GreenOps in Practice:

Tools, data, and culture for a sustainable cloud

Green Tech South West, 3rd September 2025

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digitalPebble

Who am I?

digitalPebble

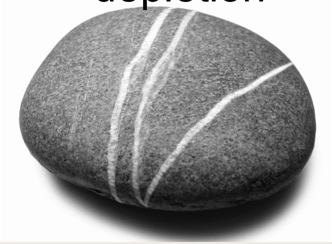
THE APACHE SOFTWARE FOUNDATION ESTABLISHED 1999

Boavizta

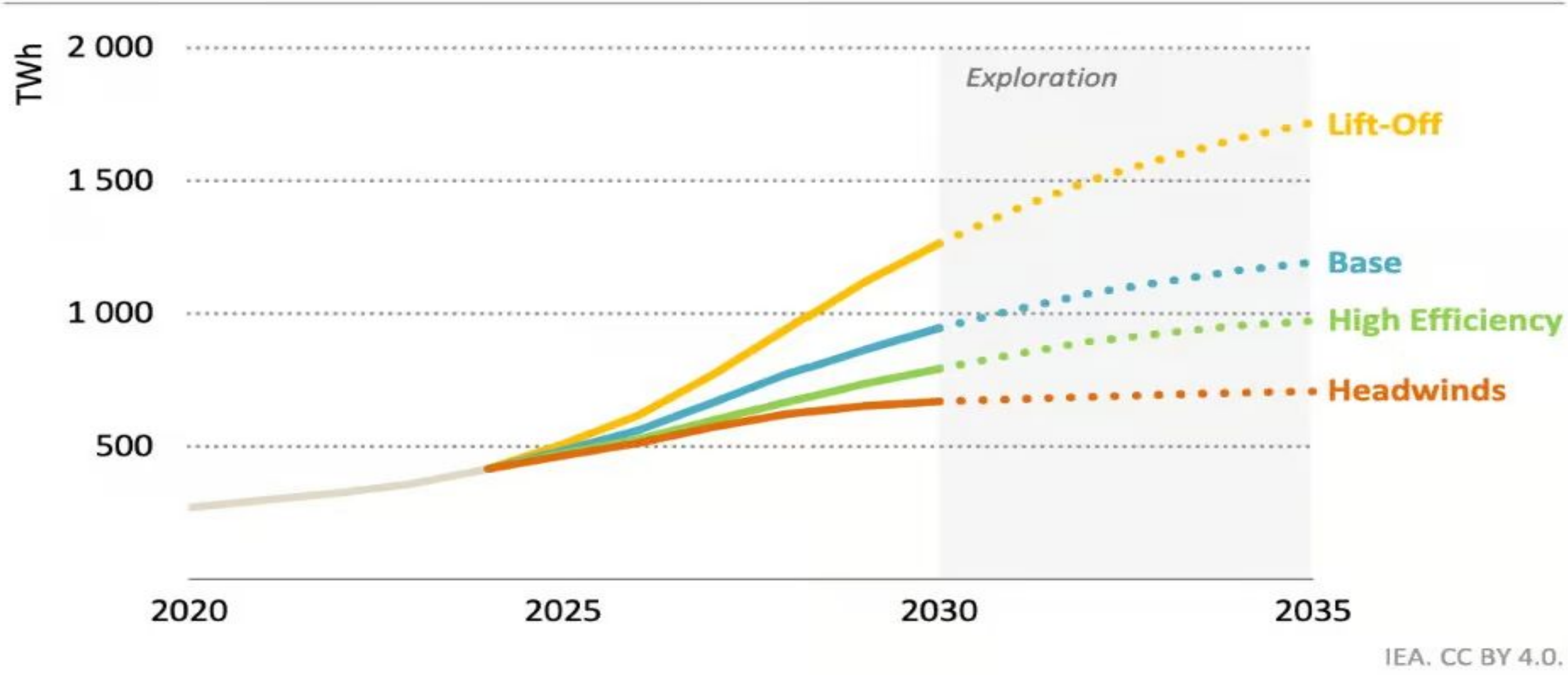
Green Software Foundation

Environmental impact of ICT

- 3 to 4% global GH 22
- Expected to x2 by 2026
- Fuelled by rise of ge oto
- Not just GHG
    - Increased energy
    - Water consumption
    - E-waste
    - Resource depletion

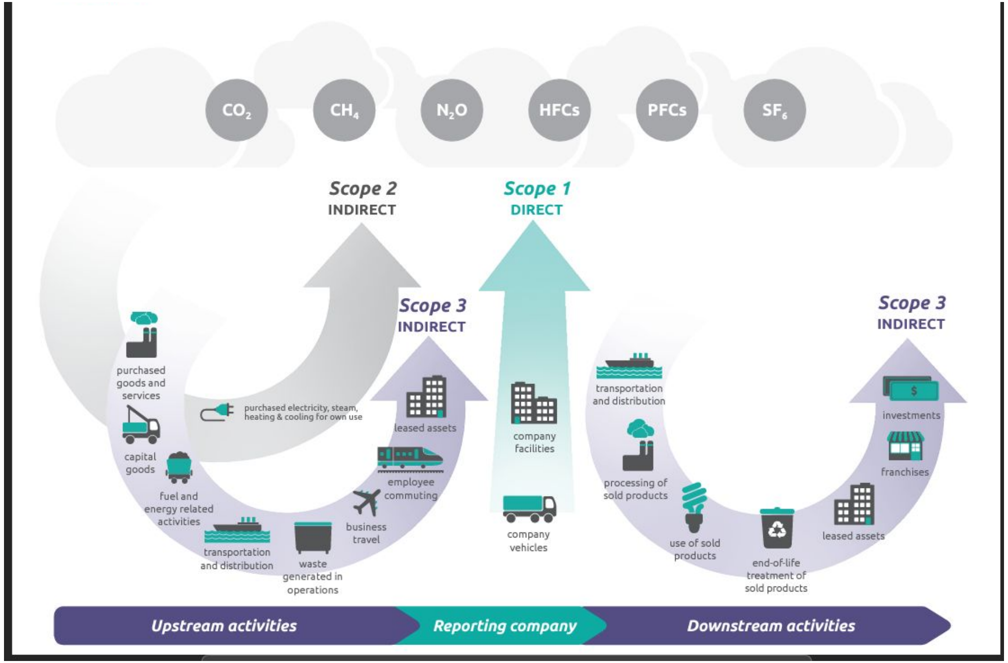


Projected electricity consumption of data centres



A few terms and concepts

GHG Protocol *https://ghgprotocol.org*



Ways of estimating scope 2

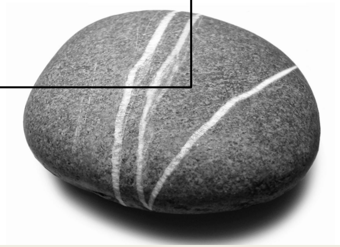
Location based

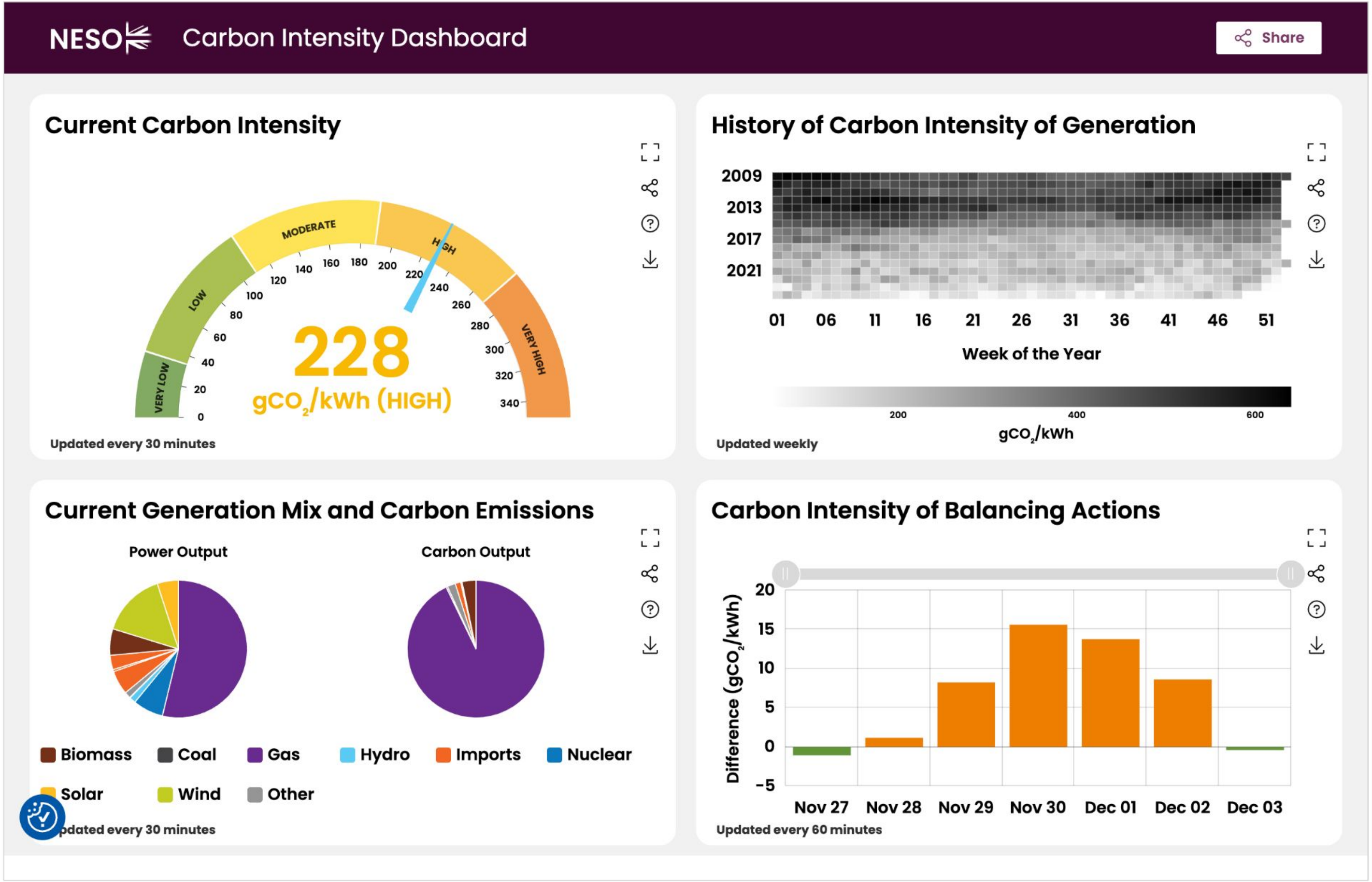
Carbon intensity of the grid at the place and time of process

Carbon neutral != Net zero

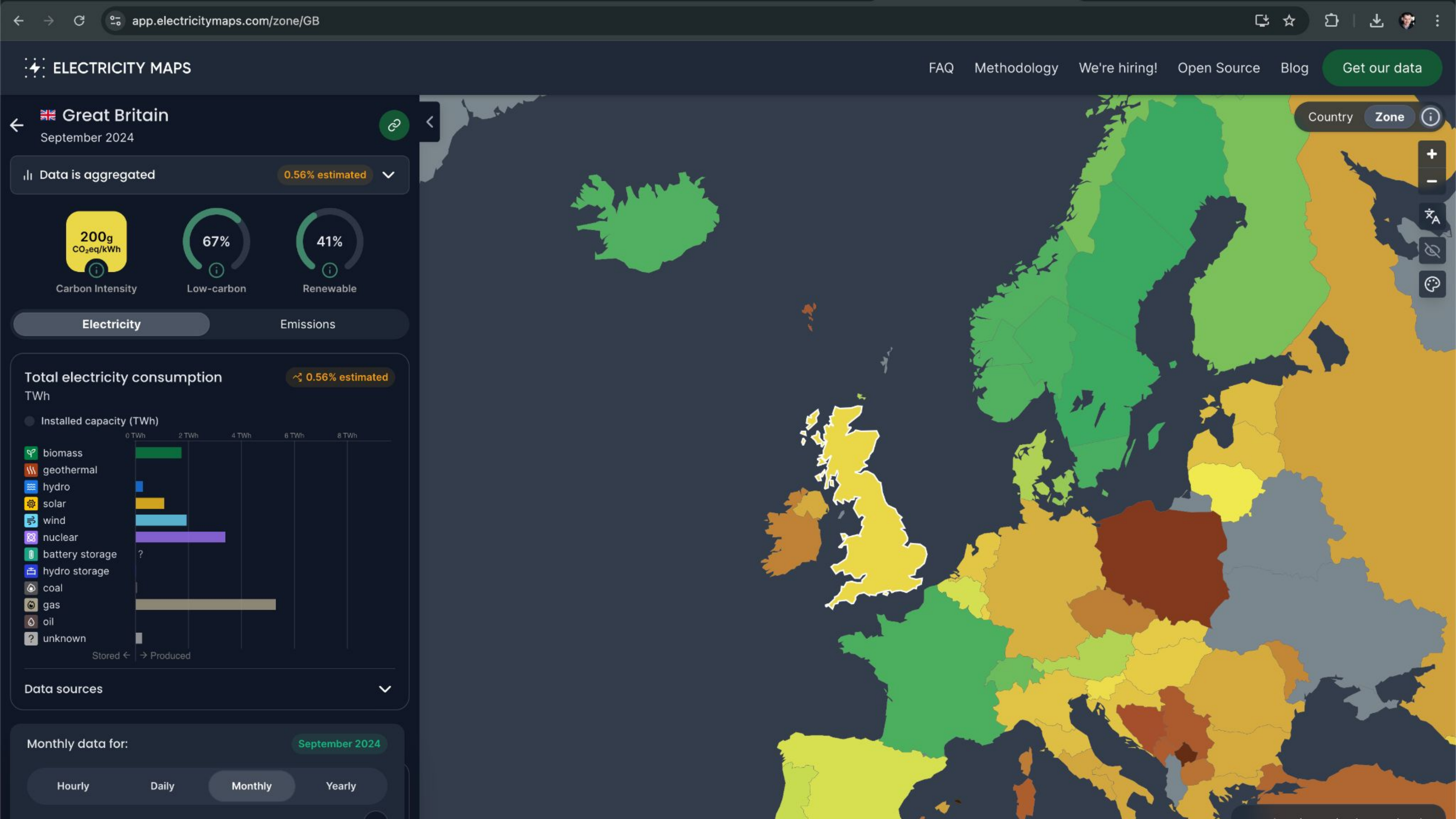
Market based

Offsetting via power purchase agreements (PPA) & buying certificates





https://dashboard.neso.energy/



app.electricitymaps.com/zone/GB
ELECTRICITY MAPS
FAQ
Methodology
We're hiring!
Open Source
Blog
Get our data
Great Britain
September 2024
Data is aggregated
0.56% estimated
200g CO₂eq/kWh
Carbon Intensity
67%
Low-carbon
41%
Renewable
Electricity
Emissions
Total electricity consumption
TWh
0.56% estimated
Installed capacity (TWh)
0 TWh
2 TWh
4 TWh
6 TWh
8 TWh
biomass
geothermal
hydro
solar
wind
nuclear
battery storage
?
hydro storage
coal
gas
oil
unknown
Stored
Produced
Data sources
Monthly data for:
September 2024
Hourly
Daily
Monthly
Yearly
Country
Zone

What can I do?

IT footprint of a typical software company

Product / service
Cloud footprint: AWS, Azure, Google
Client side: browser, app

GreenOps

Services to produce, manage or monitor the software
GitHub / CoPilot
CircleCI
DataDog

Communication
Slack
Google Meet
MS Teams

Network

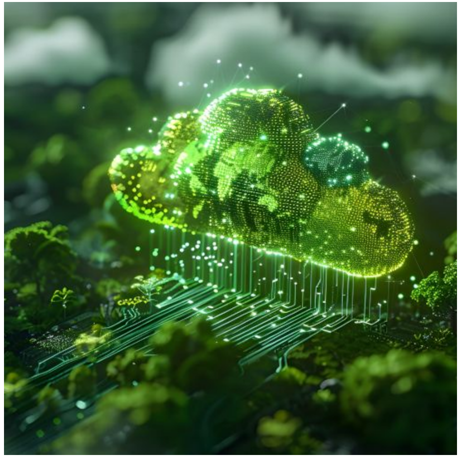
Devices
Laptops, screens

Harder to estimate

FinOps & GreenOps

FinOps

Measure and reduce the financial costs of cloud operations

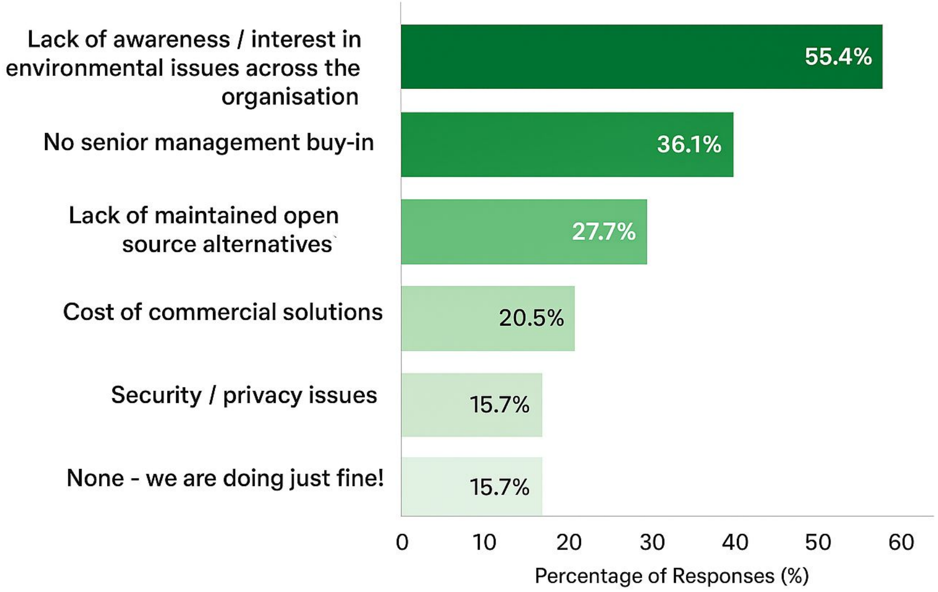


GreenOps

Measure and reduce the environmental impacts of cloud operations

What are the main hurdles to the adoption of GreenOps in your organisation?

(83 responses)



Source: survey conducted by DigitalPebble and open-source-economy.com in July 2025

Arguments to get management buy-in

Aim: get a champion in top management for your cause

- Improve the reputation of the organisation
- Retain employees
- Comply with existing commitments

- GreenOps boosts FinOps
    - “Not my wallet, but it is my planet”
    - Optimise use -> reduce costs

Start a cultural revolution!

Harness the FinOps principles (**https://www.finops.org/**)

- Teams need to collaborate
- Decisions are driven by business value of cloud
- Everyone takes ownership for their cloud usage
- FinOps data should be accessible and timely
- A centralized team drives FinOps
- Take advantage of the variable cost model of the cloud

Same cultural shift: accountability for both costs and impacts across the organisation

Work with your FinOps team (or become that team)

Common actions

- Turn off unused resources
- Autoscaling
- Right-sizing
- Choice of storage / compression

Shared requirement: Tagging

- User tags on resources
- E.g. *service area, team, product, environment*
- Allows you to attribute costs and impacts
- Absolutely essential
- Requires a policy + enforcement

Same approach: data everywhere!

Make it hard to ignore - add the data to existing reports and dashboards

Work with your Site Reliability Engineering (SRE) and / or Platforms teams

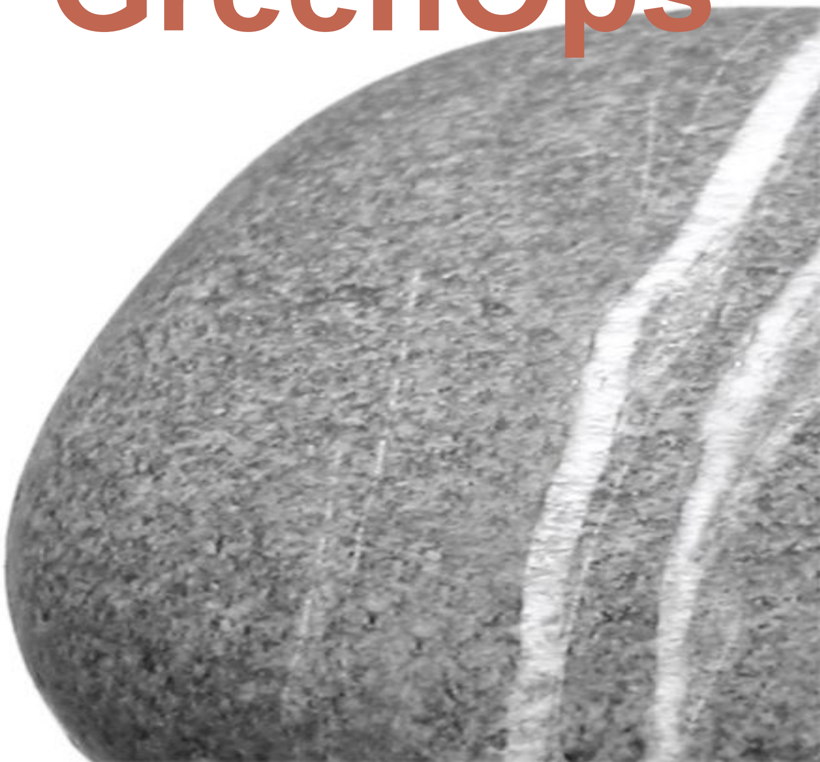
Gamify - ex: leaderboards of emissions per $ spent

Flag unused resources / possible upgrades and their impacts

Data available for FinOps e.g CUR (Cost and Usage Reports for AWS)

But what about GreenOps?

Native tools for GreenOps



AWS Customer Carbon Footprint Tool (CCFT)

Filters

By default, the charts below display all your available data, up to 38 months, calculated using the MBM method. You can select specific dates using the filter on the left, or change the calculation method using the filter on the right.

Select date range

Filter by a month range

Calculation method - *new* Info

Select emissions type

LBM
Location-based method

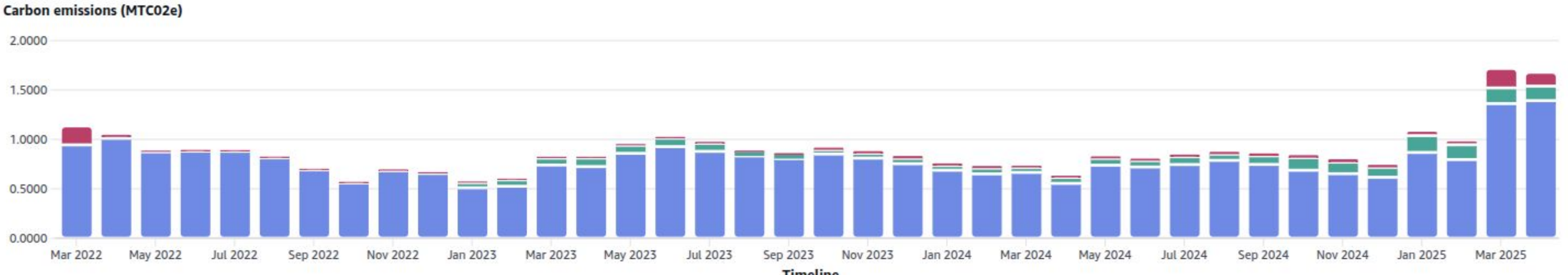
Carbon emissions summary Info

Provides your total AWS carbon emissions and the estimated savings from using AWS. The savings represent the estimated carbon emission reduction due to AWS's renewable energy purchases. If your emissions are lower than your savings, it means AWS has purchased renewable energy that compensated all or part of the emissions associated with your usage.

Estimated LBM emissions	Estimated emissions savings
33.412 MTCO2e	33.334 MTCO2e

Carbon emissions | Emissions by service | Emissions by AWS Region

Carbon emissions over time (LBM)



AWS Customer Carbon Footprint Tool (CCFT)

Carbon emissions | Emissions by service | **Emissions by AWS Region**

Emissions by AWS Region

This table displays emissions by AWS Region. Emissions from Global Services, such as Amazon CloudFront, are reported under Global.

Filter by AWS Region

1

Region	LBM carbon emissions	% of total emissions (LBM)
US East (N. Virginia)	29.893	89.4%
US East (Ohio)	2.292	6.9%
Europe (London)	1.227	3.7%

Overview of Cloud Providers' calculators

Location based since June 2025

Some scope 3 before end 2025

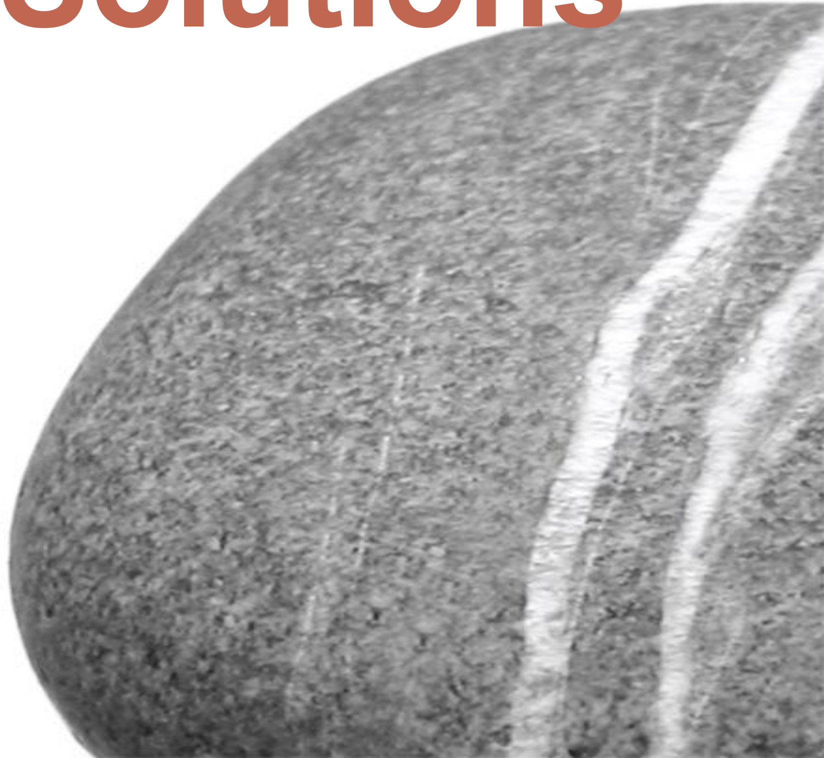
	aws	Google Cloud	Microsoft Azure
Scope 1	~ Undisclosed perimeter	✓ Backup generators only	✓ Backup generators & refrigerant leaks
Scope 2	~ Market-based	✓ Location-based, using real-time emission factors from Electricity Maps when available, or from IEA	~ Market-based
Scope 3	✗	✓ Manufacturing of IT equipment Capital Goods (buildings, infrastructure) Employee commuting Upstream of energy (included in the Electricity Maps and IEA emission factors)	✓ Manufacturing of IT equipment Upstream and downstream freight Capital goods (unspecified) Waste management End-of-life of equipment
Comments	Emissions linked to electricity consumption are nearly inexistant, as Scope 2 is computed with the market-based method, and all Scope 3 emissions are omitted. The overall lack of transparency and of details in the results provided make it difficult to re-estimate emissions.	The calculator provides a good idea of the emissions linked to a customer's usage of GCP services.	Emissions linked to electricity consumption are nearly inexistant, as Scope 2 is computed with the market-based method and Scope 3 upstream of energy is omitted. Customers may re-compute these emissions using proxies to get a more complete estimation.

From https://www.carbone4.com/en/article-digital-cloud-hidden-emissions

Limitations

- Not real time: up to 3 months delay
- Lack of granularity
  - Can’t link emissions to a specific team / product / service within the org
  - Can’t see details of which cloud services are responsible
- Partial coverage
  - Scope 3 not included
- Different methodologies
  - Can’t always compare like for like
- Not actionable
  - Need other sources of data to measure the emissions

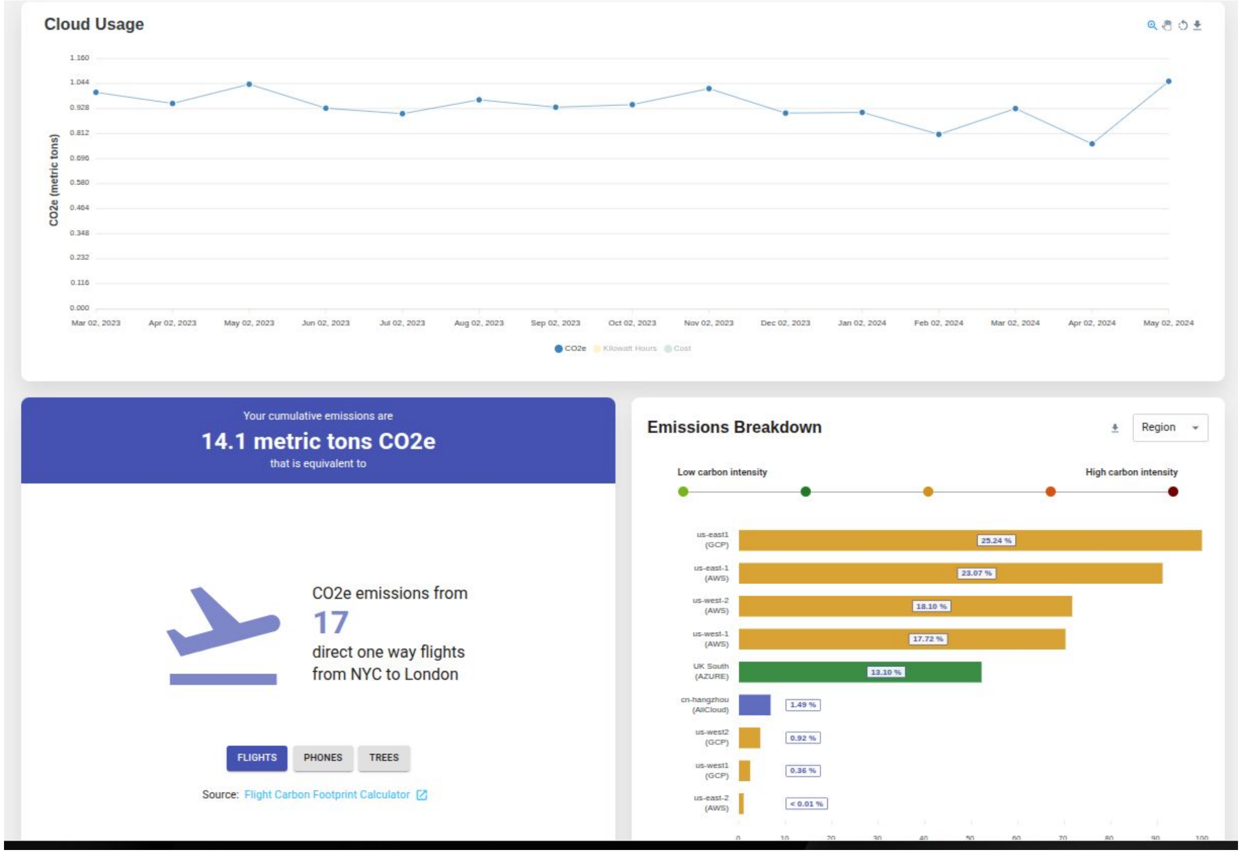
Open Source Solutions



Cloud Carbon Footprint

- https://www.cloudcarbonfootprint.org/
- Backed by Thoughtworks
- Multi cloud provider
  - AWS, Azure, Google Cloud, AliCloud
- Energy + emissions + costs
- Embodied + usage
- Drill down into emissions by cloud provider, account, service and time period
  - Not by user tag
- Recommendations!

Cloud Carbon Footprint



Cloud Carbon Footprint

- Reference tool for a long time
- Extensible / customisable

- Hard to set up
- Aging data and methodology
- No active development
- Not supported by Thoughtworks

Boavizta CloudScanner

- https://boavizta.github.io/cloud-scanner/

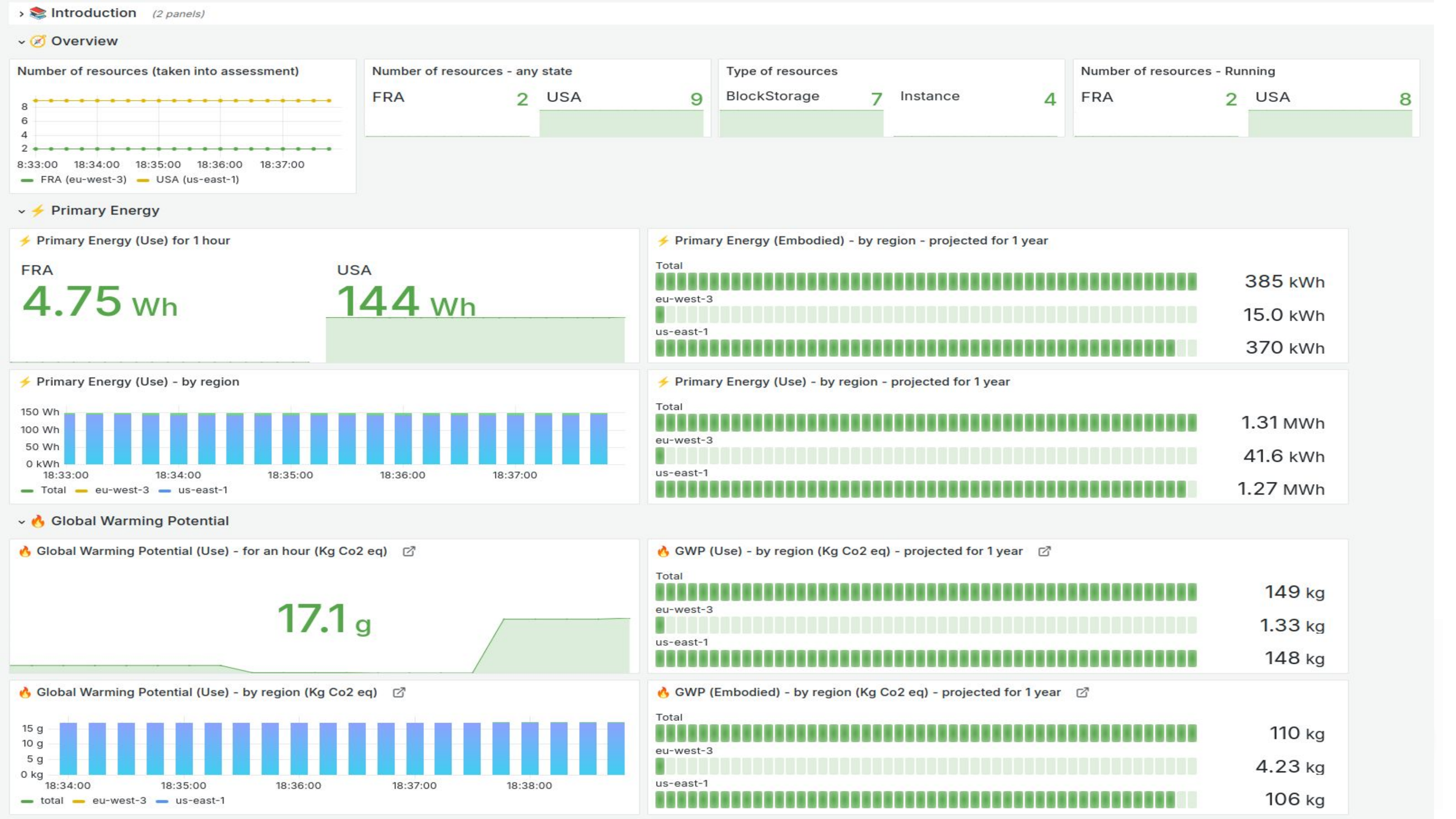
- Real time impacts for AWS EC2 instances

- Multicriteria
  - Primary Energy consumption (PE)
  - Abiotic resource depletion potential (ADP)
  - and Global Warming Potential (GWP)

- Multistage
  - Usage + embodied

- Gets data from BoaviztAPI

- Can filter by user tags



Introduction (2 panels)
Overview
Number of resources (taken into assessment)
8
6
4
2
8:33:00 18:34:00 18:35:00 18:36:00 18:37:00
FRA (eu-west-3) USA (us-east-1)
Number of resources - any state
FRA 2
USA 9
Type of resources
BlockStorage 7
Instance 4
Number of resources - Running
FRA 2
USA 8
Primary Energy
Primary Energy (Use) for 1 hour
FRA
4.75 Wh
USA
144 Wh
Primary Energy (Embodied) - by region - projected for 1 year
Total 385 kWh
eu-west-3 15.0 kWh
us-east-1 370 kWh
Primary Energy (Use) - by region
150 Wh
100 Wh
50 Wh
0 kWh
18:33:00 18:34:00 18:35:00 18:36:00 18:37:00
Total eu-west-3 us-east-1
Primary Energy (Use) - by region - projected for 1 year
Total 1.31 MWh
eu-west-3 41.6 kWh
us-east-1 1.27 MWh
Global Warming Potential
Global Warming Potential (Use) - for an hour (Kg Co2 eq)
17.1 g
GWP (Use) - by region (Kg Co2 eq) - projected for 1 year
Total 149 kg
eu-west-3 1.33 kg
us-east-1 148 kg
Global Warming Potential (Use) - by region (Kg Co2 eq)
15 g
10 g
5 g
0 kg
18:34:00 18:35:00 18:36:00 18:37:00 18:38:00
total eu-west-3 us-east-1
GWP (Embodied) - by region (Kg Co2 eq) - projected for 1 year
Total 110 kg
eu-west-3 4.23 kg
us-east-1 106 kg

Cloud Scanner

- Active development
- Easy to set up

- Only EC2 / AWS
- Decoupled from Finops
- More monitoring than reporting

Spruce

- Open Source (Apache v2)
- https://github.com/DigitalPebble/spruce
- Enrichment pipeline for usage reports
  - AWS CURs initially
- Uses Apache Spark
- Combines third party data and libraries
  - BoaviztAPI
  - CCF
  - ElectricityMaps
  - GSF RealTime Cloud
- Same data as FinOps
  - + additional columns

Spruce

- Open methodology
- Modular
  - include commercial APIs?
- Estimates for
  - Energy used per activity
  - Carbon intensity per region
  - Emissions from usage
  - Embodied emissions
  - …
- Same data as FinOps
  - added some columns
- Easy to integrate / build dashboards etc…

Query with Athena / DuckDB

```sql
select line_item_product_code, product_servicecode,
       round(sum(operational_emissions_co2eq_g),2) as co2_usage_g,
       round(sum(energy_usage_kwh),2) as energy_usage_kwh
       from enriched_curs where operational_emissions_co2eq_g > 0.01
       group by line_item_product_code, product_servicecode order by co2_usage_g desc;
```

line_item_product_code	product_servicecode	co2_usage_kg	energy_usage_kwh
AmazonEC2	AmazonEC2	5411.49	17501.57
AWSELB	AWSDataTransfer	1.82	5.67
AmazonS3	AWSDataTransfer	1.42	4.6
AmazonEC2	AWSDataTransfer	0.7	2.36
AmazonECR	AWSDataTransfer	0.07	0.28

Spruce

- Active development
- Easy to set up

- Only AWS for now
- No dashboard (yet)
- AWS services coverage to be improved

Commercial solutions

Commercial solutions

Tailpipe

sopht

greenpixie

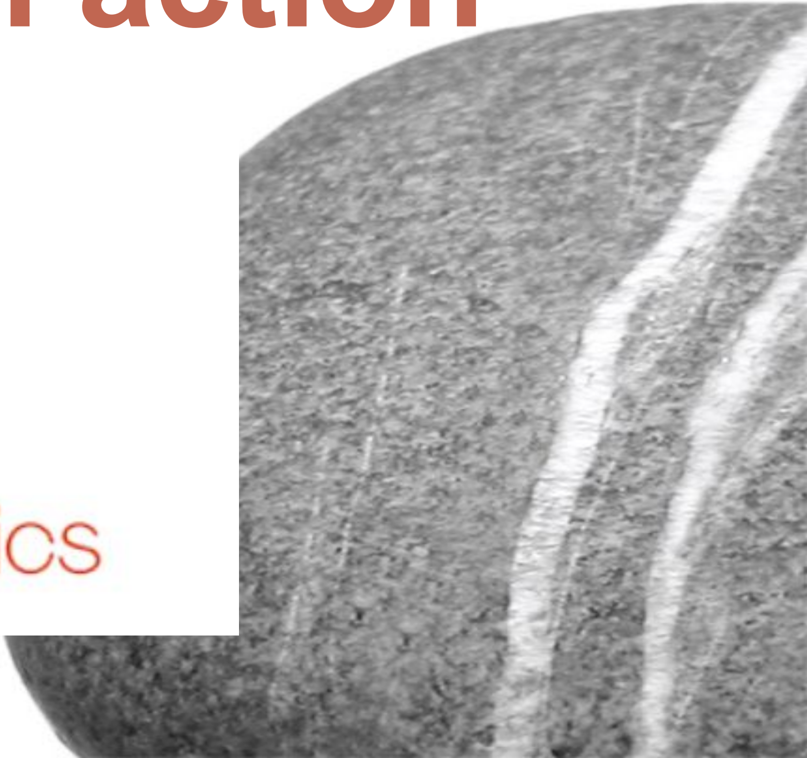
OxygenIT

Navigating the differences

- Enrichment of usage reports and/or APIs
- Cloud only vs 360° (SaaS, Devices, …)
- Recommendations ?
- Integration with FinOps tools
- Varying degrees of service coverage
- Differences in underlying methodologies
- Pricing structure
  - % cloud bill / size CUR reports / per cloud account / per API call

GreenOps in action

CameraForensics



Processing pipeline

aws

Tailpipe

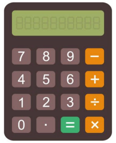
CUR reports → Enriched CUR

- \+ Embodied emissions
- \+ Energy used
- \+ Emissions usage

digitalPebble

FinOps checks: savings plans coverage

Best practices: e.g. user tags, wasted resources



Breakdown of energy use and emissions per:

- Month
- AWS product and operation
- EC2 instance types

Average monthly emissions: 1.3t CO2eq

= 3,344 miles of driving a petrol car

Recommendation #1

Location shifting

375g CO2 eq / kWh

20g CO2 eq / kWh

Recommendation #2

Review and upgrade instance types

Latest Graviton-based instances use up to 60% less energy than comparable EC2 instances for the same performance

Sometimes cheaper than older versions

Recommendation #3

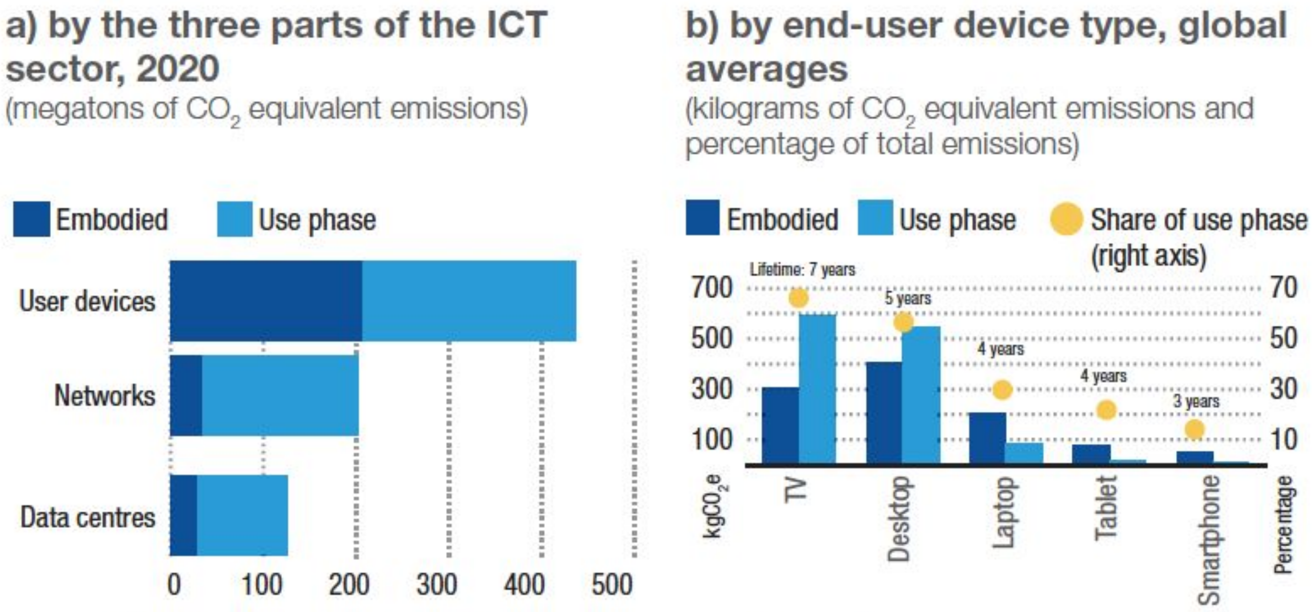
Put it in perspective

1.3 tonnes of CO_2 => 1.4 flights London - New York

Cut on the international travel first to have the greatest impact

#4 Keep your equipment for as long as possible!

Figure III.1
Greenhouse gas emissions



Source: Malmodin et al. (2024, left) and Malmodin and Lundén (2018, right).


To be continued...

Resources

Clouded II https://clouded.tv/

Digital Economy Report 2024
https://unctad.org/publication/digital-economy-report-2024

Green Software Practitioner Certification
https://learn.greensoftware.foundation/

Intro to FinOps
https://learn.finops.org/introduction-to-finops

Books
Building Green Software - O'Reilly (Currie, Hsu, Bergman)
Green Software Engineering - Packt Publishing

Wrap-up

- Want to make an environmental impact? Ride FinOps!
  - Apply operational framework to greenops

- Tools and data available
  - Open Source
  - Commercial

- Practical use case
  - You don’t have to be in a huge organisation to make a difference

Give it a try? We are here to help ;-)

Use Spruce? Contribute to it!

GreenIO London

https://greenio.tech/conference/15/london-2025-september

Thanks!

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