Trail Openers

Sustainability in digital services?

Green ICT Seinäjoki

Ville Nordberg| April 2025

Ville Nordberg

CEO & Founder

Trail runner, dad, foodie, board activist, ev-charger, 20 years in the digital business, and a co-op member.
Green Software standardization group member and Finland’s first Green Software Champion.

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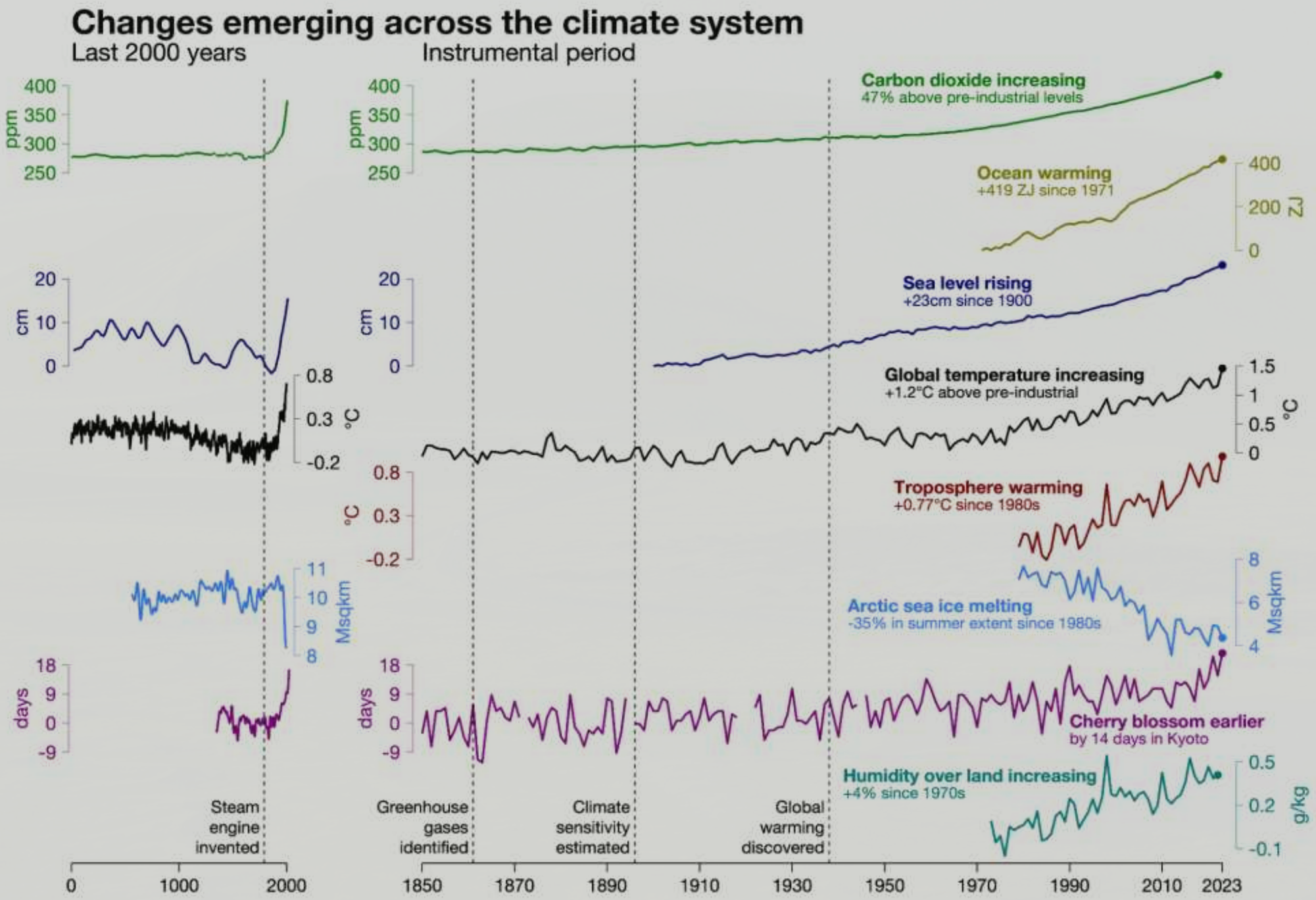
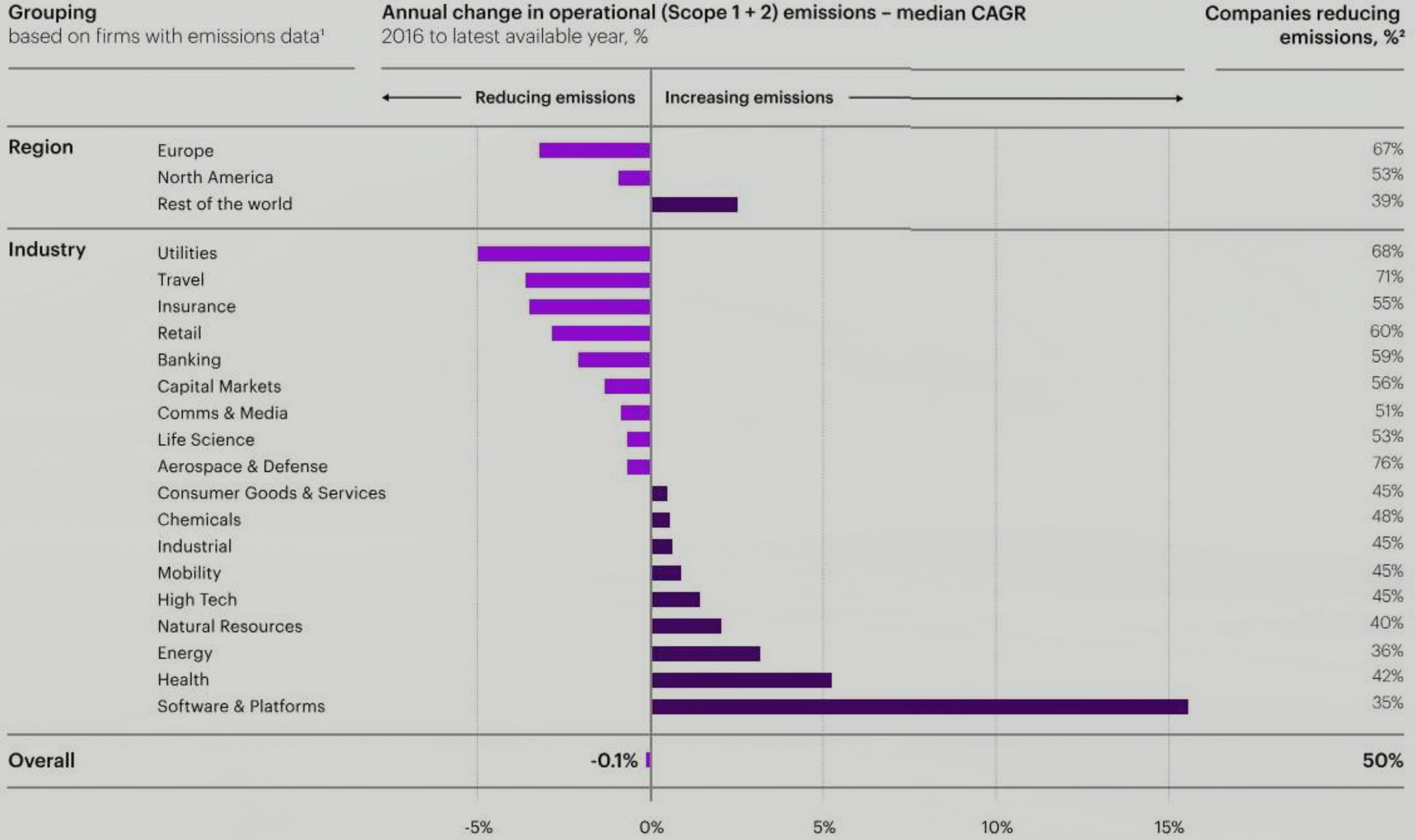
How many of you are aware of what means sustainability in digital services?



GitHub Open Access Climate Visuals

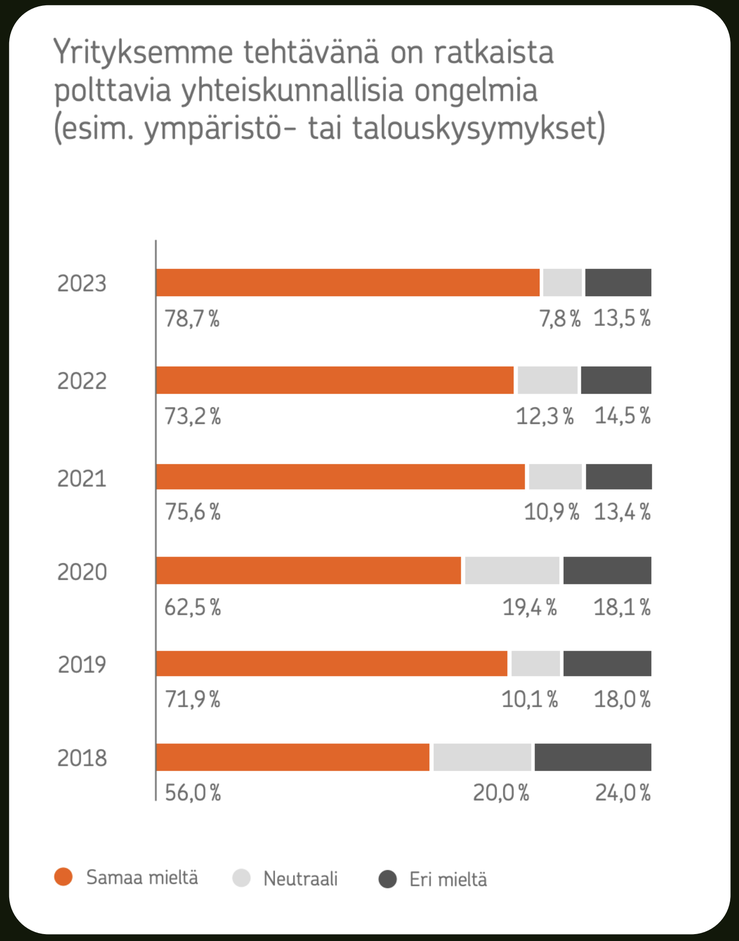


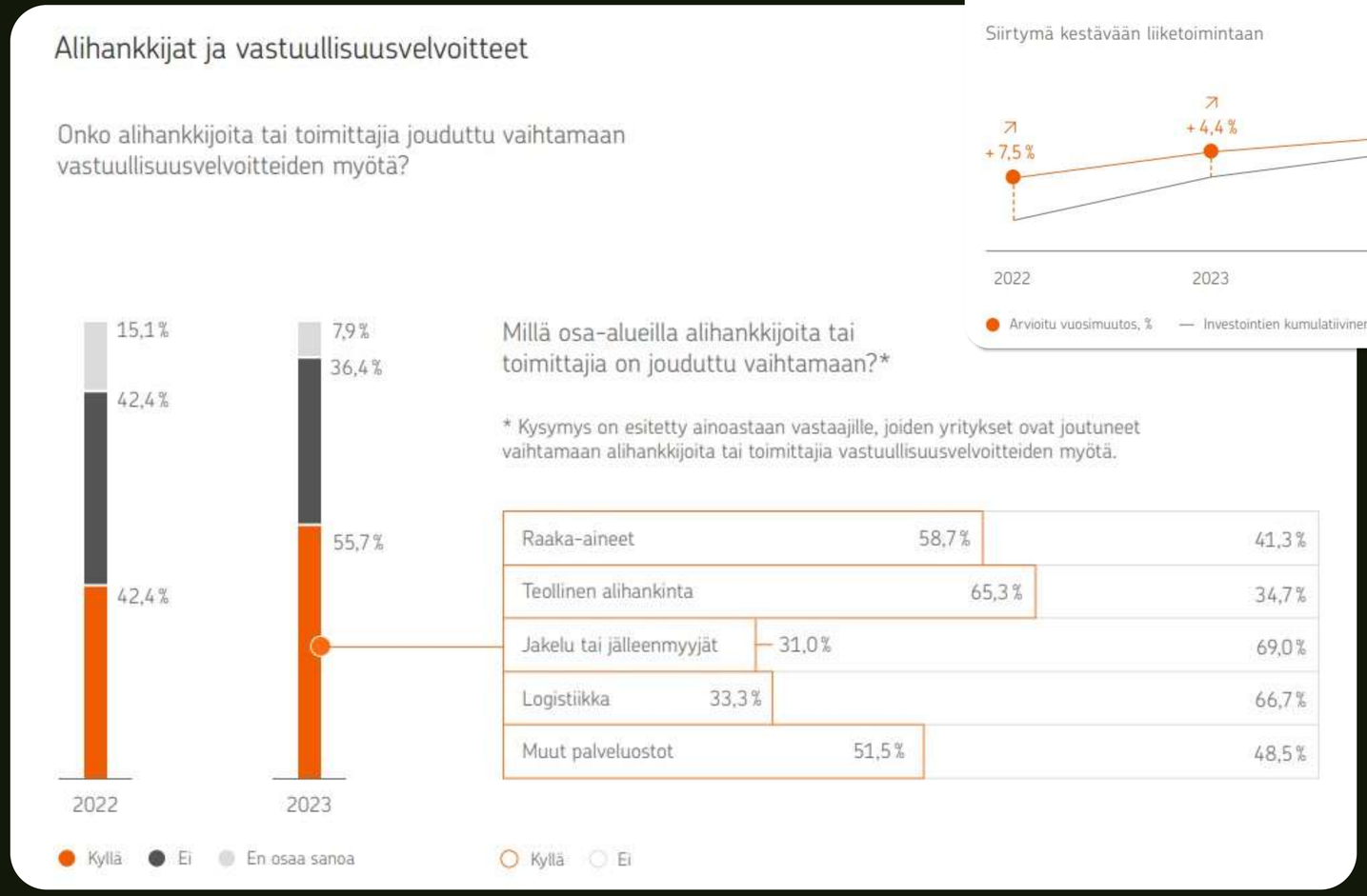
¹ Total sample of G2000 with emissions data in the selected period is 1396.

² Proportion of G2000 companies that have emissions data.

Accenture, Destination Net Zero 2023 Report

Sustainability in business is growing





OP Survey of Large Corporations 2024

ICT sector has a significant impact

Global ICT is projected to consume over 20% of total energy in 2030

The growth is naturally due to accelerated digitalization across all industries. Data, AI, and mobile are generating a mushrooming need for energy, leading the way to higher consumption.

ICT's 2-4% of global carbon emissions equal to global aviation

The exact amount varies across the literature. However, these are conservative estimates as the sector does not report its emissions regulated.

Regulators are waking up and the reporting directive creates action

CSRD reporting, originated by the finance sector, pushes companies to understand and create better transparency to climate impact and actions, including ICT.

Footprint (emissions we produce) – Handprint (emissions we help cut)

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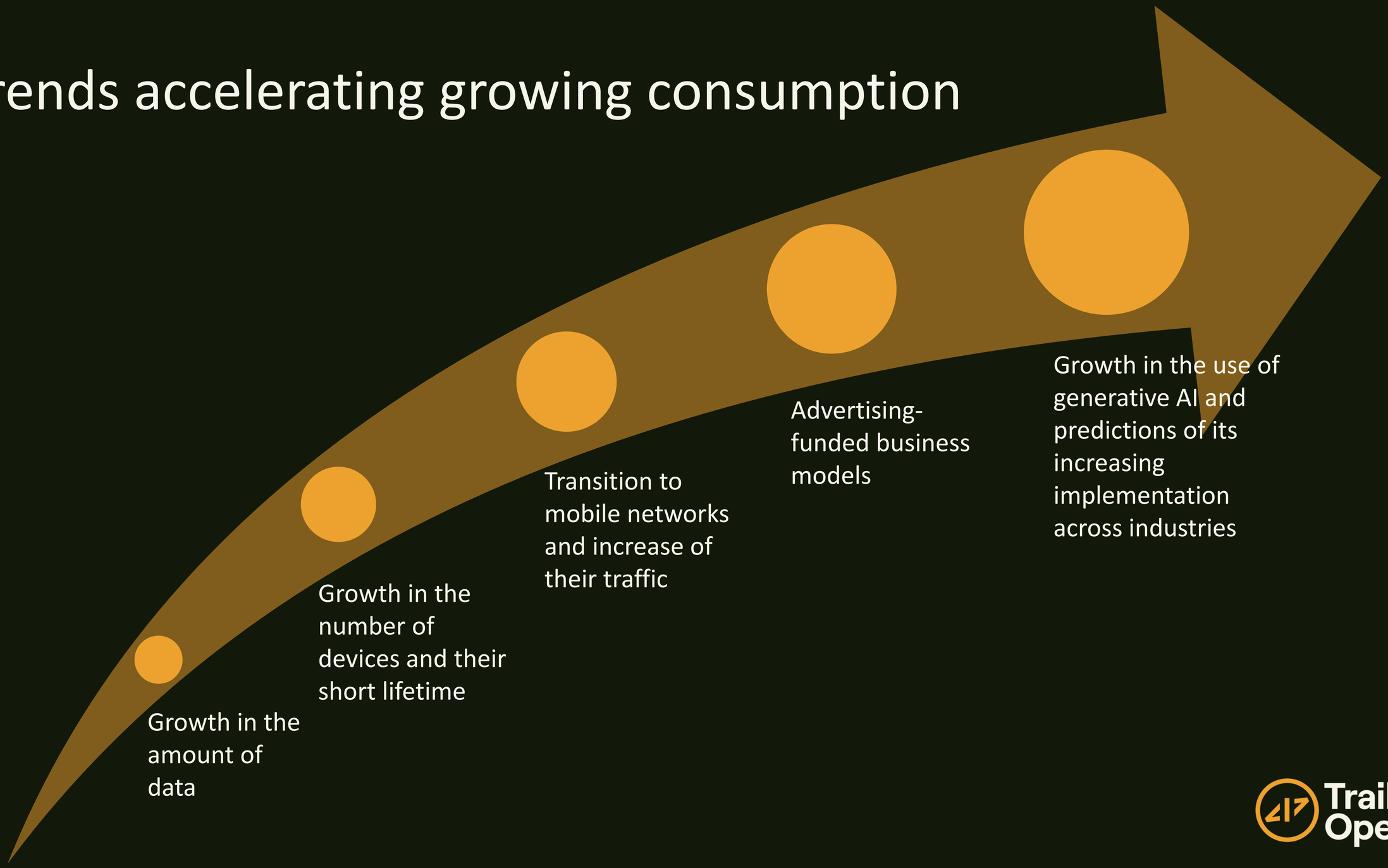
Trends accelerating growing consumption



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GenAI and energy consumption

- The energy consumption of artificial intelligence is multiplying. Previously decommissioned fossil fuel power plants in the United States have been planned to restarted to supply sufficient energy for AI, with Companies announcing intentions of their own new nuclear power plant projects.
- It has long been suggested that AI training consumes more energy than its actual use, implying that usage would not significantly impact overall energy consumption. However, recent studies indicate the opposite, highlighting the energy-intensive nature of AI usage.
- While advancements in AI technology have brought notable improvements in energy efficiency, this progress is paralleled by the exponential growth in AI usage.
- These gains in energy efficiency do not offset the significant overall increase in energy consumption driven by the widespread adoption of AI, even with more efficient models.
- Projections suggest that Europe’s energy consumption could rise by as much as 50% over the next decade due to the expansion of data centers, fueled by the growing demands of AI.
- Deploying smaller, task-specific AI models can be far more efficient, consuming only a fraction of the energy compared to large-scale, multipurpose models.

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Fundamental Principles to More Sustainable Services

Energy efficiency

Use less energy to do the same job. Consume the least amount of electricity as possible, think power usage effectiveness (PUE), serverless and event-driven architectures, for example.

Hardware efficiency

Use less hardware to do the same job. Utilize the least amount of embodied carbon possible. Increase device utilization and lifetime. Think optimized scalability and auto-scaling.

Carbon awareness

Change your service's behaviour depending is the electricity clean or dirty. Think time and location shifting, and demand shaping. Globally this is a big thing, in the Nordics a bit smaller.

Understand, measure, and optimize these fundaments

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Energy Consumption Ballpark in Digital Services

16–33%

Server infrastructure

Well operated cloud infrastructure produces significantly less carbon emissions compared to traditional on-premises servers.

22–35%

Data transfer

Data transfer over mobile/wireless networks is generally consider to create more emissions than using optical fibres.

32–59%

End-user devices

Mobile devices are typically better optimized in energy usage than larger devices like wide-screen displays.

Providing services from servers to users

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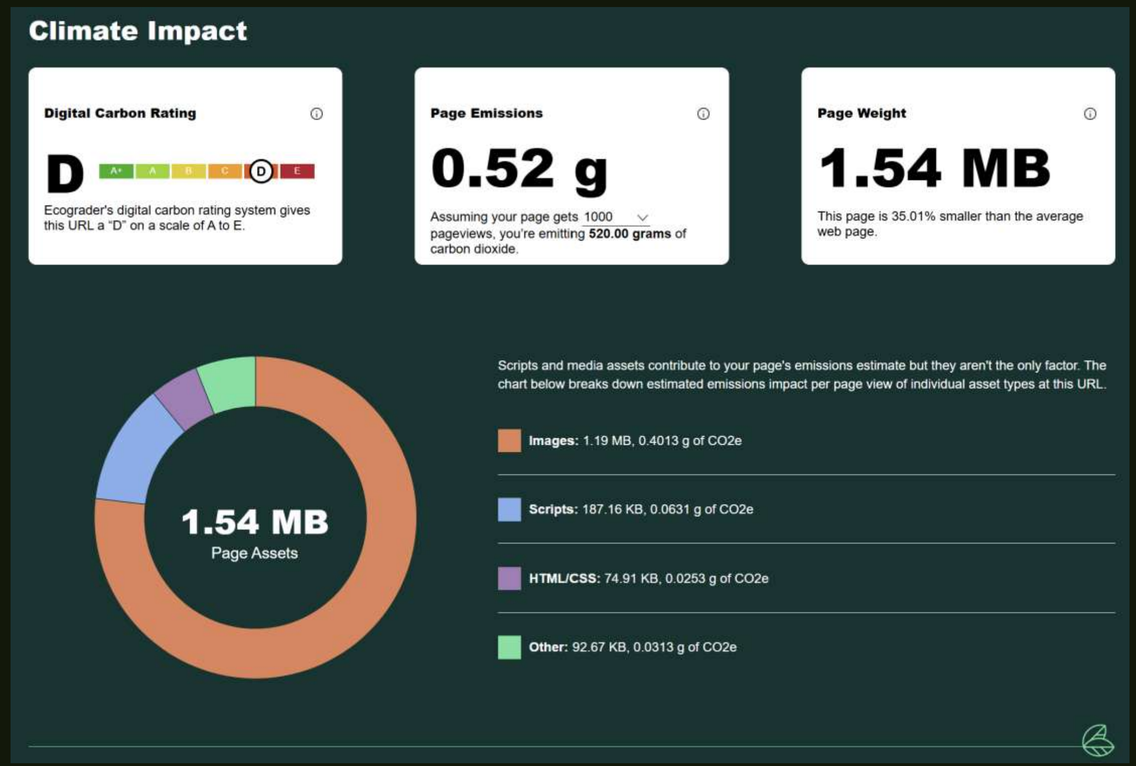
Report from tieke.fi

- This is only projection using a basic measurement of data transfer
- Results do show that optimization work is done a bit but plenty still left
- It also seems that there are low hanging fruits to catch
- There are also potential cost savings to achieve

Some improvement ideas

- Images are not packed good enough. A common habit in websites nowdays.
- Improving page rendering might be a good idea, concentrating first on fonts
- There is also a bit inefficient cache implementation.
- Are WP’s optimization moduls in use?

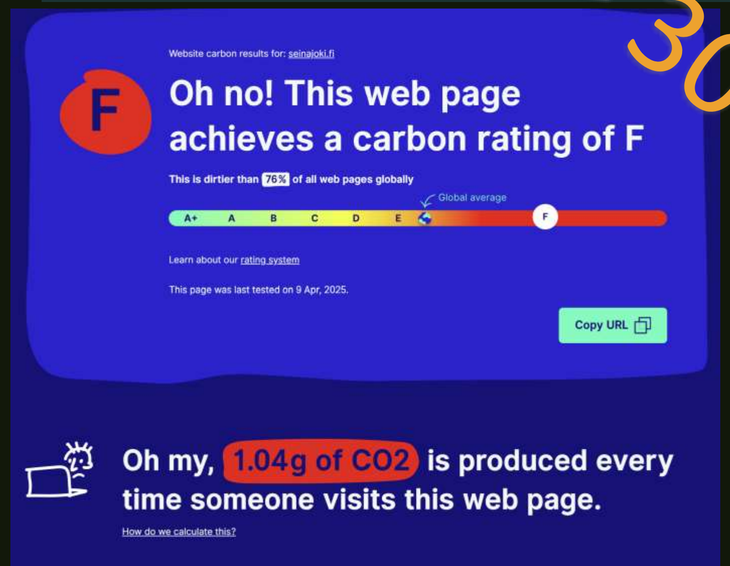


https://ecograder.com/report/w2sLZLQOwk1HkyMkRru0put4

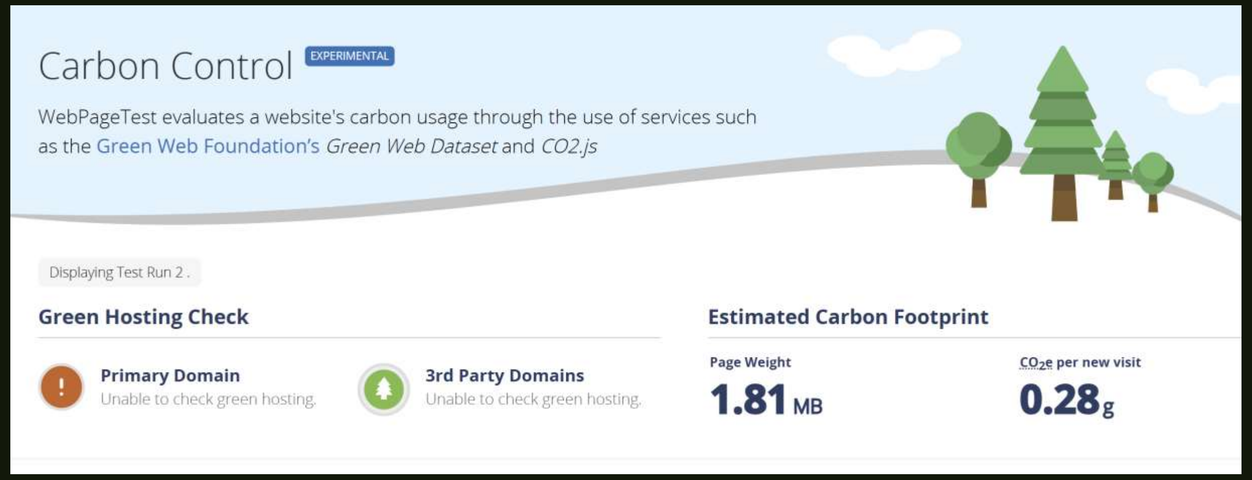
Some other results

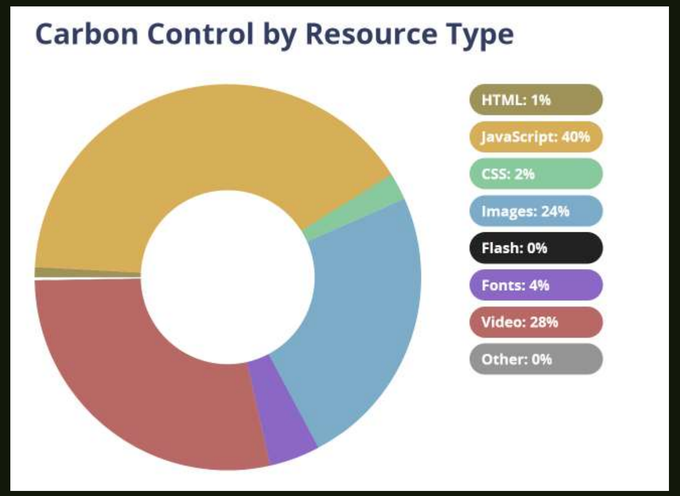
Seinajoki.fi

> 30 %



Utu.fi





Standardization

SCI, ISO/IEC 21031:2024 ☑
ITU-T L.1480 ☑
Resource-efficient software (ISO Open consultation)
ISO/IEC JTC 1/SC 7/AHG 10 ”Green Software”

The standardization of Green ICT practices is helping organizations better understand their digital environmental impact and take meaningful action.

It also enables buyers to compare various options based on their environmental performance.

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Sustainable + Resource-Efficient = Full-Stack Job

- Emphasize and encourage to efficiency actions
- Create visibility with metrics and dashboards
- Bring these topics actively to planning
- Minimize micro-services overhead
- Consider modular monoliths
- Use serverless archi-tectures when possible
- Design for scalability
- Avoid overprovisioning
- Remove unused features & libraries
- Optimize API calls
- Minimize dependecies
- Reduce network calls in code
- Optimize image and video handling
- Monitor resource usage and energy consumption
- Remove obsolete resources
- Ensure automatic scaling
- Run tests only when needed
- Think GreenOps*
- Right data modeling to fit the purpose
- Data pruning and retention policies
- Incremental and event-driven processing
- Auto-scale databases
- Right-sizing instances and services
- Use spot instances
- Prefer green data-centers
- Use content delivery networks

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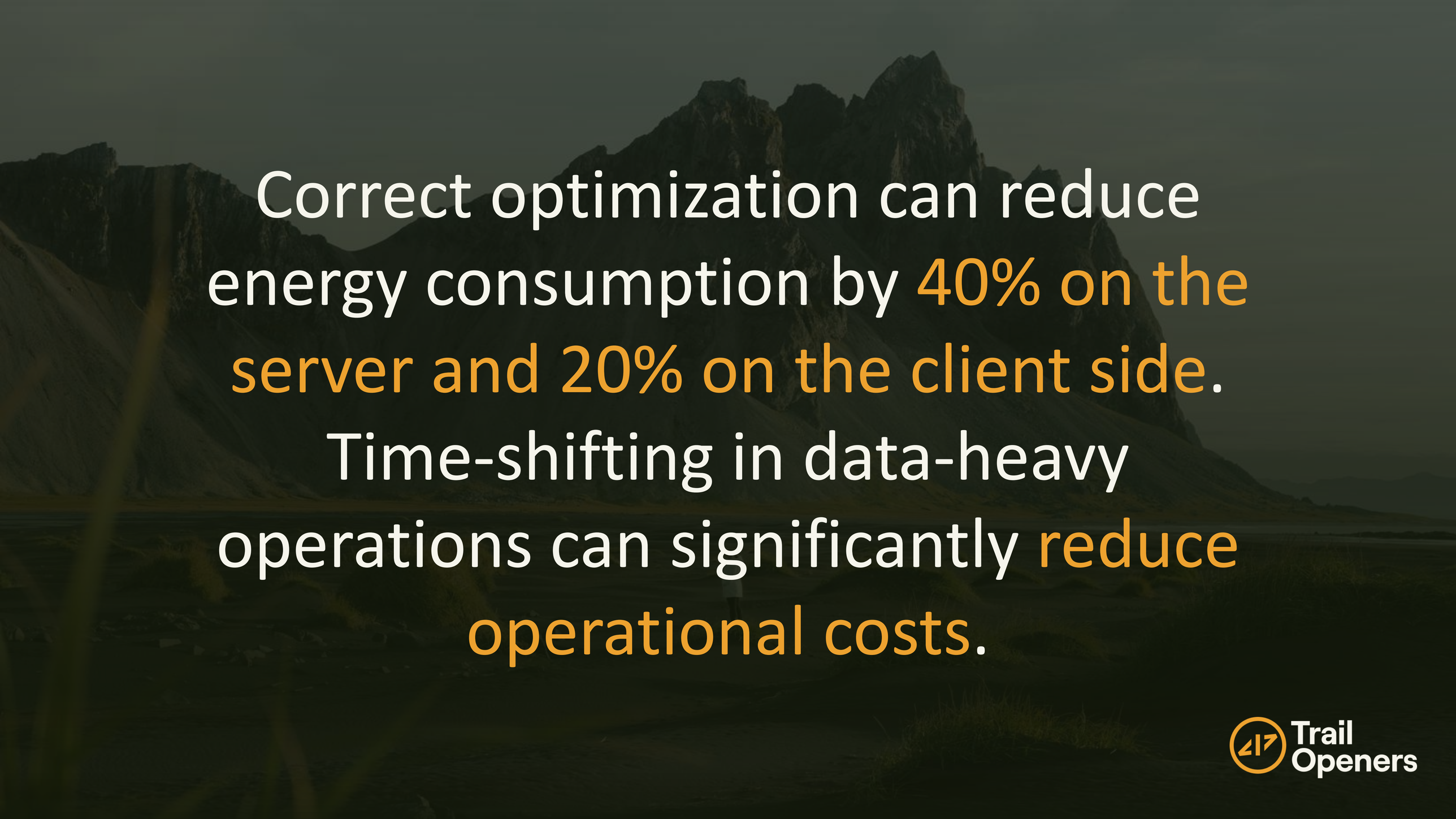
*GreenOps = GitOps + FinOps (a definition by CNCF's Environmental Sustainability Group)


Correct optimization can reduce energy consumption by 40% on the server and 20% on the client side.
Time-shifting in data-heavy operations can significantly reduce operational costs.
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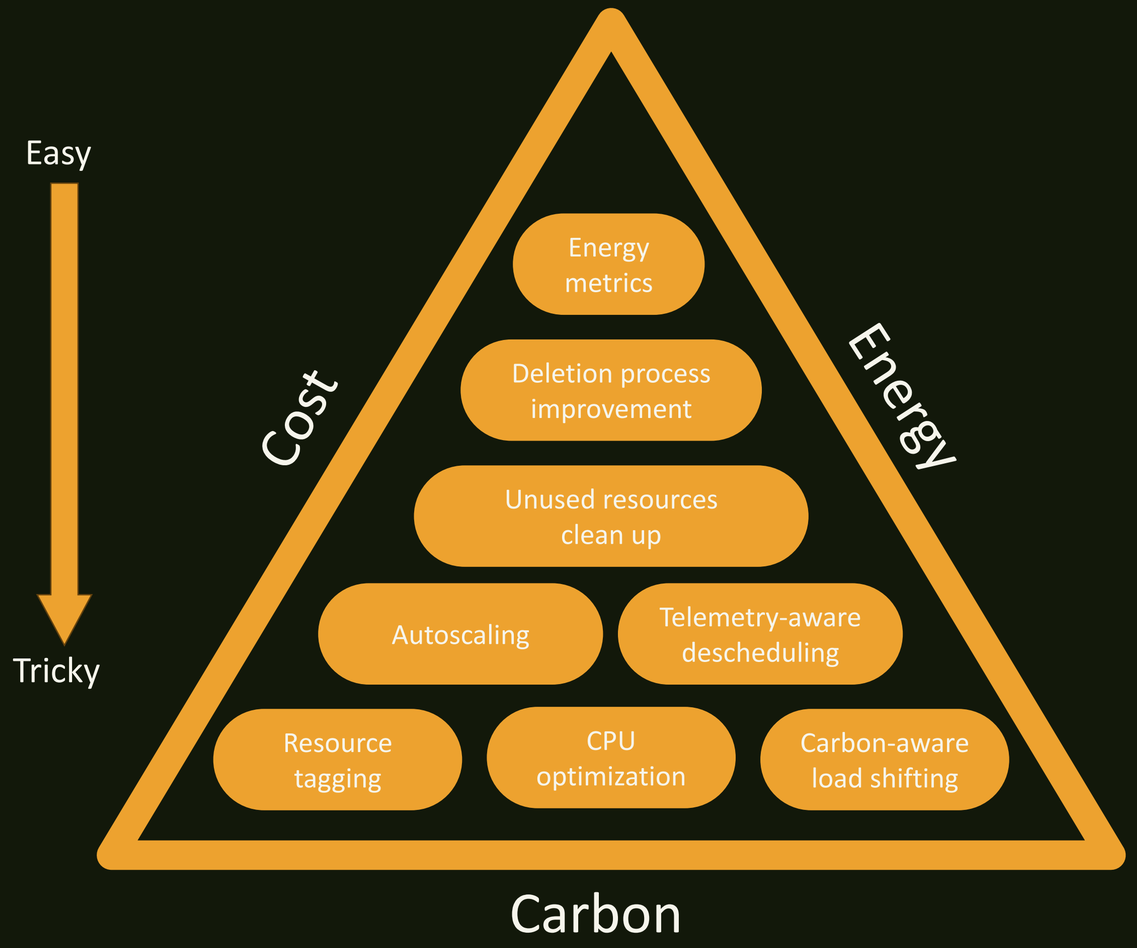
Operational Efficiency – Finding The Right Balance



Aiming for sustainability and resource efficiency is not work-free. Running less or turning stuff off requires time and attention. Finding the right balance and depth of action is essential. Aligning with faster delivery, cost optimization, and developer and ops time savings are good proxies. Nobody wants to go green with the cost of productivity.

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CNCF's GreenOps Triangle

Cost Savings Are Real

Energy Use Per Transaction

Lower energy consumption per transaction reduces electricity costs. Energy-efficient algorithms and reducing computational complexity can significantly cut energy costs.

Idle Resource Utilization

Minimizing idle time by using serverless functions or autoscaling reduces the pay for unused/underutilized resources. For cloud, this translates into reduced bills by paying only for active usage.

Data Transfer Volume

Optimizing data handling, like reducing data payloads, efficient API usage, and caching, can lower network usage fees, which can be costly at high traffic services.

CI/CD Pipeline Efficiency

Streamlining CI/CD pipelines, such as minimizing unnecessary builds/tests or using incremental builds, reduces infrastructure costs associated with CI/CD servers.

Data Storage Efficiency

Efficient storage reduces the footprint on high-cost storage solutions, cutting bills significantly, especially in data-intensive applications, directly impacting costs charged by storage volume.

Scaling Efficiency

Reducing unnecessary scaling lowers the cost of computing. Reducing over-provisioning results in savings, especially during off-peak hours or low-demand periods.

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Example roadmap to Emissions Minimization

Phase 1
Foundation & Measurement

Goal: Emissions visibility and baseline metrics.

- **Readiness assessment**
  (Determine maturity and speed for change)
- **Emissions audit**
  (Cloud Carbon Footprint, Scaphandre)
- **Setup GreenOps dashboards**
  (Grafana, PBI, Prometheus)
- **Define KPIs**
  (gCO2e/user, per GB, per deployment)

Tools: Cloud Carbon Footprint, Azure/AWS Monitoring, Scaphandre, Grafana, Power BI

Phase 2
Optimization & Reduction

Goal: Reduce emissions 25–40% from baseline.

- **Right-size resources**
  (Azure Advisor, AWS Optimizer)
- **Carbon-aware scheduling & region selection**
- **Green coding practices**
  (Carbon Aware SDK)
- **Sustainable CI/CD**
  (ephemeral environments, carbon-triggered builds)

Tools: Cloud Custodian, Terraform, Electricity Map API, GitHub Actions

Phase 3
Transformation & Reporting

Goal: Reach 50–60% carbon intensity reduction.

- **Embed green design patterns**
  (JAMstack, edge, serverless)
- **Include Scope 3 & end-user emissions** (Website Carbon Calculator, ecoPing)
- **Automate reporting & integrate green KPIs**
  (GHG, SBTi, ESG platforms, OKRs, roadmaps, release criteria)
- **Certify & promote achievements**
  (GSF, ISO 14001/50001)

Tools: Normative, Planetly, WebsiteCarbon, Green Software Patterns

Optional Acceleration Path:
For cloud-native or sustainability-mature organizations, phases may be combined to achieve significant results within 12–18 months.

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Tangible and simple examples on what we've done

30% less processor time used in the CI/CD build step

In developing an EV charging service, we reduced the current environment's code check time by 60 minutes daily. After spotting this optimization, the fix took five minutes resulting better efficiency.

Nearly 90% reduction in data transfer in parts of the front-end

While analysing the service and creating a sustainability roadmap for a SaaS martech company, we identified major optimization need in the data transfer related to libraries, waste code, and media.

Efficient architecture resulted in no need for a database

A subscription-based service in digital healthcare was designed with Azure components and Stripe to be as light and efficient as possible. We did this without a database.

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Towards greener AI solutions

- Use existing LLMs, do not create your own
- Adjust and train existing models with your own material
- Use energy efficient models (e.g. TinyML, savings might be over 100x)
- Do you really need LLMs or can you use SLMs (if LLM increases accuracy 1-3 %, is this really needed)
- Use GenAI only when it is useful (consider energy consumption e.g. Google Search vs. ChatGPT)
- Find out cloud providers energy type used. It also matters when and where you drive your workloads.
- Add AI-actions to your carbon monitoring

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No one can do everything but everyone can do something

Extend the life of your laptop by six months

This makes a huge different in CO2 emissions. Laptop batteries are designed to last 5–6 years.

Remove unnecessary data

Probability of data reuse is decreasing radically over time. Only 5% of data is actively used after three months of storaging.

Extend the life of your mobile phone

There are more cellular subscriptions than people. Adding one year to life of all mobile phones = removing million cars from roads.

- Bookmarks in browser
- Screen brightness
- Emails
- Use of multimedia
- Remote work
- Cleaning the useless digital material

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There are many resources available

Software Carbon Intensity (SCI)

The SCI specification by the Green Software Foundation provides a method to measure and reduce the carbon emissions associated with software. A standard in development: ISO/IEC 21031.

Web Sustainability Guidelines

The W3C's Web Sustainability Guidelines provide best practices for designing and implementing digital products and services that prioritize environmental sustainability and user experience.

Green Software Directory

GitHub's Green Software Directory is a curated list of open-source projects focused on enhancing software sustainability by reducing energy consumption and carbon emissions.

Electricity Maps

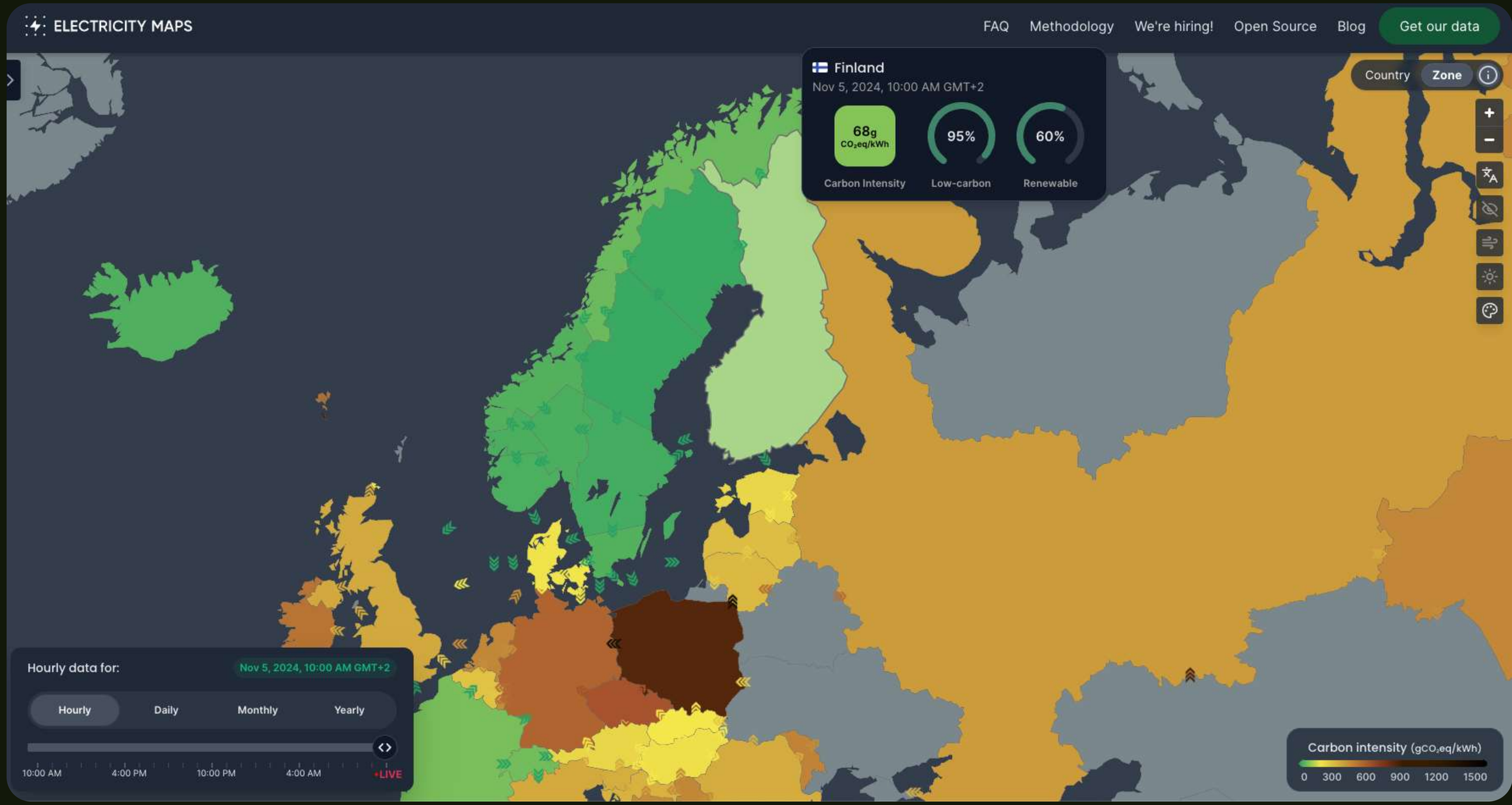
Real-time data on the carbon intensity of electricity in different regions, helping to understand and reduce the environmental impact of energy consumption. Used by AWS, Google, and Salesforce.

GR491 Handbook

A comprehensive guide developed by the Institute for Sustainable IT, offering 61 recommendations and 516 criteria across eight categories to promote responsible and sustainable digital service design.

Carbon Aware SDK

A toolset to create software applications that are optimized based on the carbon intensity of electricity, allowing scheduling at times and locations where energy is greener.


ELECTRICITY MAPS
FAQ
Methodology
We're hiring!
Open Source
Blog
Get our data
Finland
Nov 5, 2024, 10:00 AM GMT+2
68g CO₂eq/kWh
Carbon Intensity
95%
Low-carbon
60%
Renewable
Country
Zone
Hourly data for:
Nov 5, 2024, 10:00 AM GMT+2
Hourly
Daily
Monthly
Yearly
10:00 AM
4:00 PM
10:00 PM
4:00 AM
LIVE
Carbon intensity (gCO₂eq/kWh)
0
300
600
900
1200
1500

AWS

Active Regions

By default the API will only return regions which have a Grid intensity of <= 100

Canada (Central) Updated: today at 9:30 AM	`ca-central-1`	34 Intensity (CO2gE/KWh)
Europe (Stockholm) Updated: today at 11:00 AM	`eu-north-1`	47 Intensity (CO2gE/KWh)
Europe (Paris) Updated: today at 10:00 AM	`eu-west-3`	50 Intensity (CO2gE/KWh)
Canada West (Calgary) Updated: today at 11:59 AM	`ca-west-1`	54 Intensity (CO2gE/KWh)
South America (São Paulo) Updated: today at 11:52 AM	`sa-east-1`	64 Intensity (CO2gE/KWh)

Prediction from Google: By 2025, 3 out of 4 developers will lead with sustainability as their primary development principle

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Cheers!

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