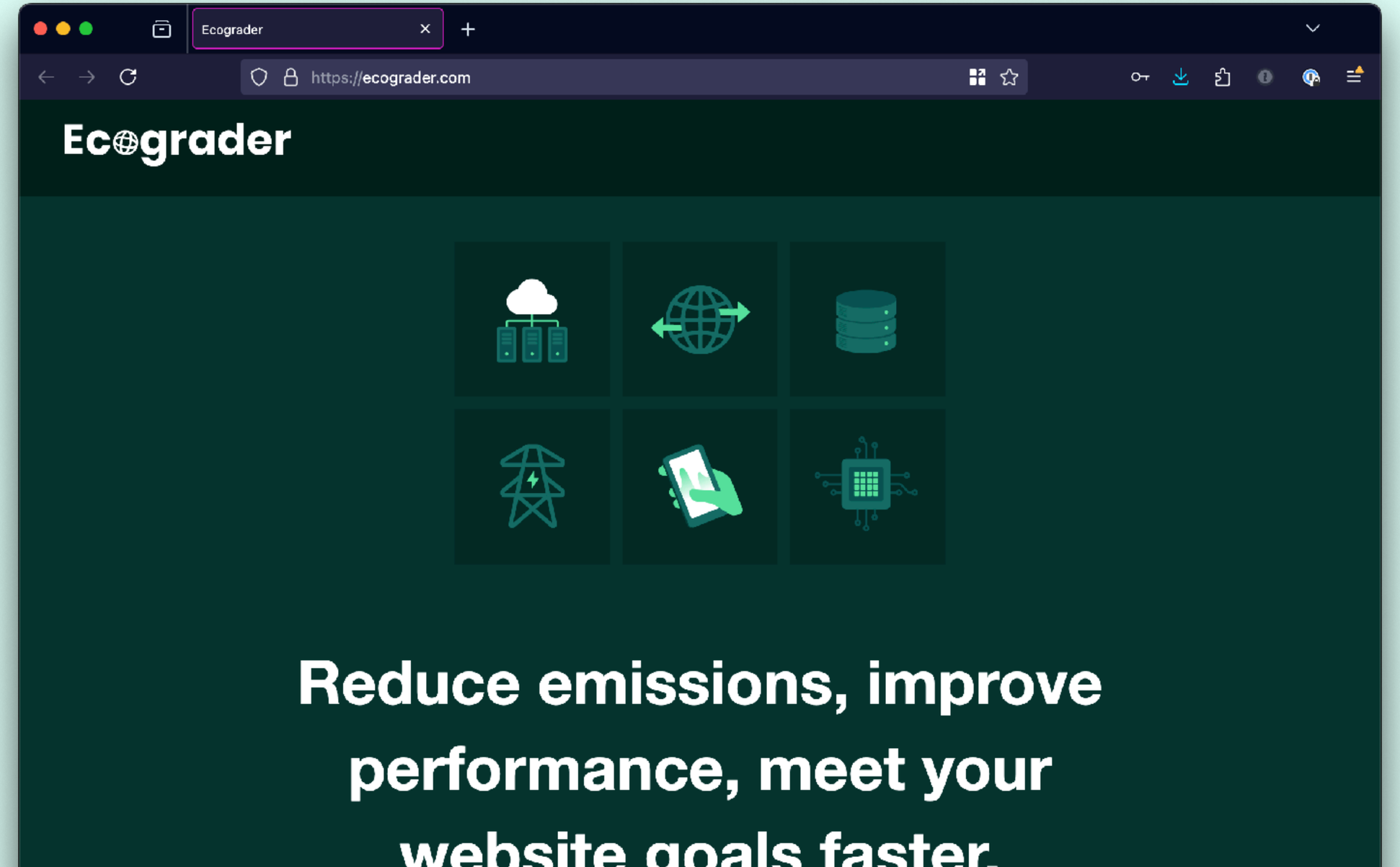
Simplify image

Use image compression

```
<img src="" alt="" lazyload="lazy" />
```

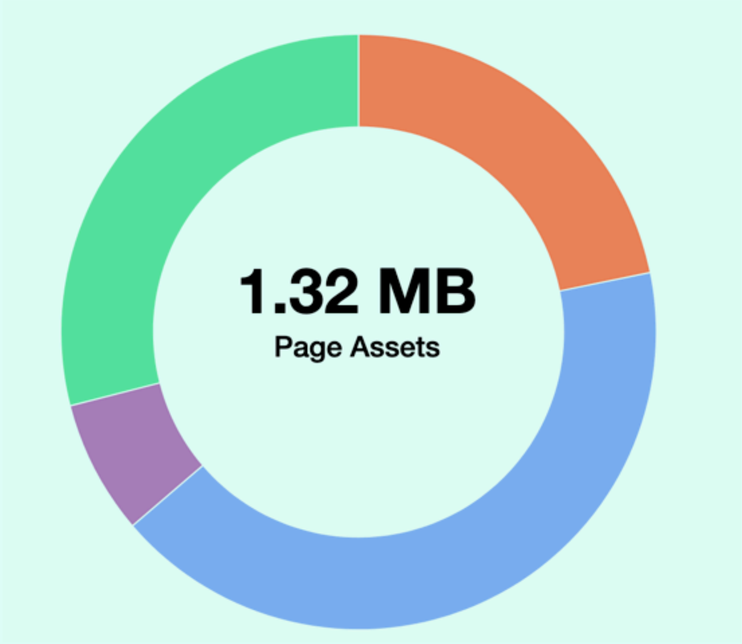
Reduce JavaScript and CSS

ecograder.com



Dutch city 1 vs Dutch City 2

ecograder.com

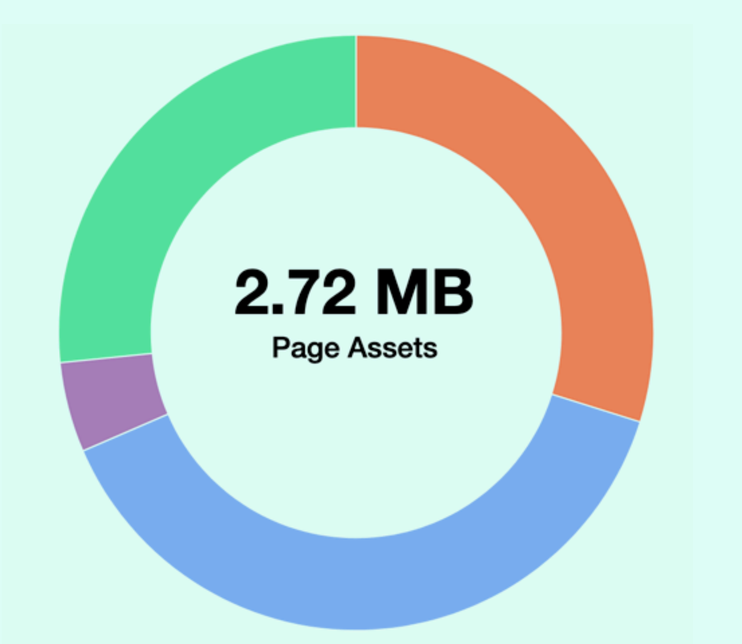


Images: 288.29 KB, 0.0973 g of CO2e

HTML/CSS: 95.82 KB, 0.0323 g of CO2e

Scripts: 555.30 KB, 0.1873 g of CO2e

Other: 383.77 KB, 0.1294 g of CO2e



Images: 813.52 KB, 0.2744 g of CO2e

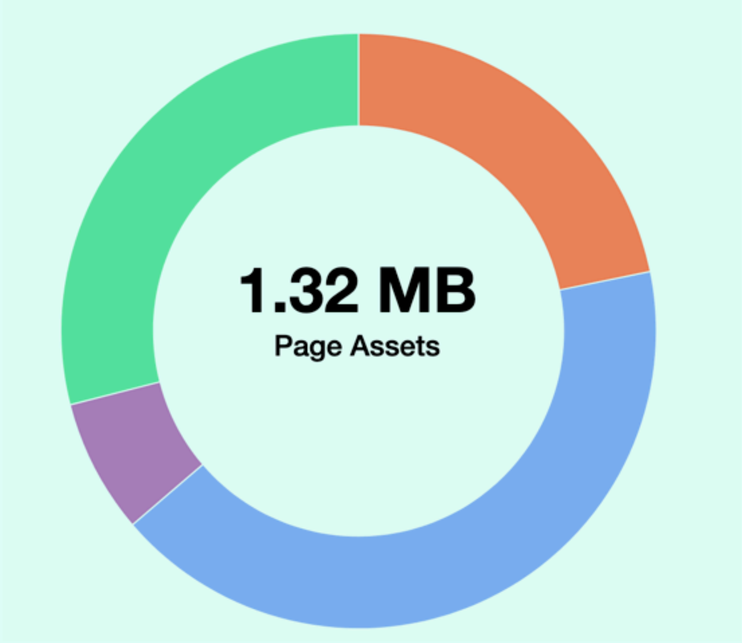
HTML/CSS: 131.81 KB, 0.0445 g of CO2e

Scripts: 1.05 MB, 0.3557 g of CO2e

Other: 724.94 KB, 0.2446 g of CO2e

Dutch city 1 vs Dutch City 2

ecograder.com



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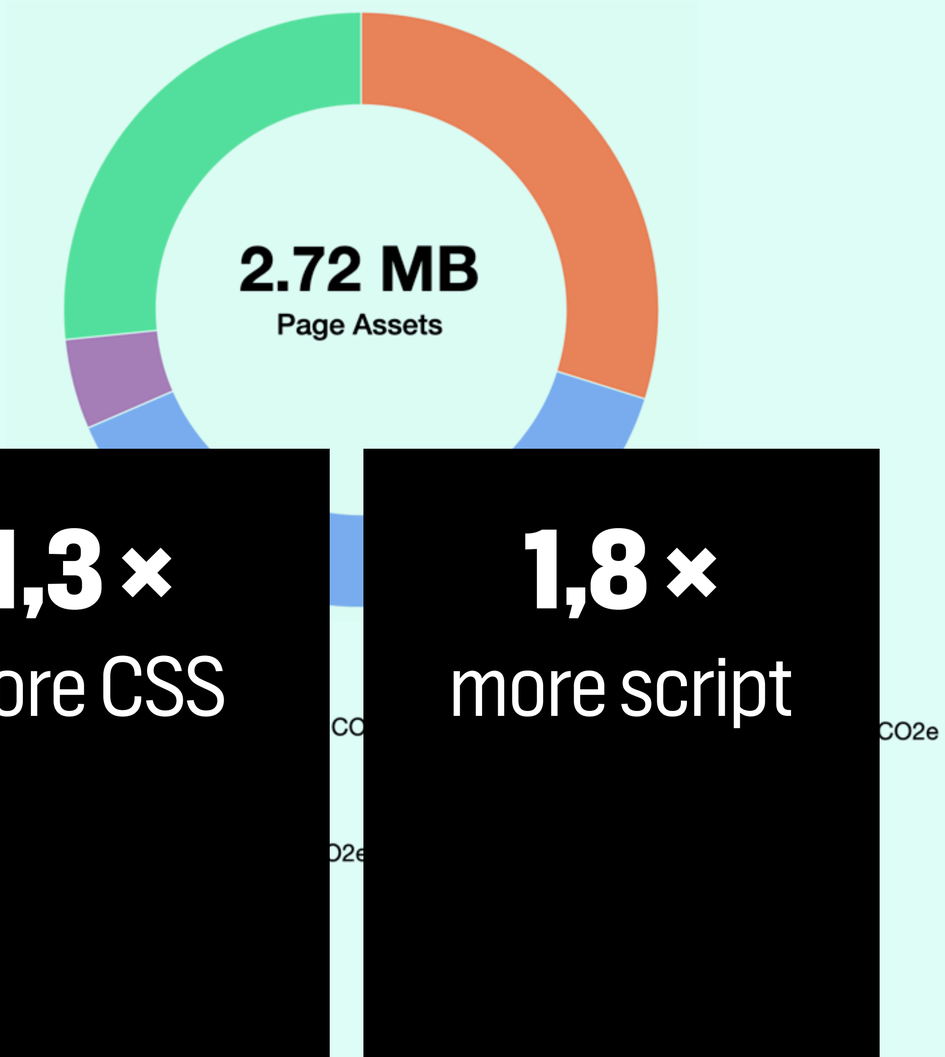


1,3 ×
more CSS

1,8 ×
more script

WSG

4.3. Compress files where it is beneficial

WSG

3.4. Tree shaking should be used to remove unnecessary code

WSG

3.16 Dependencies are appropriately used and maintained

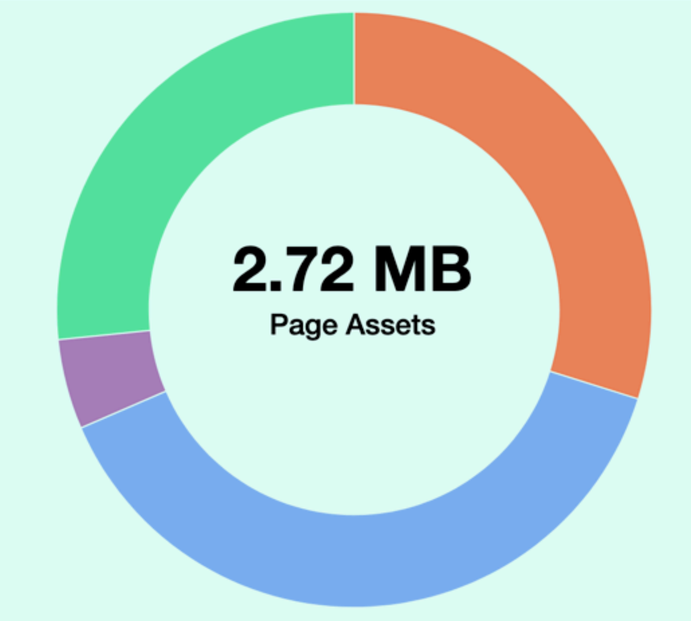
WSG

3.21. Take advantage of native features and functionality

Dutch City 2

ecograder.com

248 kB
in total in 2005



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Scripts: 1.05 MB, 0.3557 g of CO2e

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00	GET	web.archi...	kop_achtergrond.gif		img	gif	5.89 kB
00	GET	web.archi...	bullet_meer.gif		img	gif	2.62 kB
00	GET	web.archi...	button_zoek.gif		img	gif	2.45 kB
00	GET	web.archi...	spacer.gif		img	gif	2.48 kB
00	GET	web.archive....	footer_home.gif		img	gif	cached

TML CSS JS XHR Fonts Images Media WS Other | Disable Cache | No Throttling

ansferred	S...
42 kB	3...
89 kB	3...
62 kB	5...
45 kB	1...
48 kB	4...
ached	1....

Headers Cookies Request Response Timings Security

Name: spacer.gif
Dimensions: 1 × 1
MIME Type: image/gif

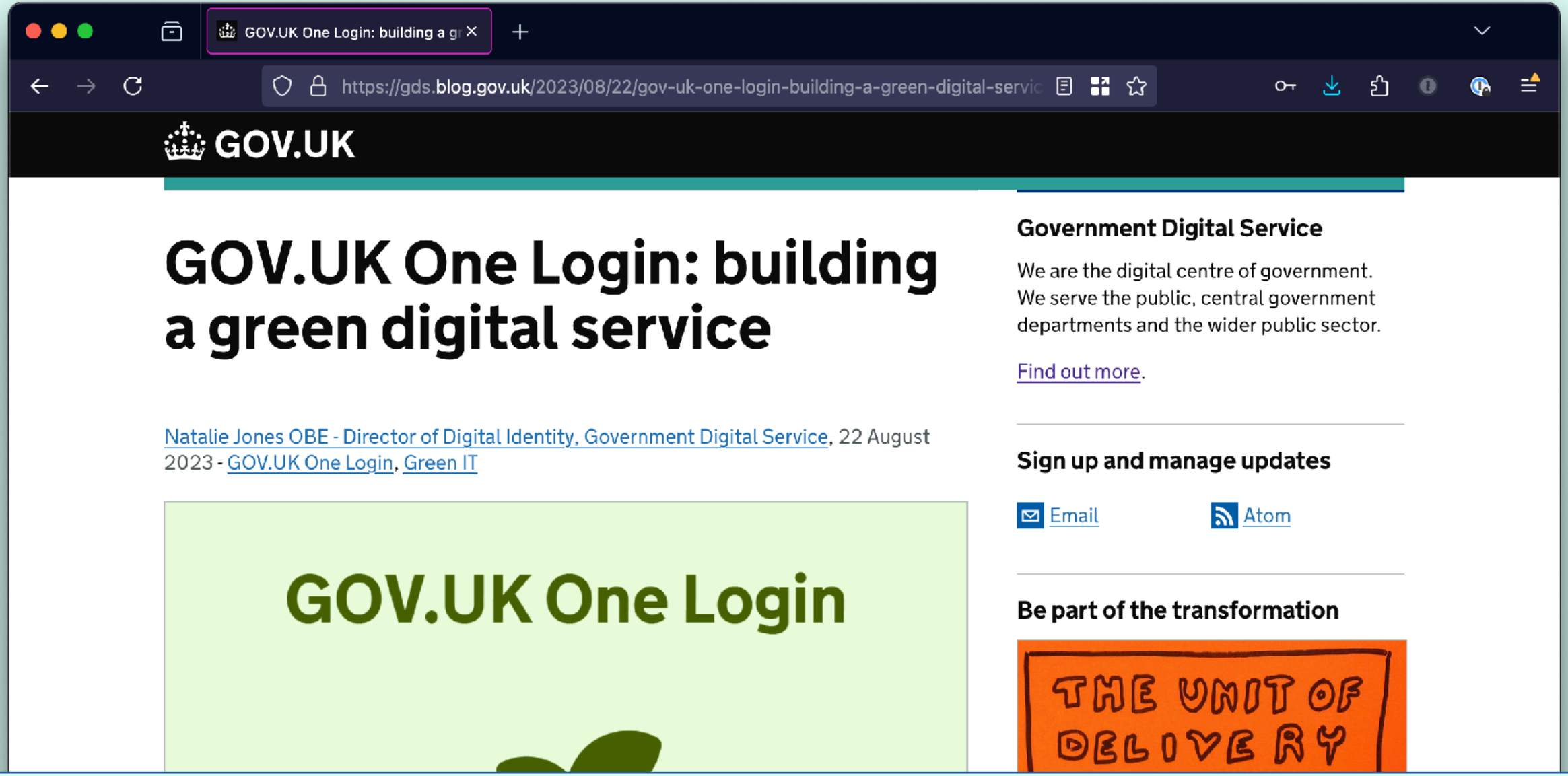
“Make the logo bigger”

logo_city.gif (2005) 310px by 70px

4.31 kB

logo-denhaag.jpg (2025) 960px by 303px

173.53 kB



gds.blog.gov.uk/2023/08/22/gov-uk-one-login-building-a-green-digital-service

WSG

5.2. Assign a sustainability representative

2.

Support older devices

Only more sustainable once you've read

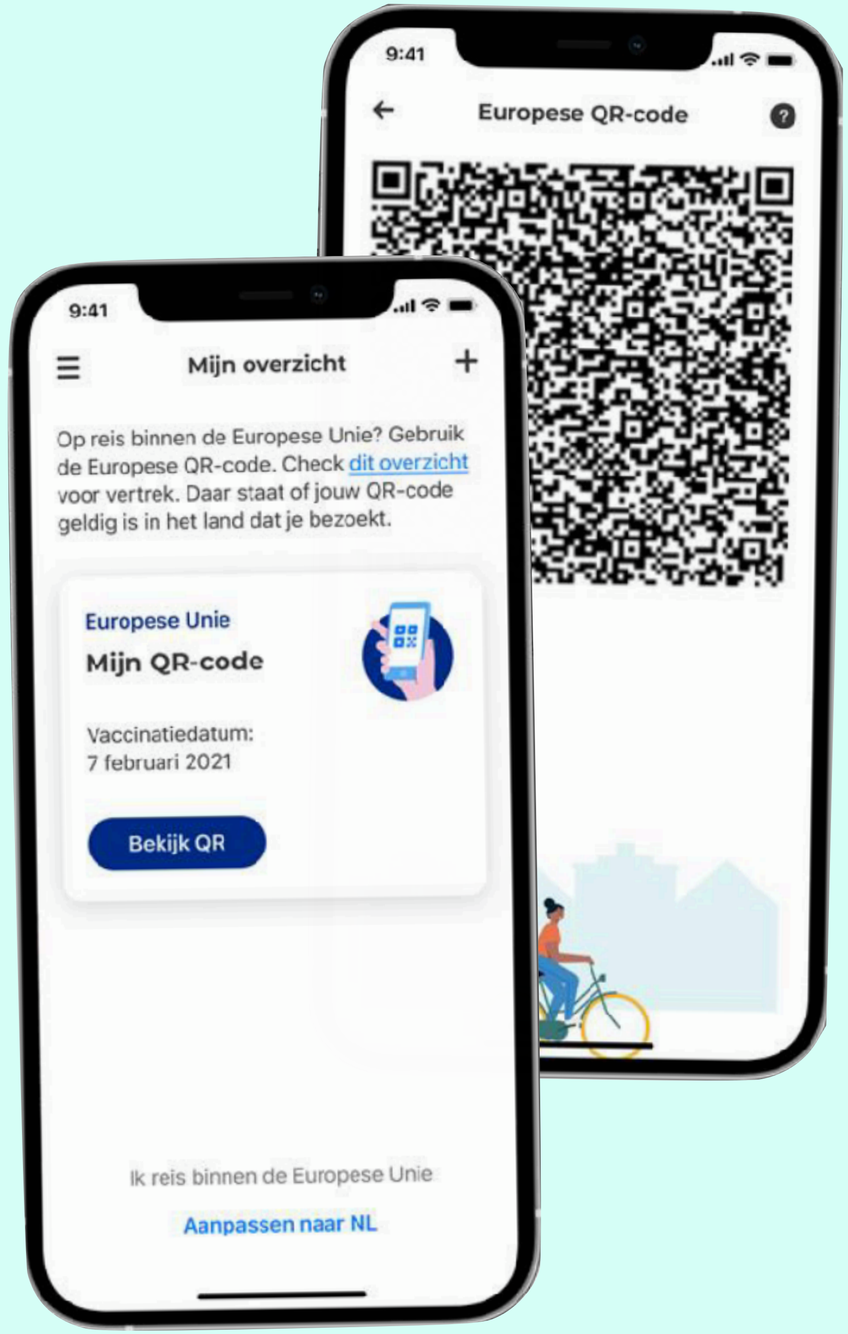
~100 books

Gerry McGovern, World Wide Waste

Don't be the reason users upgrade

Dutch CoronaCheck app required Android 6+, iOS 12+

There was a paper fallback.



Progressive enhancement

Make functionality available in **simpler ways** before adding **more complex ways**.

“In 10 years nothing you built today that depends on JS for the content will be available, visible, or archived anywhere on the web.”

– Tantek Çelik

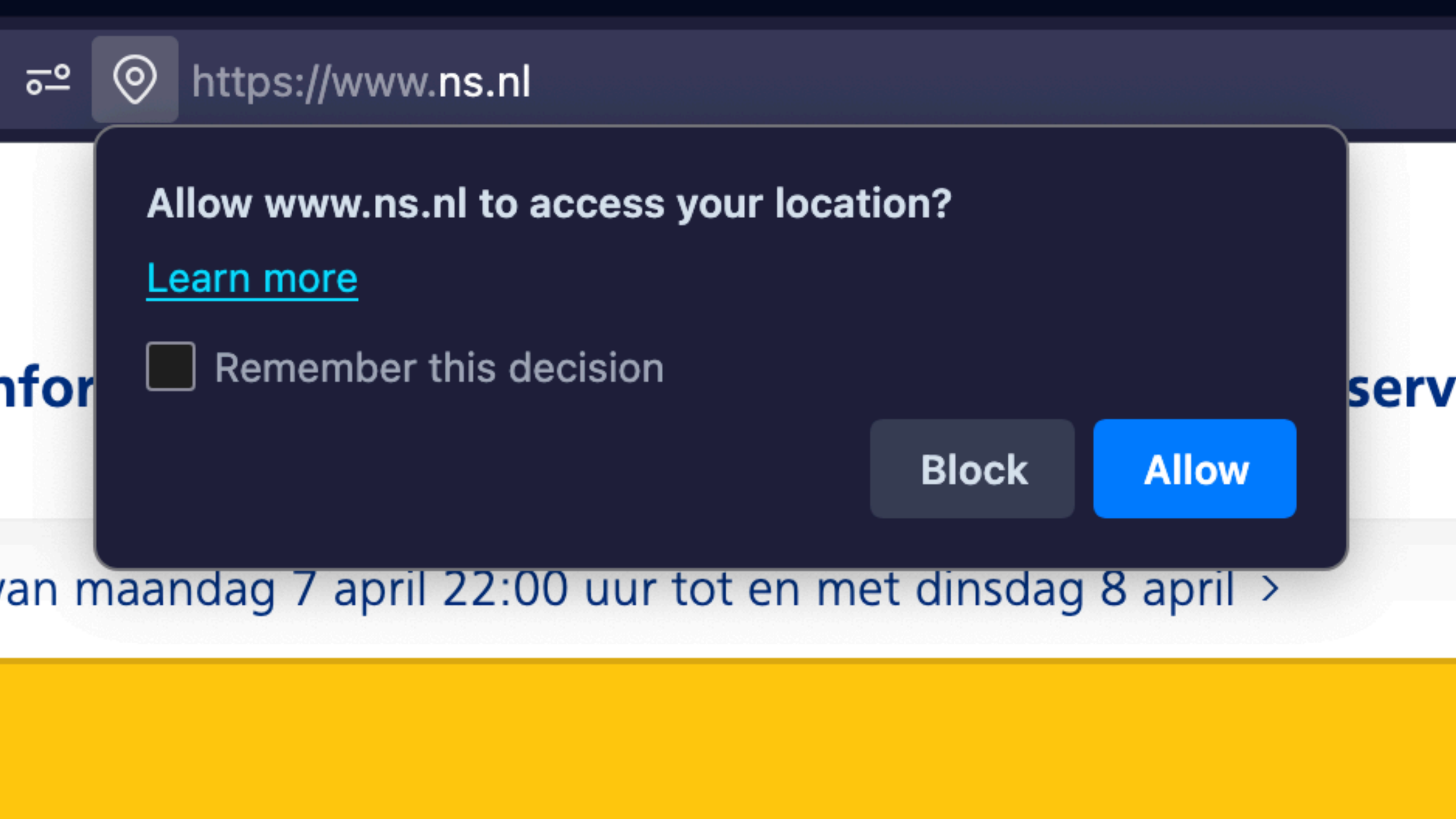
tantek.com/2015/069/t1/js-dr-javascript-required-dead

starting point for all

simpler version
(eg content)

JavaScript loaded

potentially fancier version


https://www.ns.nl
Allow www.ns.nl to access your location?
Learn more
Remember this decision
Block
Allow
van maandag 7 april 22:00 uur tot en met dinsdag 8 april ›

Departure station

FIND TIMES

starting point for all

↓

simpler version

It looks like you departing from London, UK.

FIND TIMES

location worked?

↓

more complex version

3.

Choose green hosting

WSG

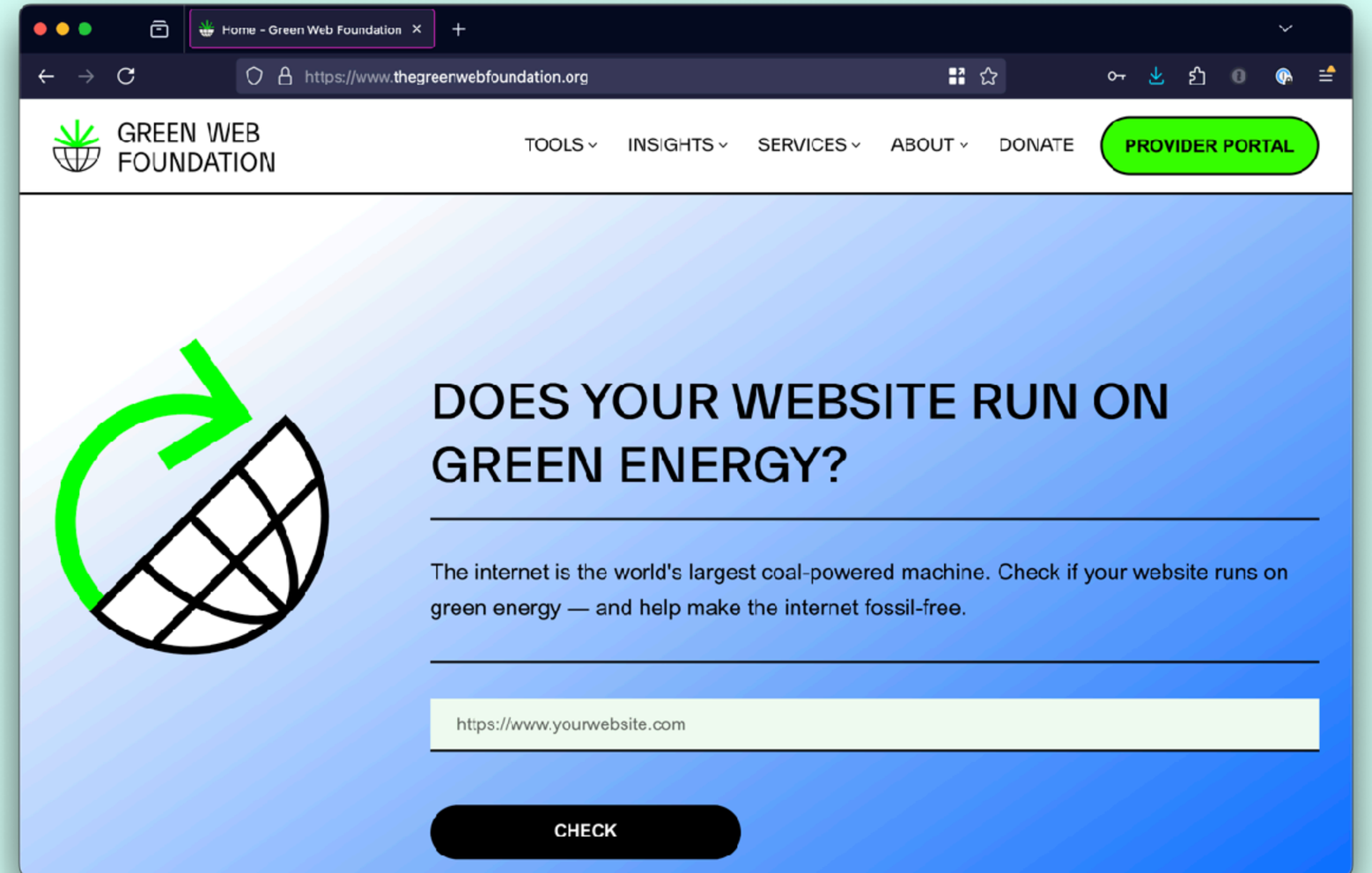
4.1. Choose a sustainable hosting provider

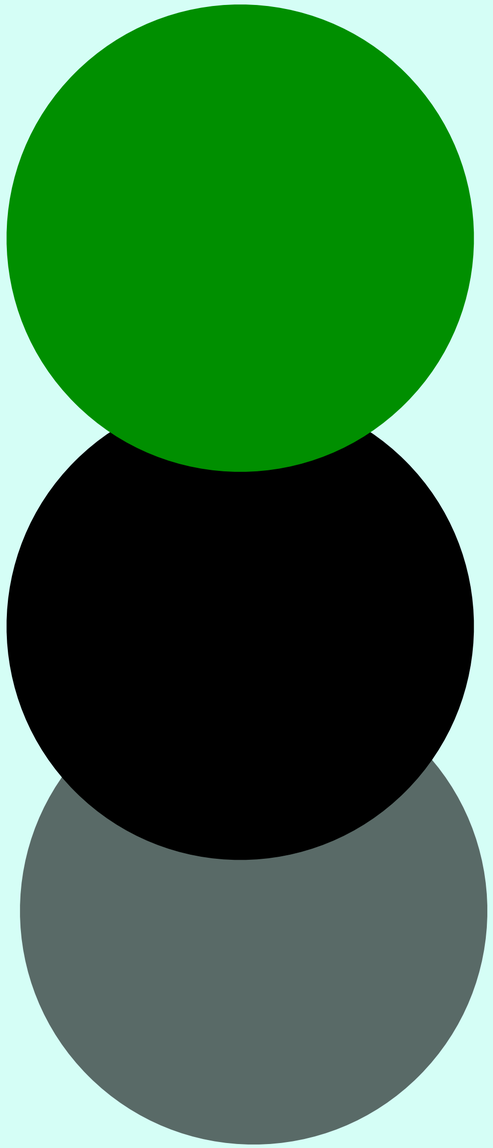

The
cloud
is
real

Use or move to a green provider

Find out current state

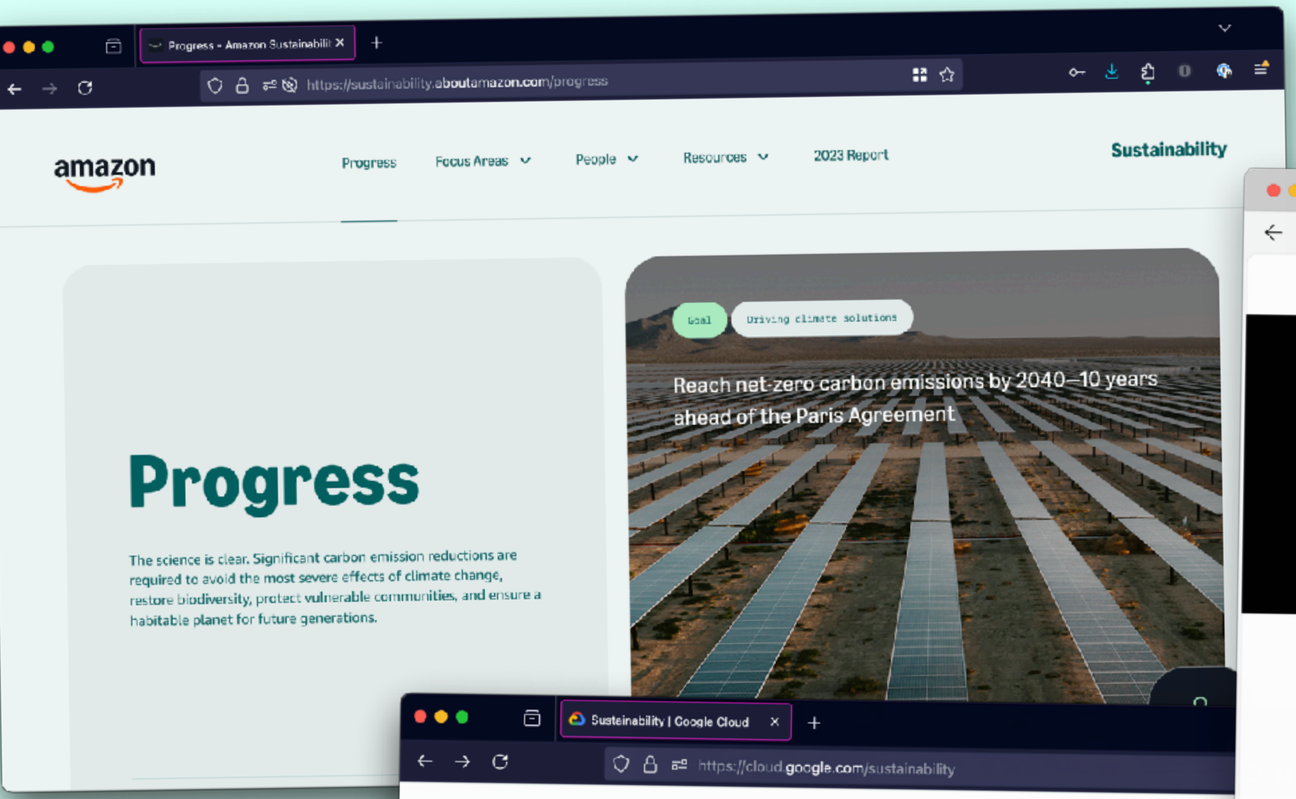
thegreenwebfoundation.org

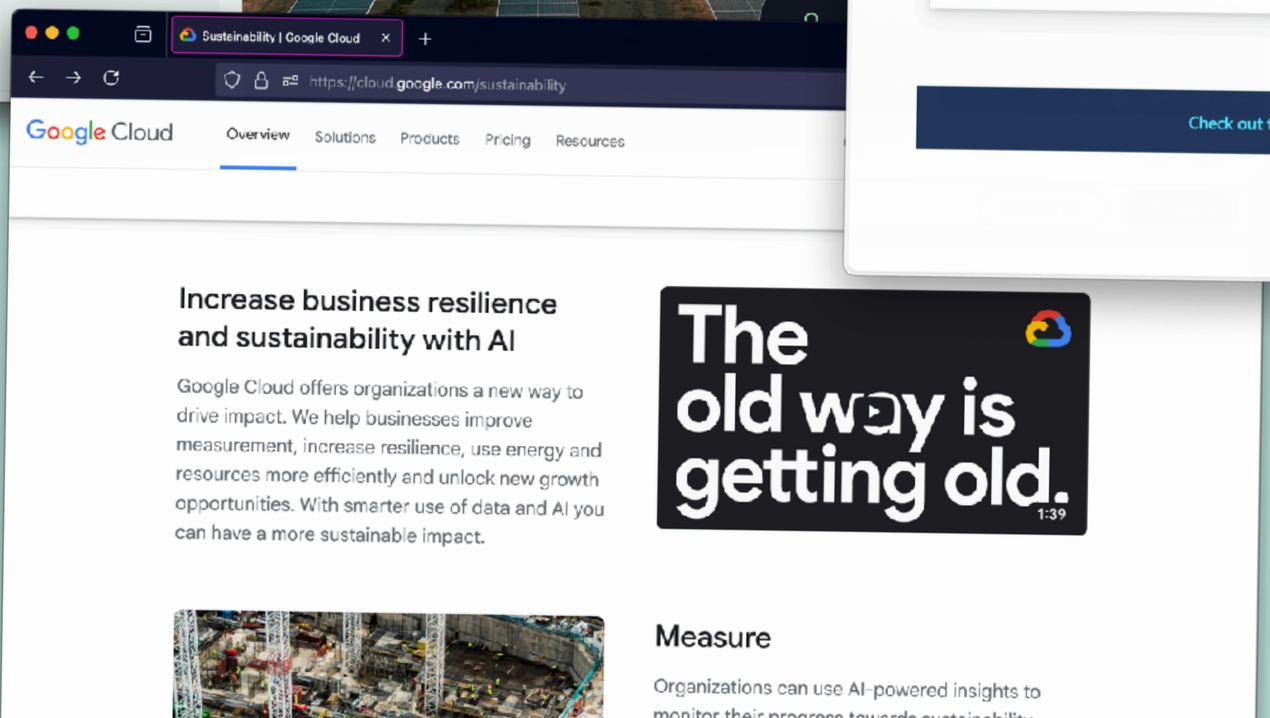


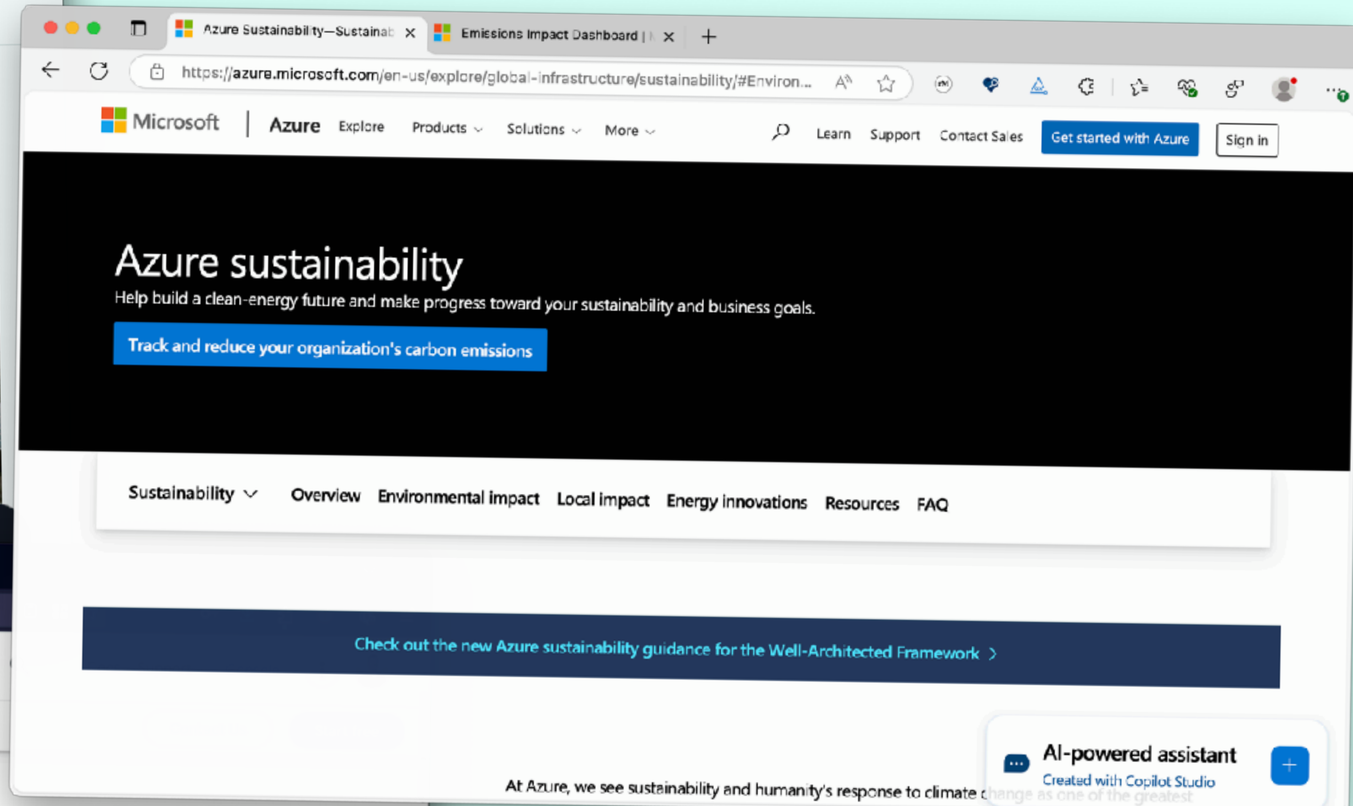


GWF lists **329** verified green hosting providers in **34** countries.

Ask sales reps how theirs compares.


Progress - Amazon Sustainabilit
https://sustainability.aboutamazon.com/progress
amazon
Progress
Focus Areas
People
Resources
2023 Report
Sustainability
Progress
The science is clear. Significant carbon emission reductions are required to avoid the most severe effects of climate change, restore biodiversity, protect vulnerable communities, and ensure a habitable planet for future generations.
Goal
Driving climate solutions
Reach net-zero carbon emissions by 2040—10 years ahead of the Paris Agreement


Sustainability | Google Cloud
https://cloud.google.com/sustainability
Google Cloud
Overview
Solutions
Products
Pricing
Resources
Increase business resilience and sustainability with AI
Google Cloud offers organizations a new way to drive impact. We help businesses improve measurement, increase resilience, use energy and resources more efficiently and unlock new growth opportunities. With smarter use of data and AI you can have a more sustainable impact.
The old way is getting old.
1:39
Measure
Organizations can use AI-powered insights to


Azure Sustainability—Sustainab
Emissions Impact Dashboard |
https://azure.microsoft.com/en-us/explore/global-infrastructure/sustainability/#Environ...
Microsoft
Azure
Explore
Products
Solutions
More
Learn
Support
Contact Sales
Get started with Azure
Sign in
Azure sustainability
Help build a clean-energy future and make progress toward your sustainability and business goals.
Track and reduce your organization's carbon emissions
Sustainability
Overview
Environmental impact
Local impact
Energy innovations
Resources
FAQ
Check out the new Azure sustainability guidance for the Well-Architected Framework
AI-powered assistant
Created with Copilot Studio
At Azure, we see sustainability and humanity's response to climate

Factors include:

renewable energy

equipment longevity

waste recycling

From: WSG, 4.1

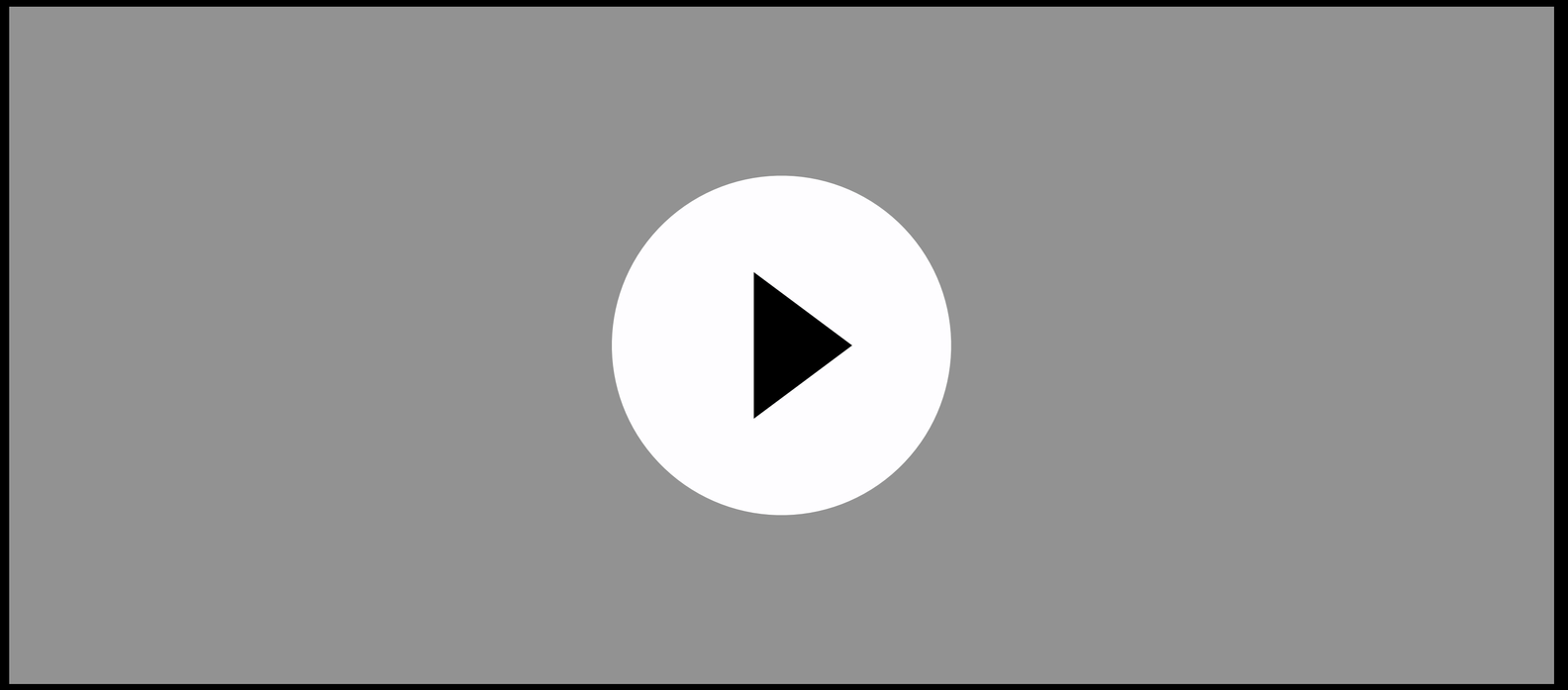
Consider timing

Carbon intensity

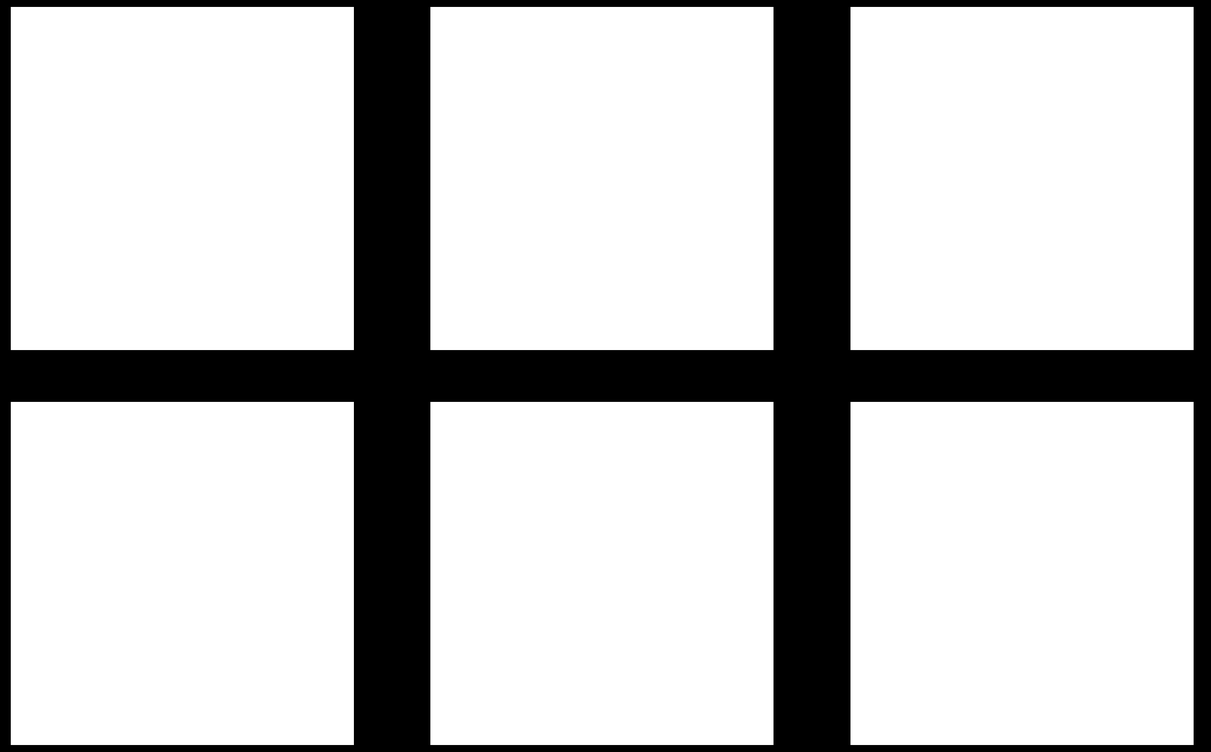
How clean energy is at a given time

(eg CO^2/kWh)

Our team



Our team



Our team

Anna

Mei

Jacob

Ouiam

David

George


organicbasics
Organic Sweat

Shop Women Shop Men **organic**basics Regular store Manifesto EUR 0

tap to learn more

Shop women

Shop men

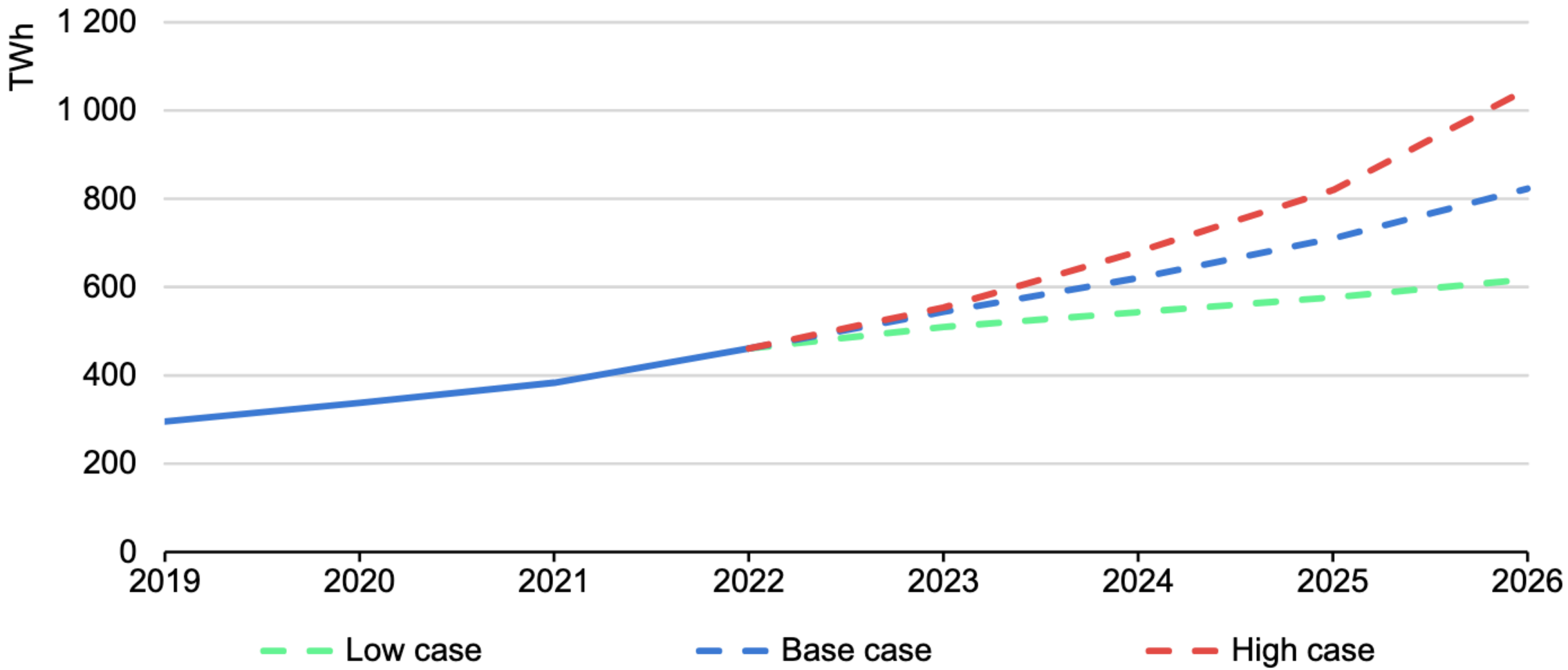
4.

Only necessary features

Avoid technology that has relatively large energy use


AI

Global electricity demand from data centres, AI, and cryptocurrencies, 2019-2026



International Energy Agency, Electricity 2024, Analysis and forecast to 2026.

From Efficiency Gains to Rebound Effects: The Problem of Jevons' Paradox in AI's Polarized Environmental Debate

ALEXANDRA SASHA LUCCIONI, Hugging Face, Canada
EMMA STRUBELL, Carnegie Mellon University, USA
KATE CRAWFORD, Microsoft Research; University of Southern California, USA

As the climate crisis deepens, artificial intelligence (AI) has emerged as a contested force: some champion its potential to advance renewable energy, materials discovery, and large-scale emissions monitoring, while others underscore its growing carbon footprint, water consumption, and material resource demands. Much of this debate has concentrated on direct impacts—energy and water usage in data centers, e-waste from frequent hardware upgrades—without addressing the significant indirect effects. This paper examines how the problem of Jevons' Paradox applies to AI, whereby efficiency gains may paradoxically spur increased consumption. We argue that understanding these second-order impacts requires an interdisciplinary approach, combining lifecycle assessments with socio-economic analyses. Rebound effects undermine the assumption that improved technical efficiency alone will ensure net reductions in environmental harm. Instead, the trajectory of AI's impact also hinges on business incentives and market logics, governance and policymaking, and broader social and cultural norms. We contend that a narrow focus on direct emissions misrepresents AI's true climate footprint, limiting the scope for meaningful interventions. We conclude with recommendations that address rebound effects and challenge the market-driven imperatives fueling uncontrolled AI growth. By broadening the analysis to include both direct and indirect consequences, we aim to inform a more comprehensive, evidence-based dialogue on AI's role in the climate crisis.

Additional Key Words and Phrases: Artificial intelligence, Environmental Impacts, Lifecycle Assessment, Rebound Effects, Sustain-

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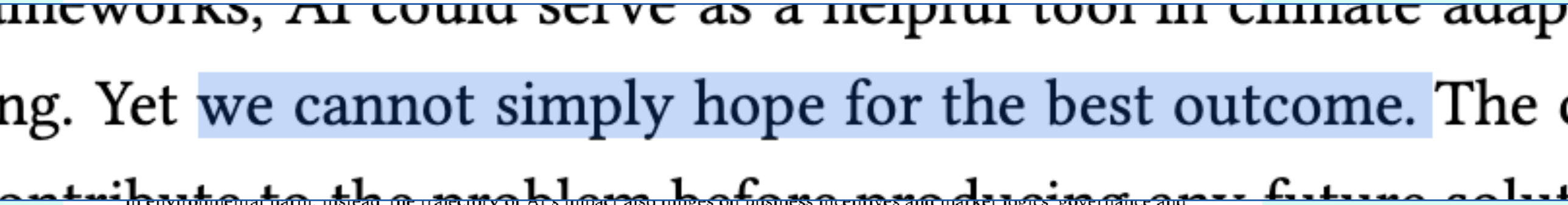
As the climate crisis deepens, artificial intelligence (AI) has emerged as a contested force: some champion its potential to advance

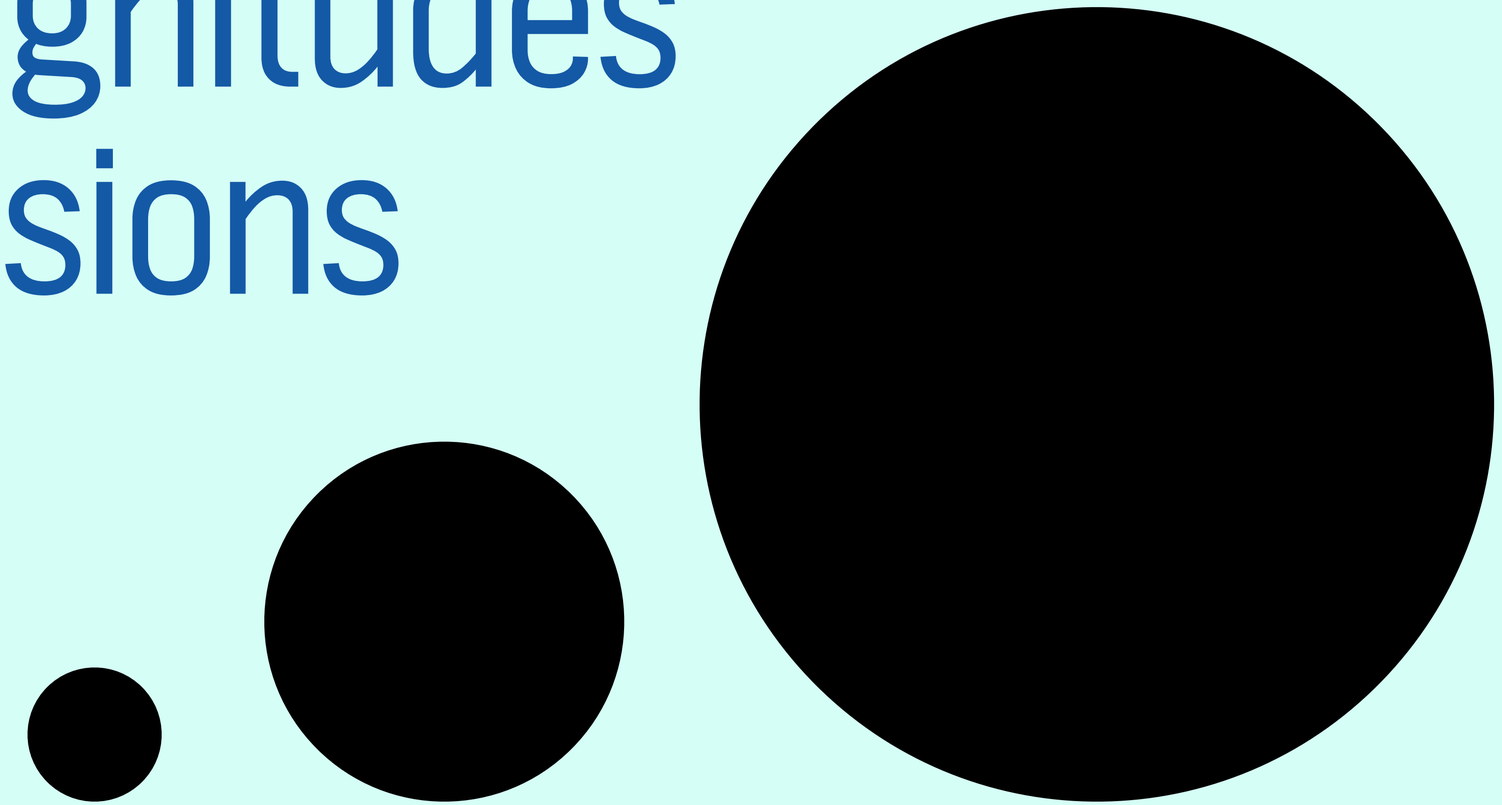


in environmental harm. Instead, the trajectory of AI's impact also hinges on business incentives and market logics, governance and policymaking, and broader social and cultural norms. We contend that a narrow focus on direct emissions misrepresents AI's true climate footprint, limiting the scope for meaningful interventions. We conclude with recommendations that address rebound effects and challenge the market-driven imperatives fueling uncontrolled AI growth. By broadening the analysis to include both direct and indirect consequences, we aim to inform a more comprehensive, evidence-based dialogue on AI's role in the climate crisis.

Additional Key Words and Phrases: Artificial intelligence, Environmental Impacts, Lifecycle Assessment, Rebound Effects, Sustainability

1 Introduction

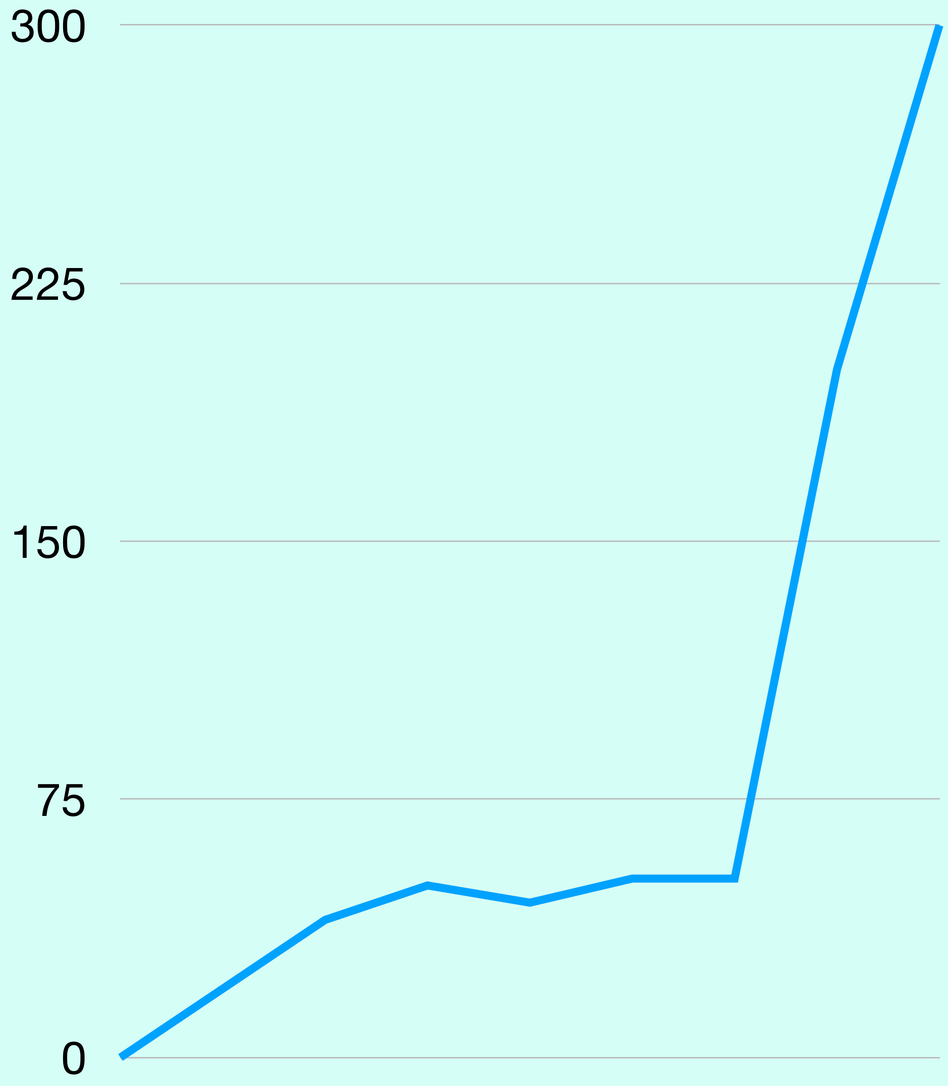
Adding AI means adding magnitudes more emissions



“Emissions would increase by 60× for a GPT-3 style model; for a GPT-4 style model, it could be 200×.”

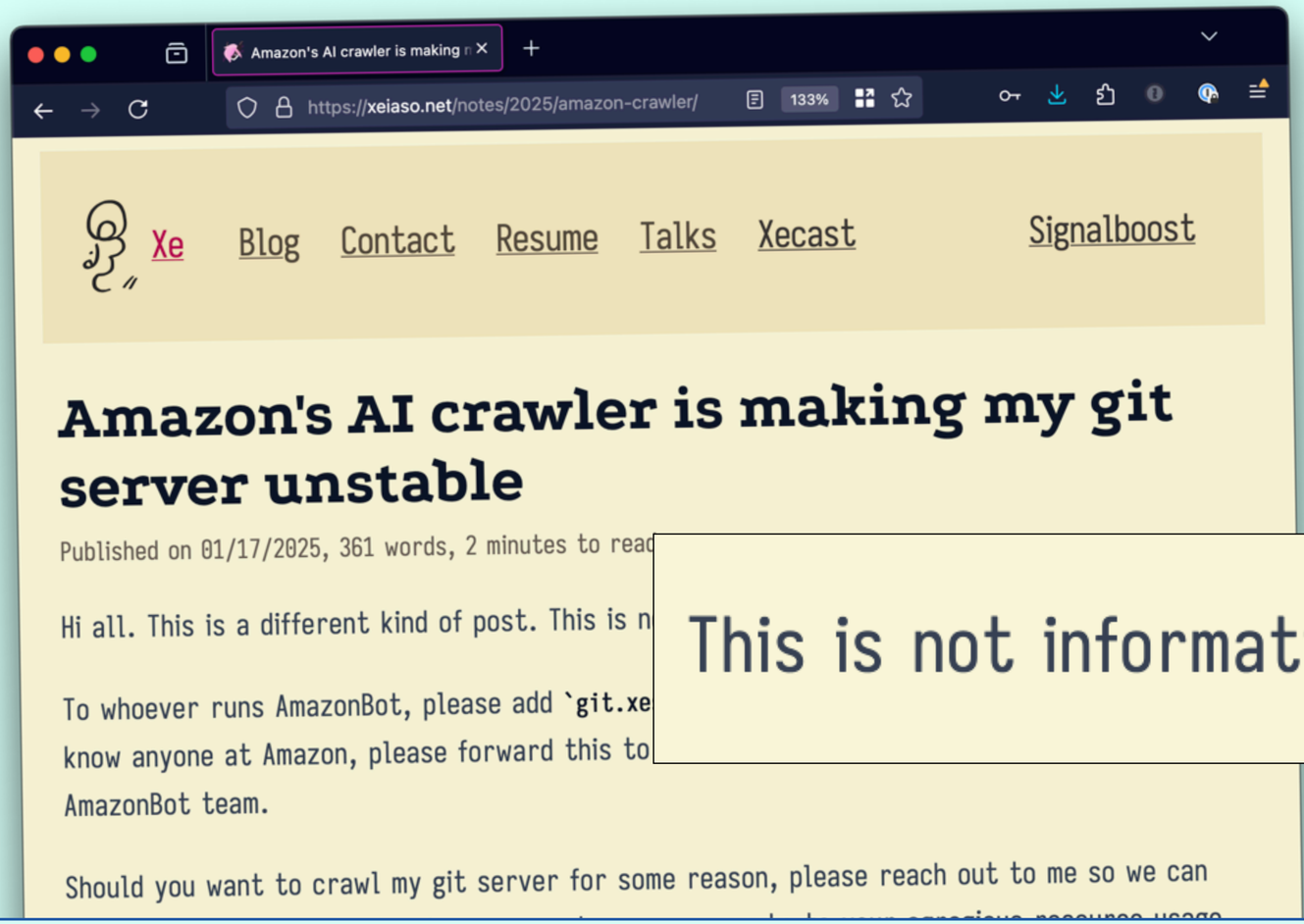
– Wim Vanderbauwhede

wimvanderbauwhede.codeberg.page/articles/google-search-vs-chatgpt-emissions



Training LLMs can involve **unhuman** strain on websites

AI crawlers vs sysadmins

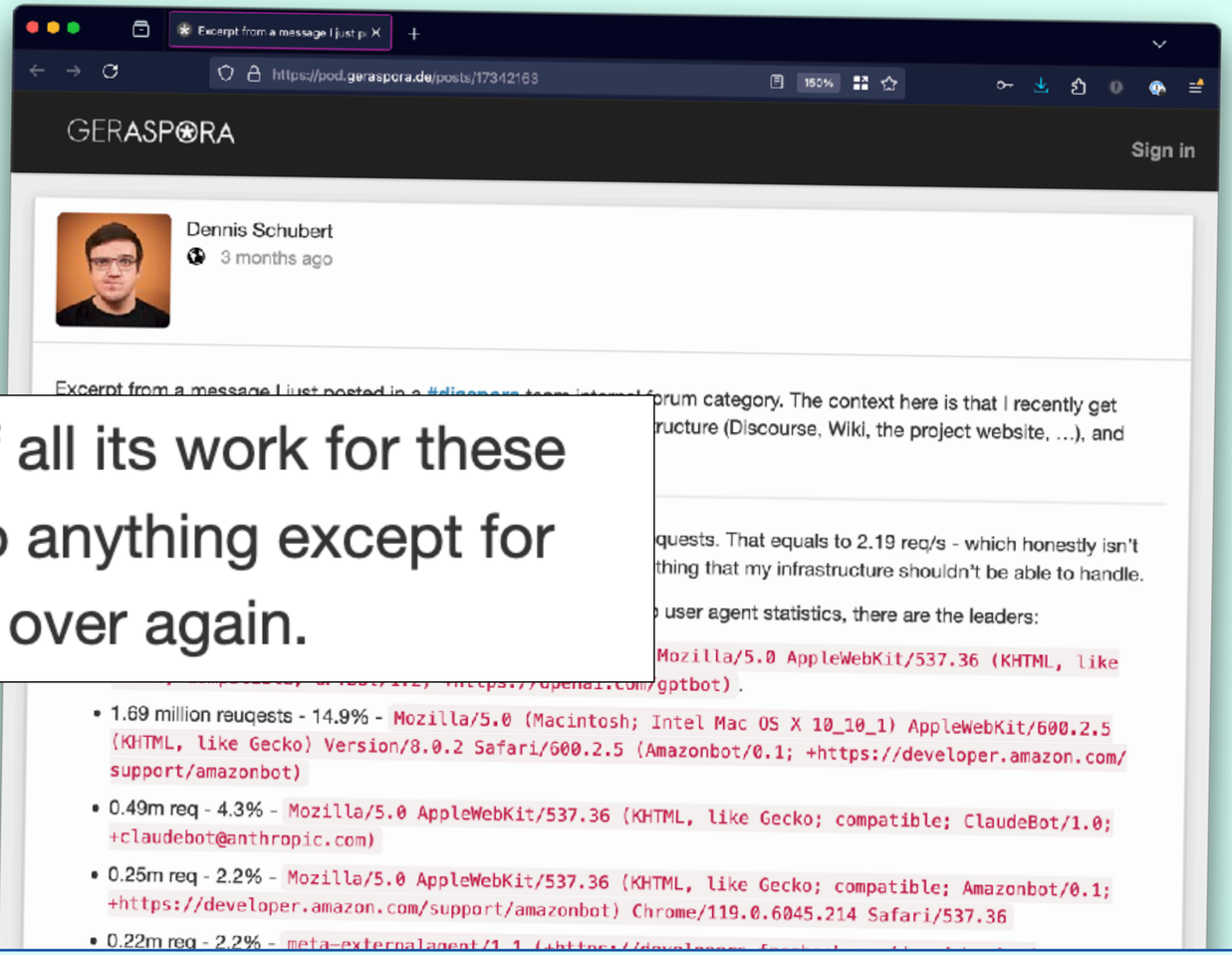


This is not informative. This is a cry for help.

xeiaso.net/notes/2025/amazon-crawler

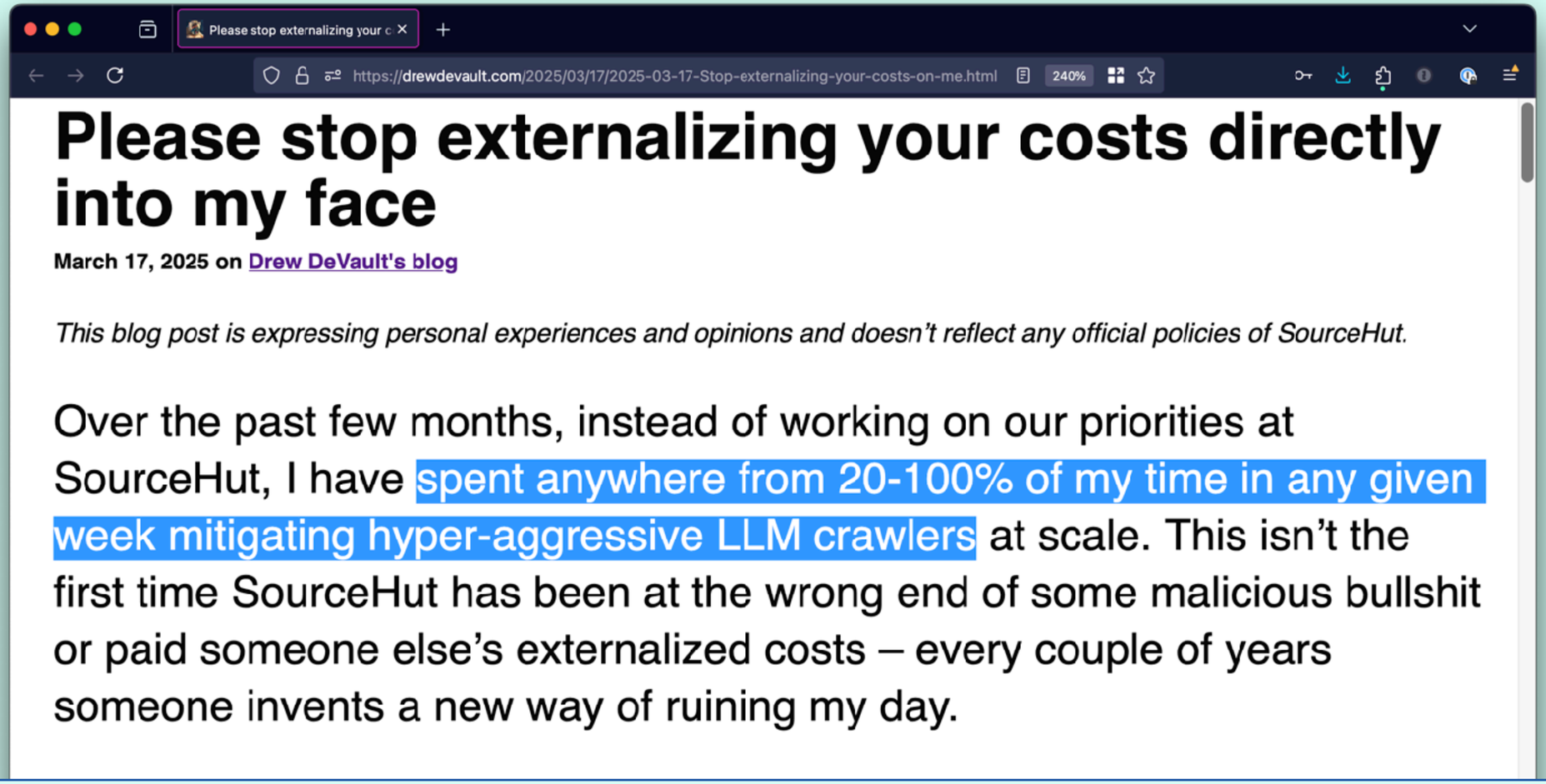
AI crawlers vs sysadmins

it looks like my server is doing 70% of all its work for these fucking LLM training bots that don't to anything except for crawling the fucking internet over and over again.



pod.geraspora.de/posts/17342163

AI crawlers vs sysadmins

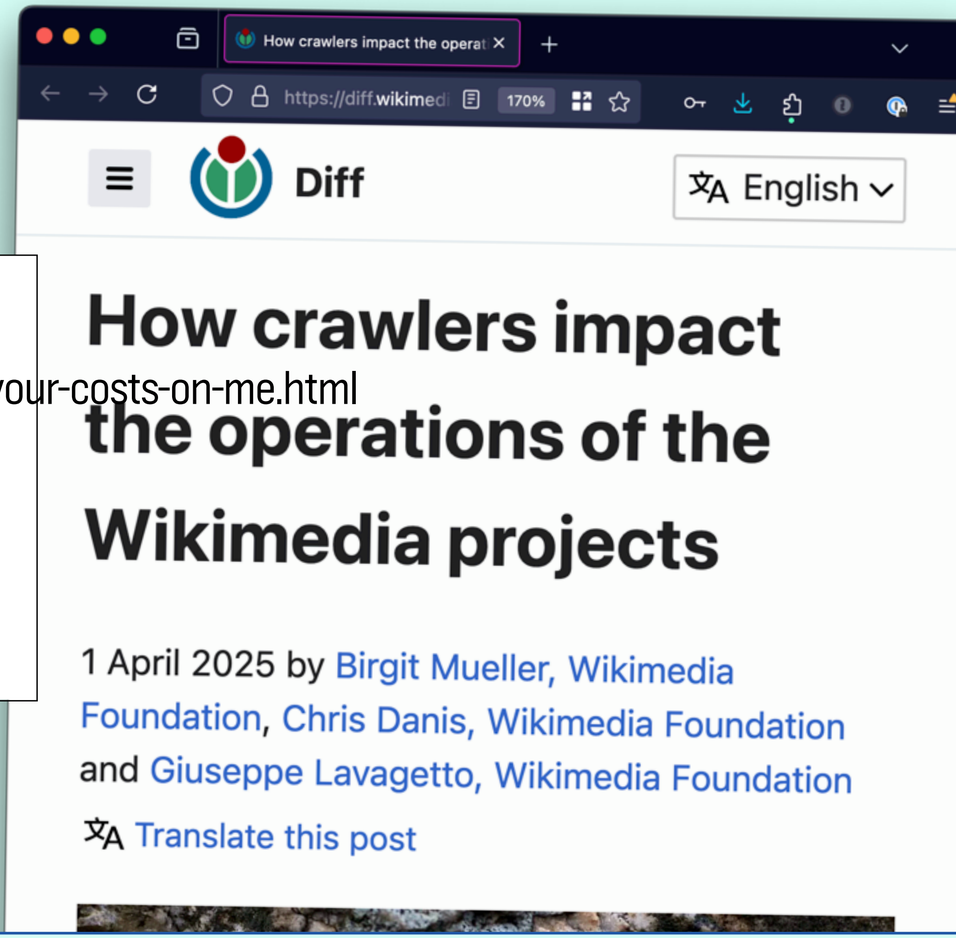


drewdevault.com/2025/03/17/2025-03-17-Stop-externalizing-your-costs-on-me.html

AI crawlers vs sysadmins

bandwidth used for downloading multimedia content [grew] by 50%. This increase is not coming from human readers, but largely from automated programs that scrape [Wikimedia] to feed images to AI models.

drewdevault.com/2025/03/17/2025-03-17-Stop-externalizing-your-costs-on-me.html



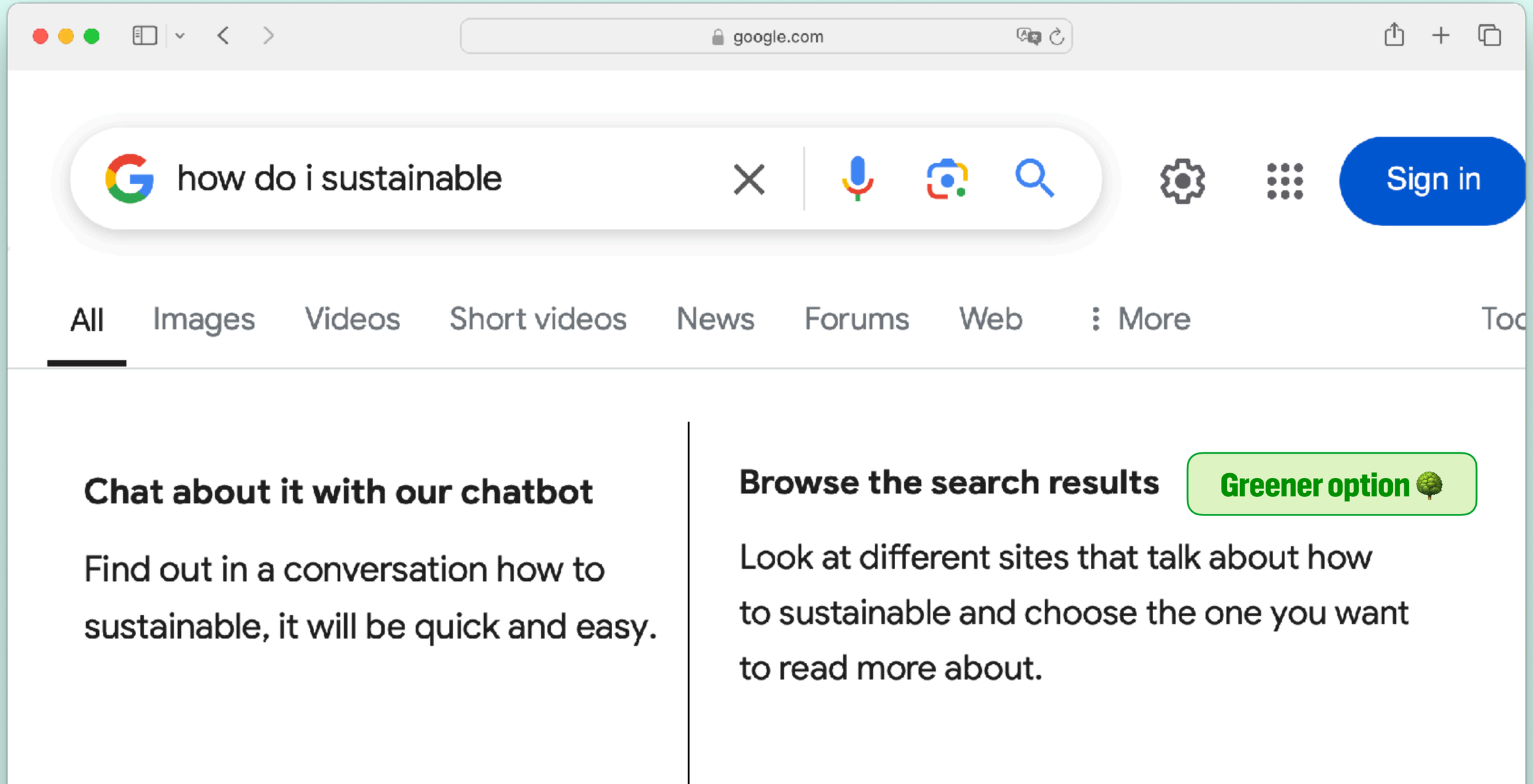
diff.wikimedia.org/2025/04/01/how-crawlers-impact-the-operations-of-the-wikimedia-projects

Maybe let users opt-out of the heavy things

WSG

5.4 Communicate the ecological impact of user choices

You could give users choice



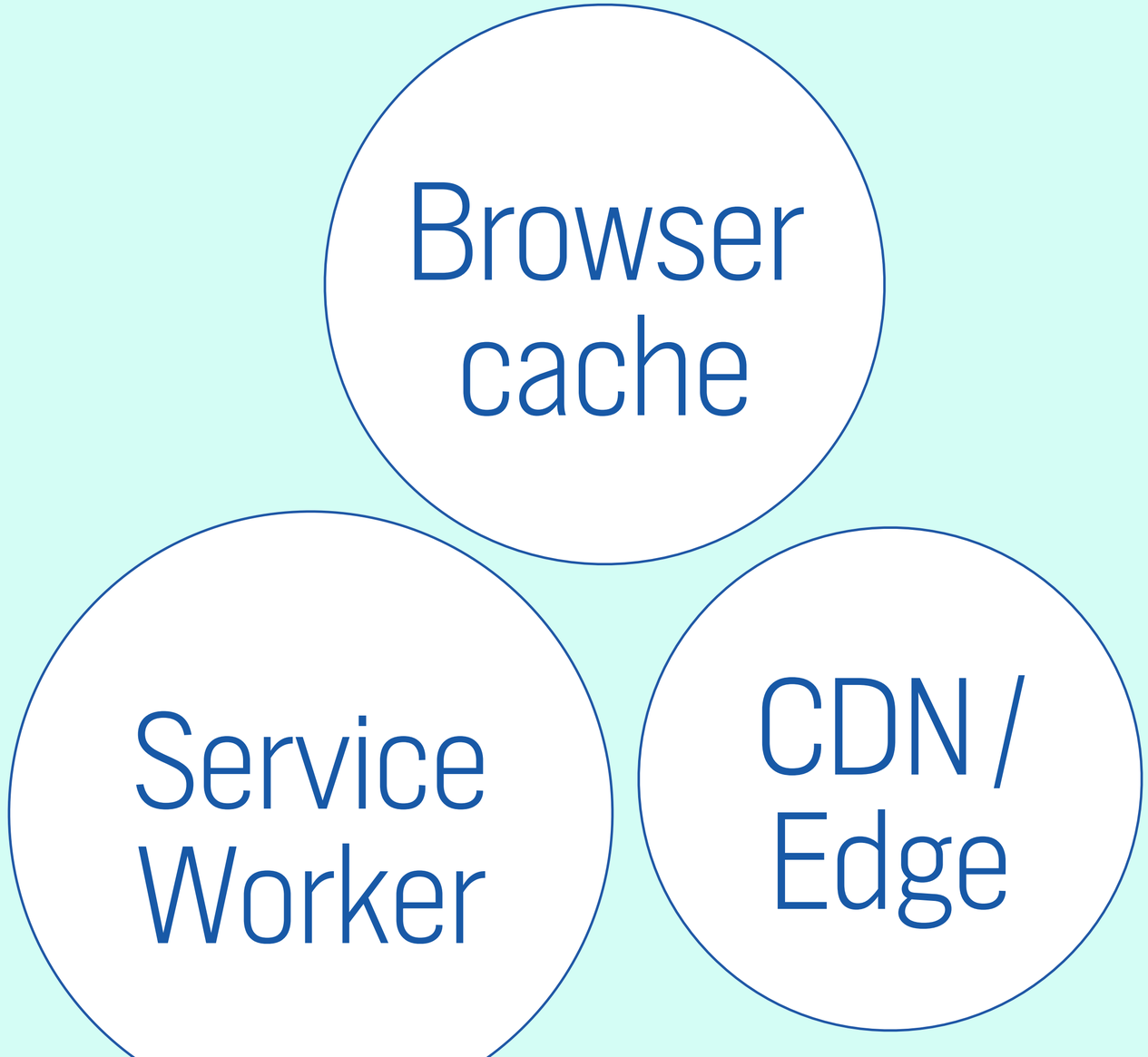
Work on removing rather than adding

5.

Weed out all the things

Reduce requests

Reduce requests

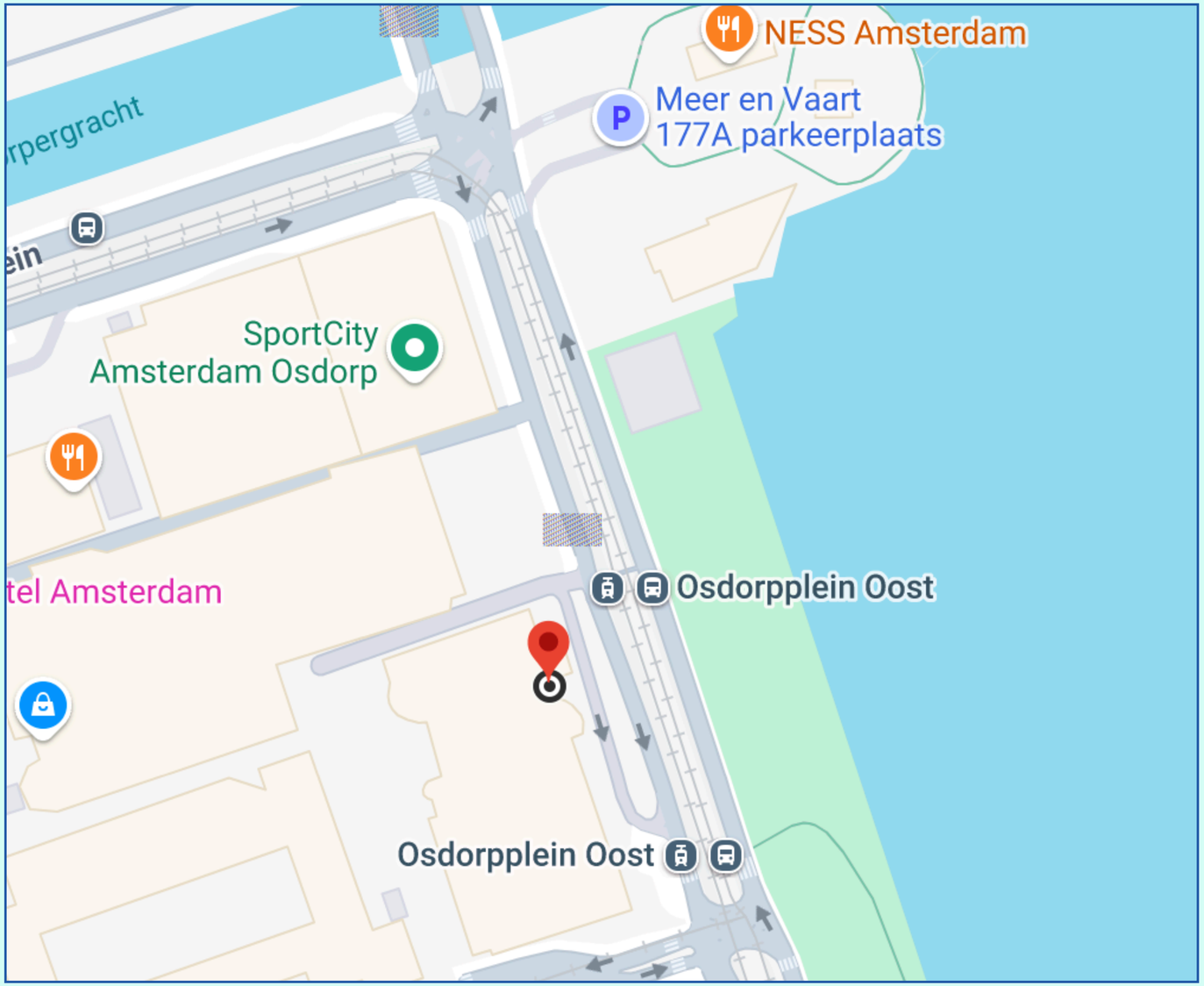


Reduce requests

Show an image first, load video only when user wants it

Reduce requests

Only load the actual map when user clicks it



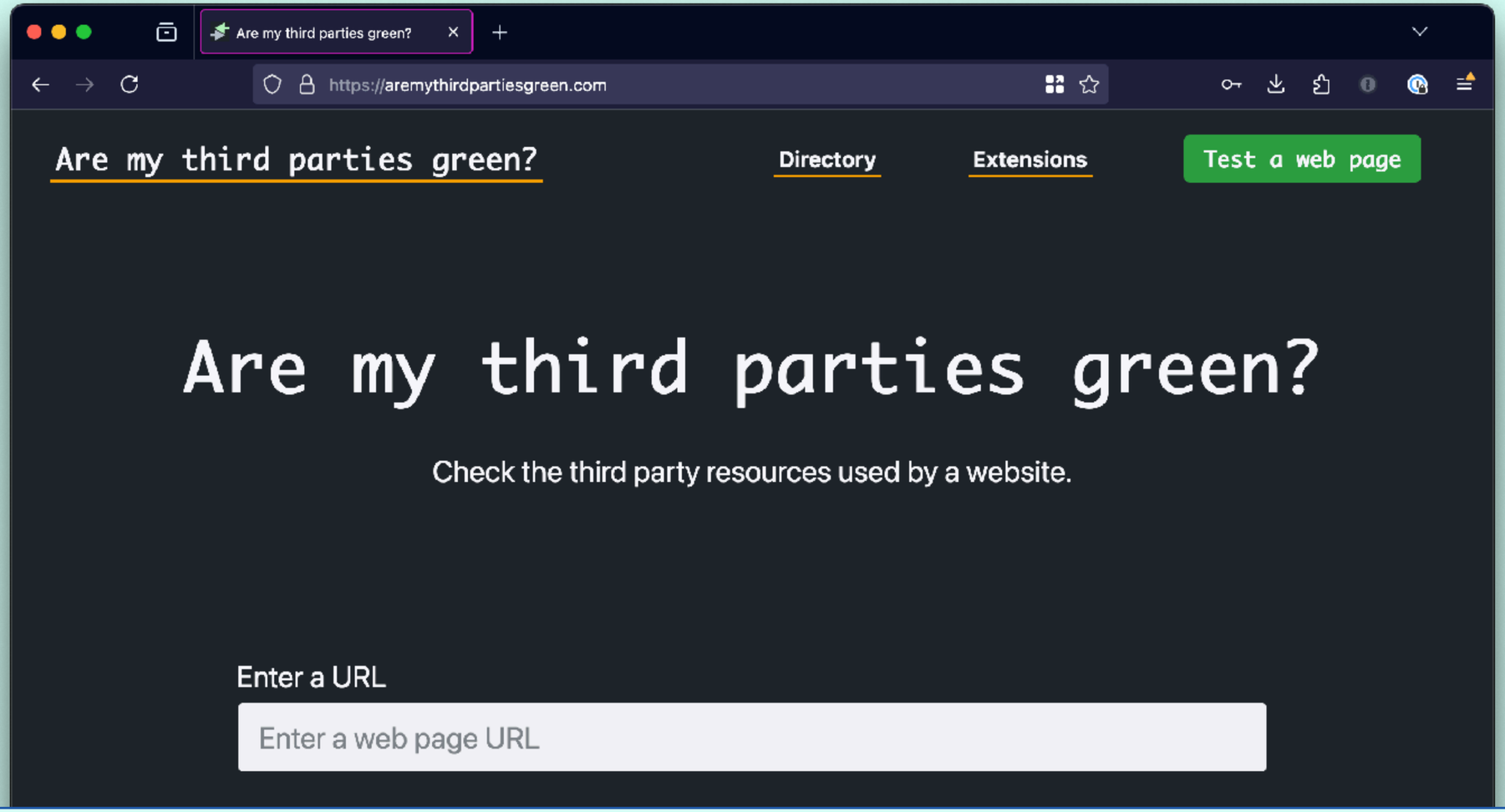
Less duplication

WSG

3.5 Redundancy and duplication in code should be avoided

Check third parties

Check this tool by Fershad Irani



aremythirdpartiesgreen.com

Summary

Make smaller web pages

Support older devices

Choose green hosting

Design services that last

Weed all the things

Thank you!

Thanks to: ...

Slides + links are live on

hidde.blog/slides

Links

HTTP Archive Web Almanac 2024, Sustainability. https://almanac.httparchive.org/en/2024/sustainability

GOV.UK, Greening Government Commitments ICT annual report 2023 to 2024, https://www.gov.uk/government/publications/greening-government-ict-annual-report-2023-to-2024/greening-government-commitments-ict-annual-report-2023-to-2024

Tools

Ecograder, https://ecograder.com/.

Books

Gerry McGovern, World Wide Waste (2020).

Technical specifications

Software Carbon Intensity (SCI) Specification. https://sci.greensoftware.foundation/.
Digital Services Ecodesign ISO standard. https://www.iso.org/standard/86105.html
Web Sustainability Guidelines. https://w3c.github.io/sustainableweb-wsg/