# Sustainability at the software layer

Optimising for cost and carbon with carbon-aware software design

Chris Adams, The Green Web Foundation

This talk is online - bit.ly/sust-soft-layer

# Hello!

I'm Chris. My background:

**Loco2 -** Low CO2 travel in Europe by train
**A.M.E.E (Avoid Mass Extinction Engine) -** CO2 calculation as an API
**Icebreaker One -** data infrastructure for a net zero future
**Spend Network -** public spending analysis for net zero
**Green Web Foundation -** make the web green
**ClimateAction.tech -** largest community online of technologists transition into climate

**Get in touch:**

chris@thegreenwebfoundation.org, @mrchrisadams everywhere else

# What we'll cover...

**Trends in the layers above, and below the datacentre** - trends in software design, and trends in energy markets

**Our two main levers -** efficiency and carbon intensity

**Green, Open, Lean, Decentralised (GOLD)** - a way to think about decarbonising digital

# We are in a climate crisis largely because we keep burning fossil fuels, instead of finding a path off them

# The internet is the biggest machine in the world and it mostly runs on fossil fuels.

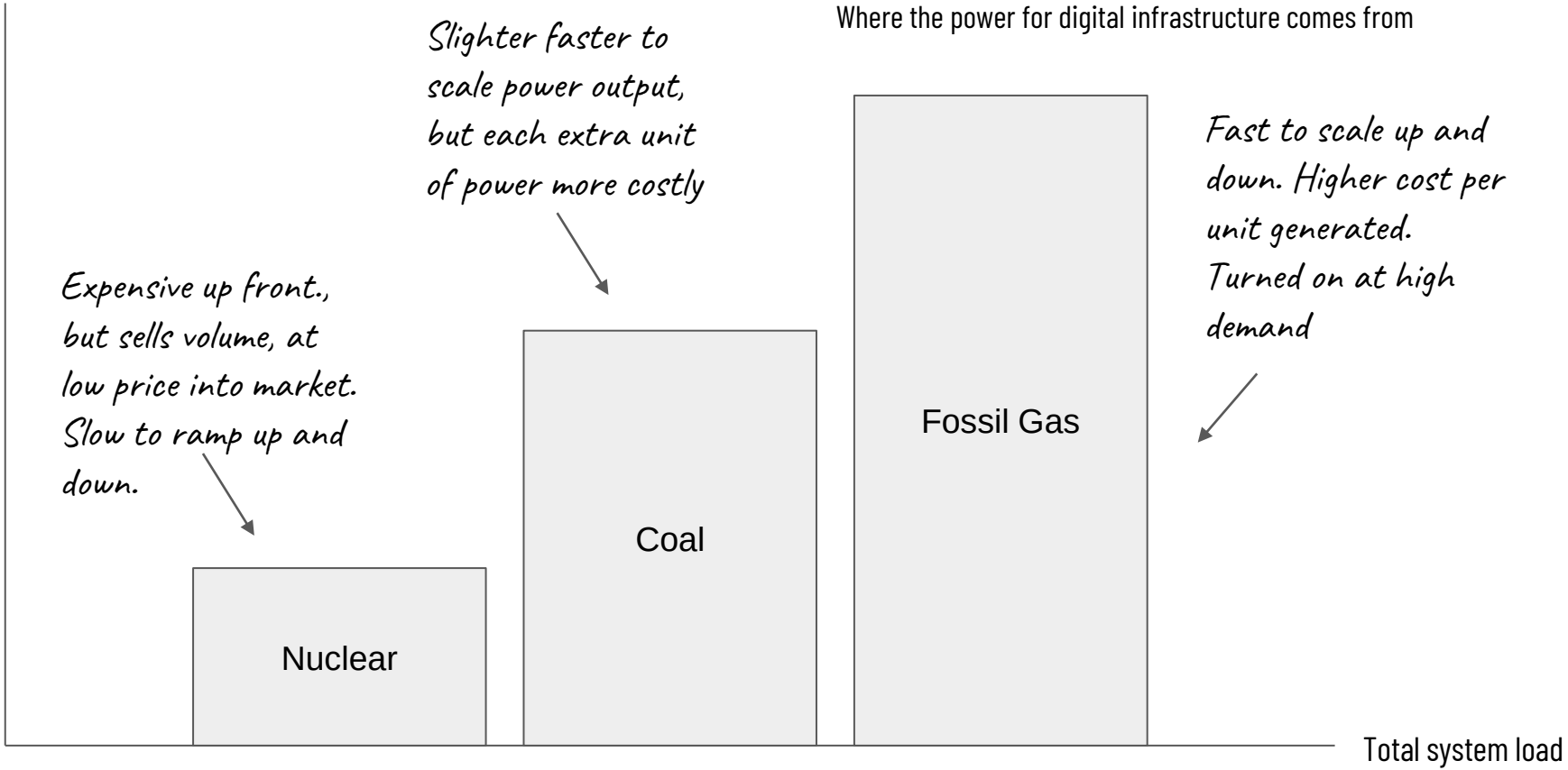
# Grokking the grid

Just enough on electricity market design to help you see cloud differently

Cost of per KwH of generation

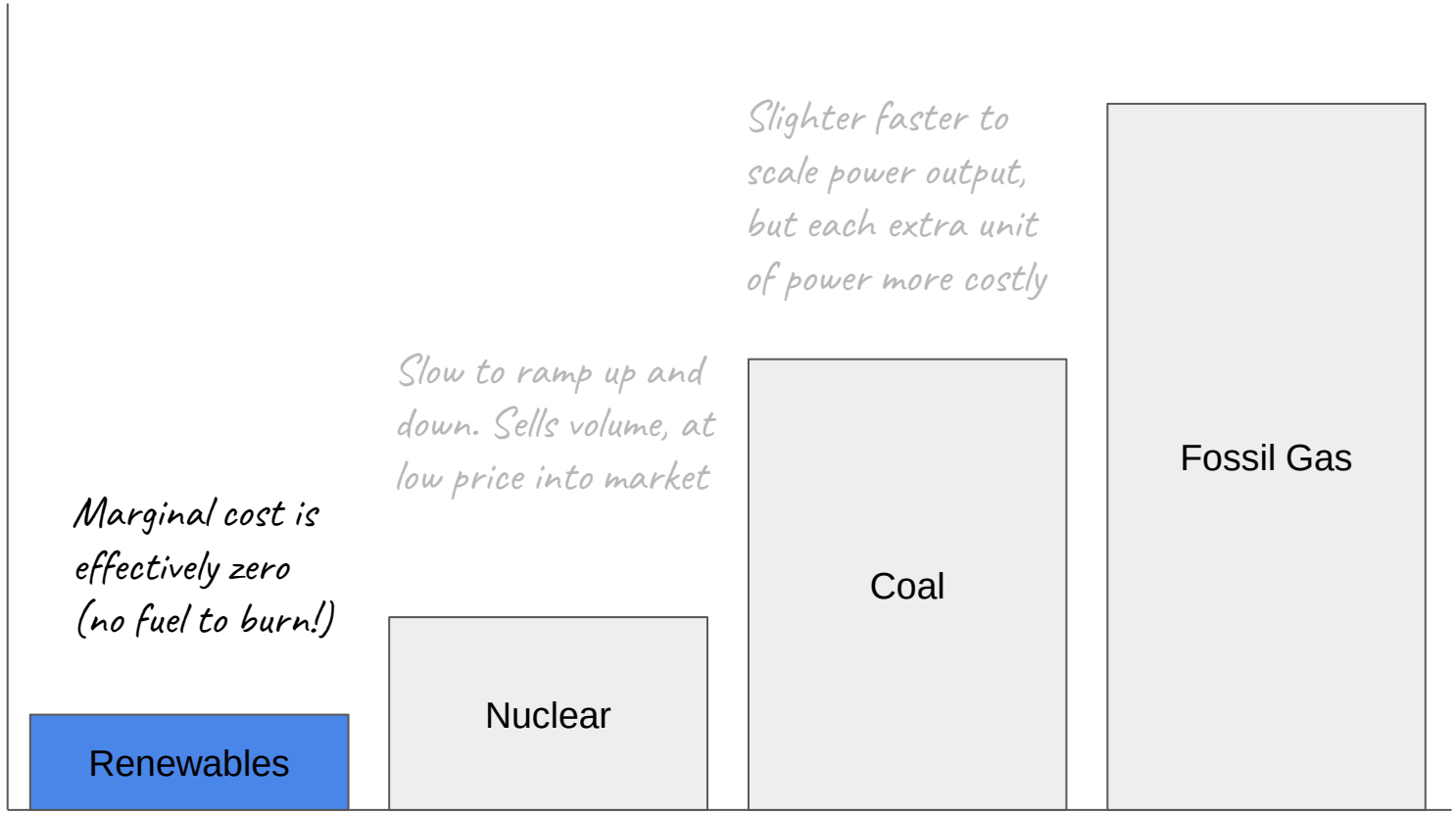
# Marginal cost of *energy*

Where the power for digital infrastructure comes from



Cost of per KwH of generation

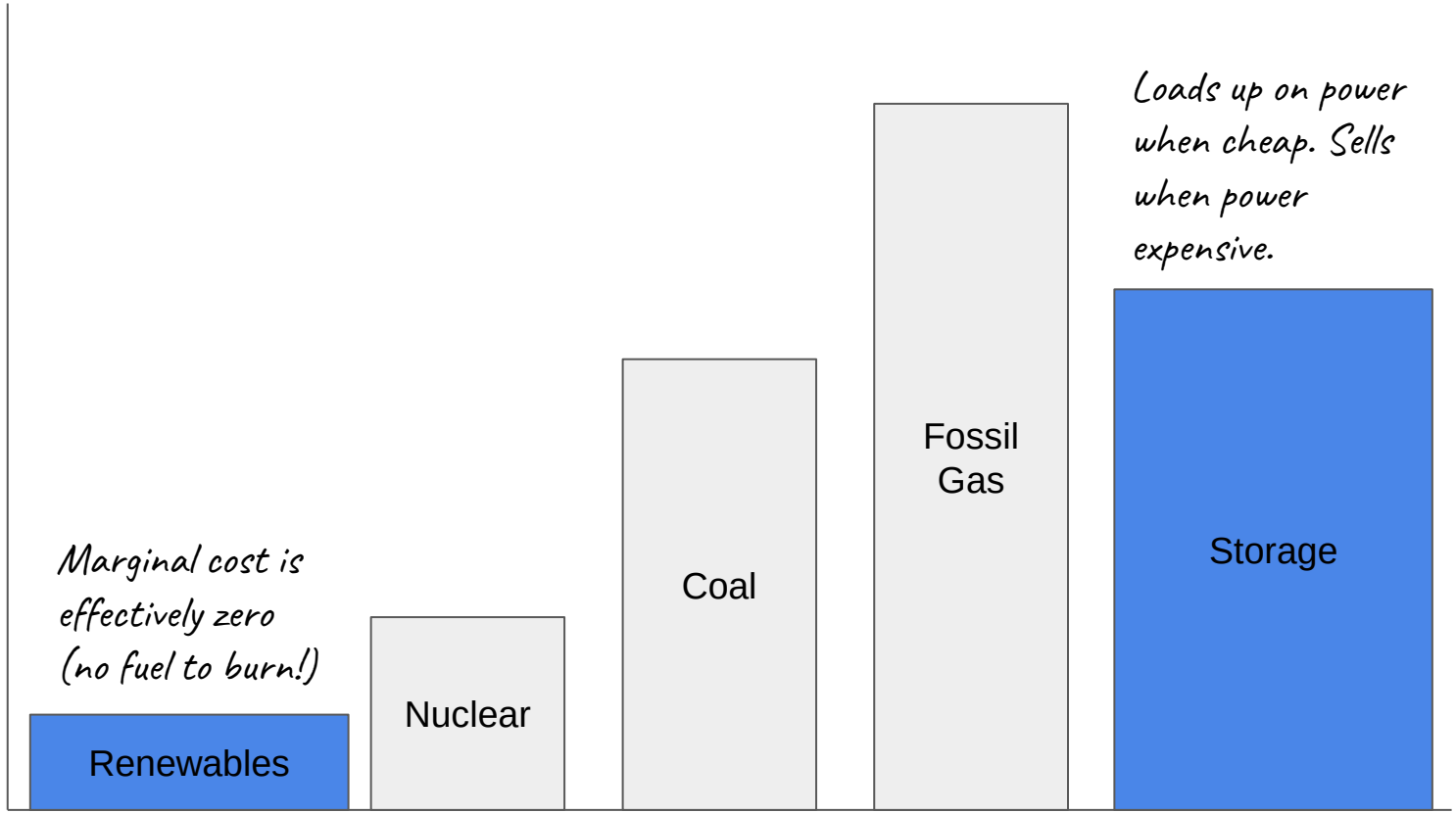
# Marginal cost of *energy*




Total system load

Cost of per KwH of generation

# Marginal cost of *energy*

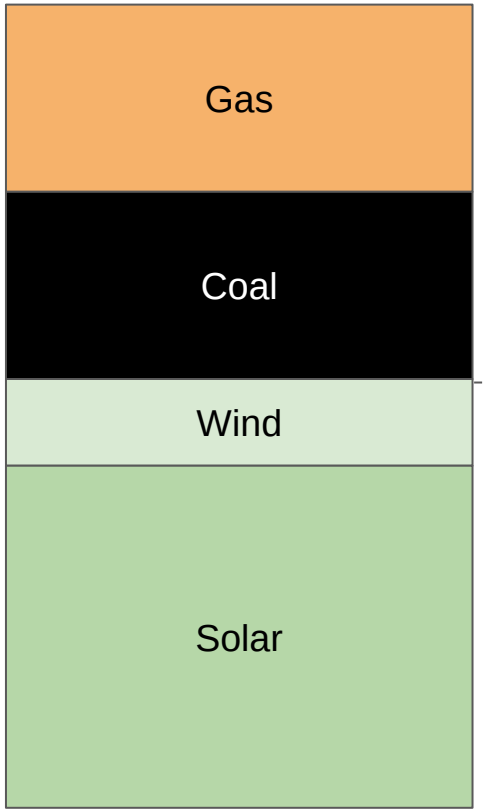



Total system load

*A recent survey of 1,200 companies across six countries showed that, of those sourcing renewables, 92% are doing so in order to reduce electricity costs*

Renewable Energy Buyer's Toolkit
http://resource-platform.eu/toolkit/

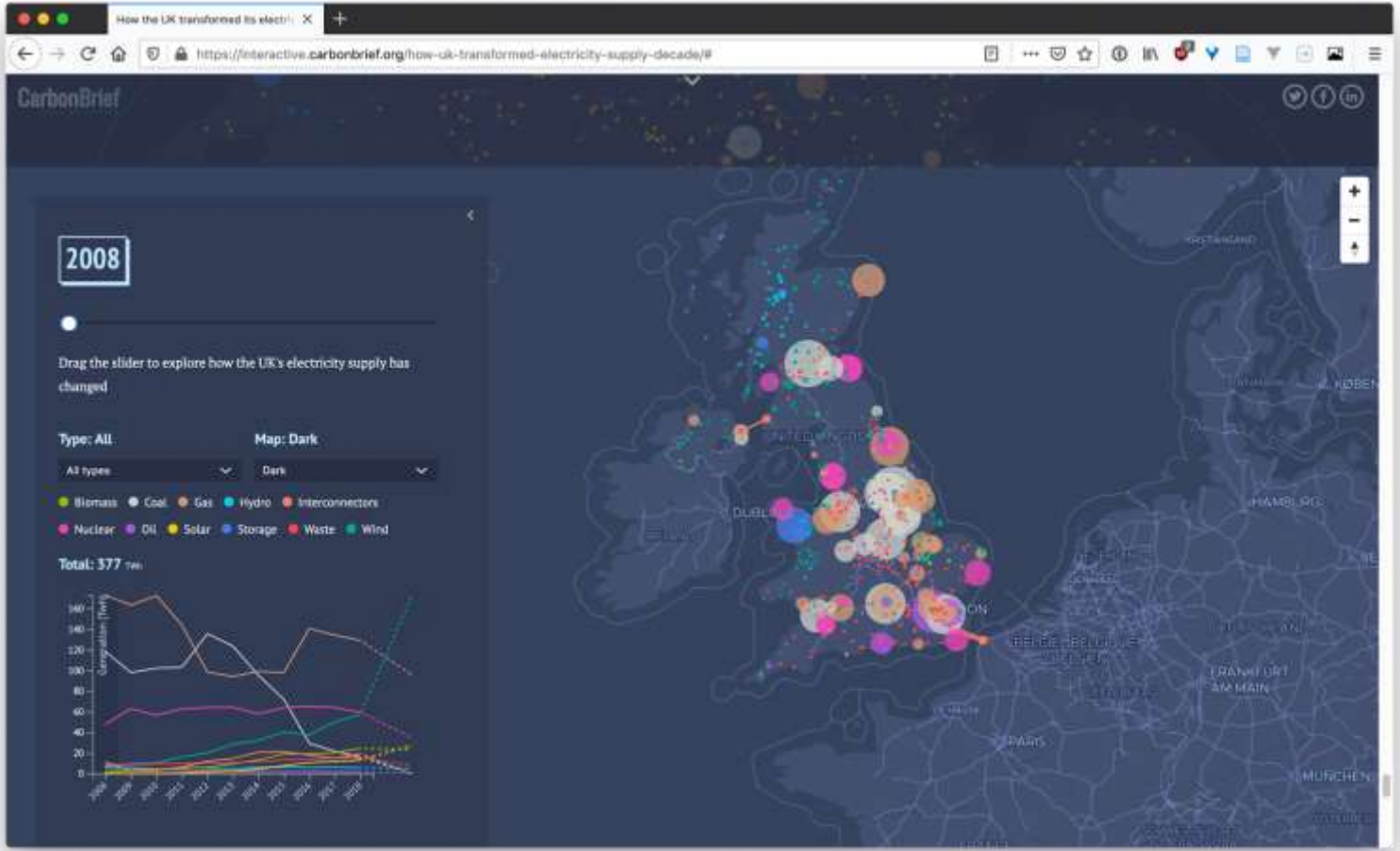
# Fossil energy versus green, non-fossil energy



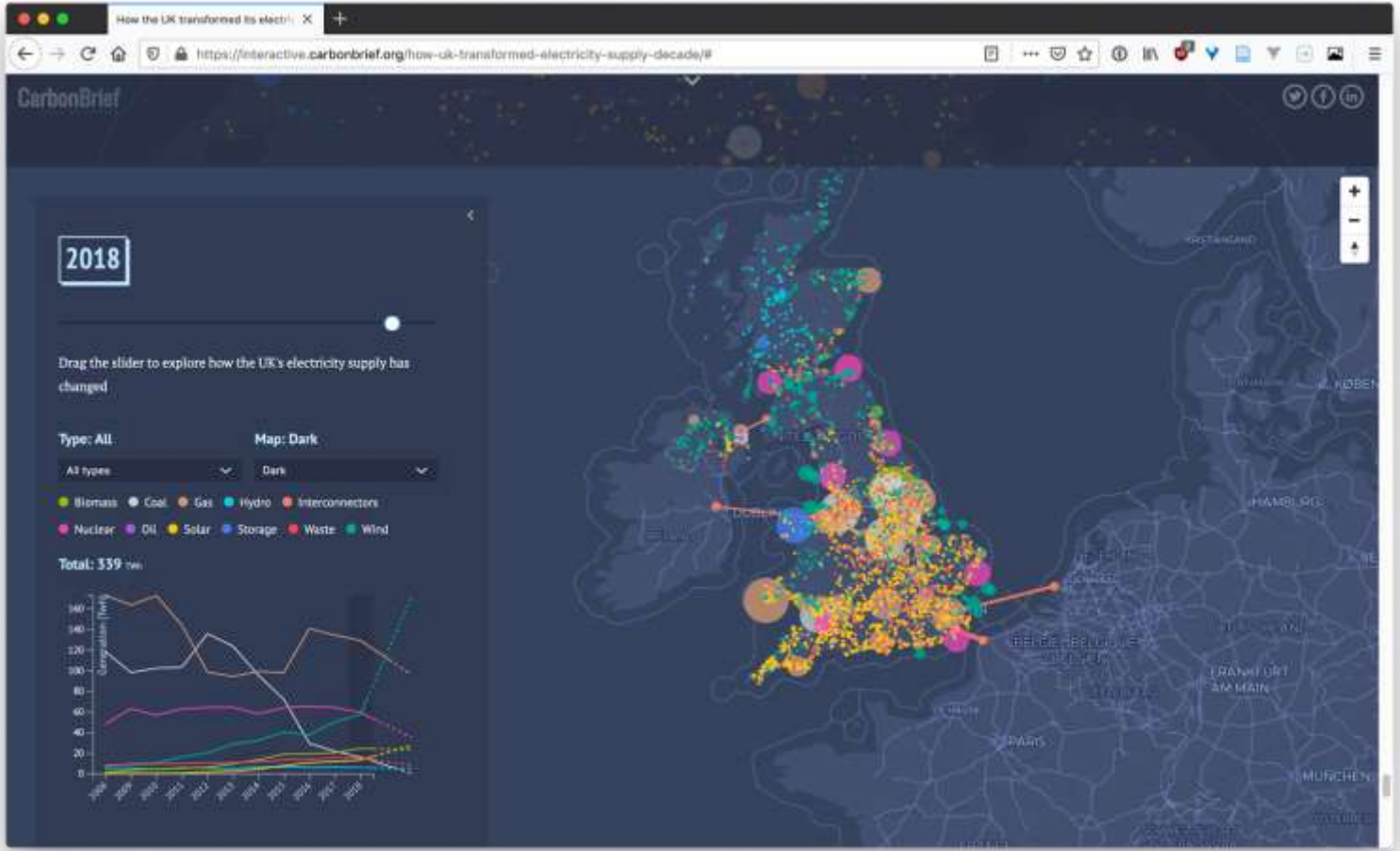

*You don't have direct control over what others feed into the grid.*

*If you know the mix going into the grid, you can at least account for it.*

*This energy comes from the wind and sun. No carbon more carbon emissions from burning fuel!*




How the UK transformed it's electricity supply in a decade (link)

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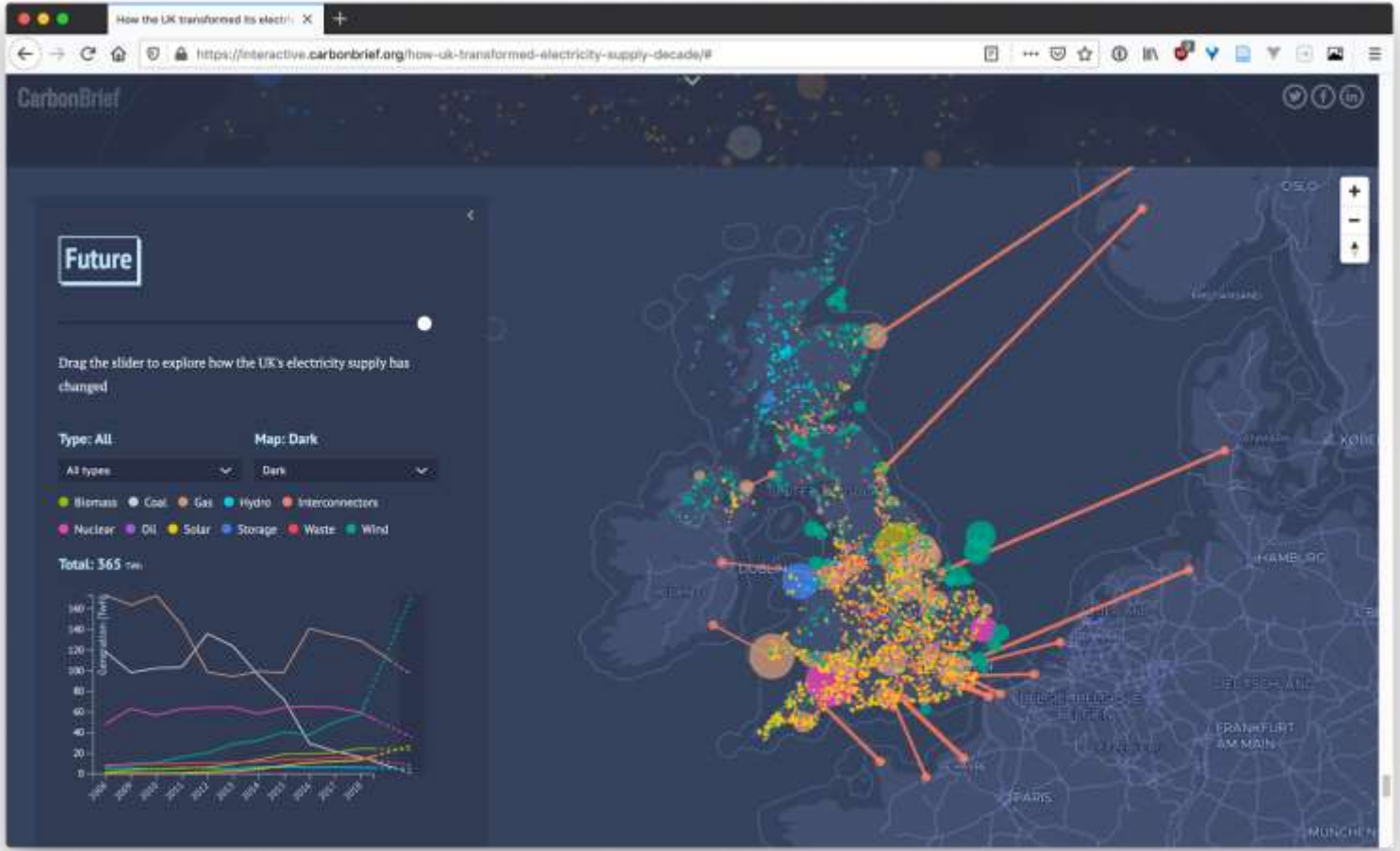


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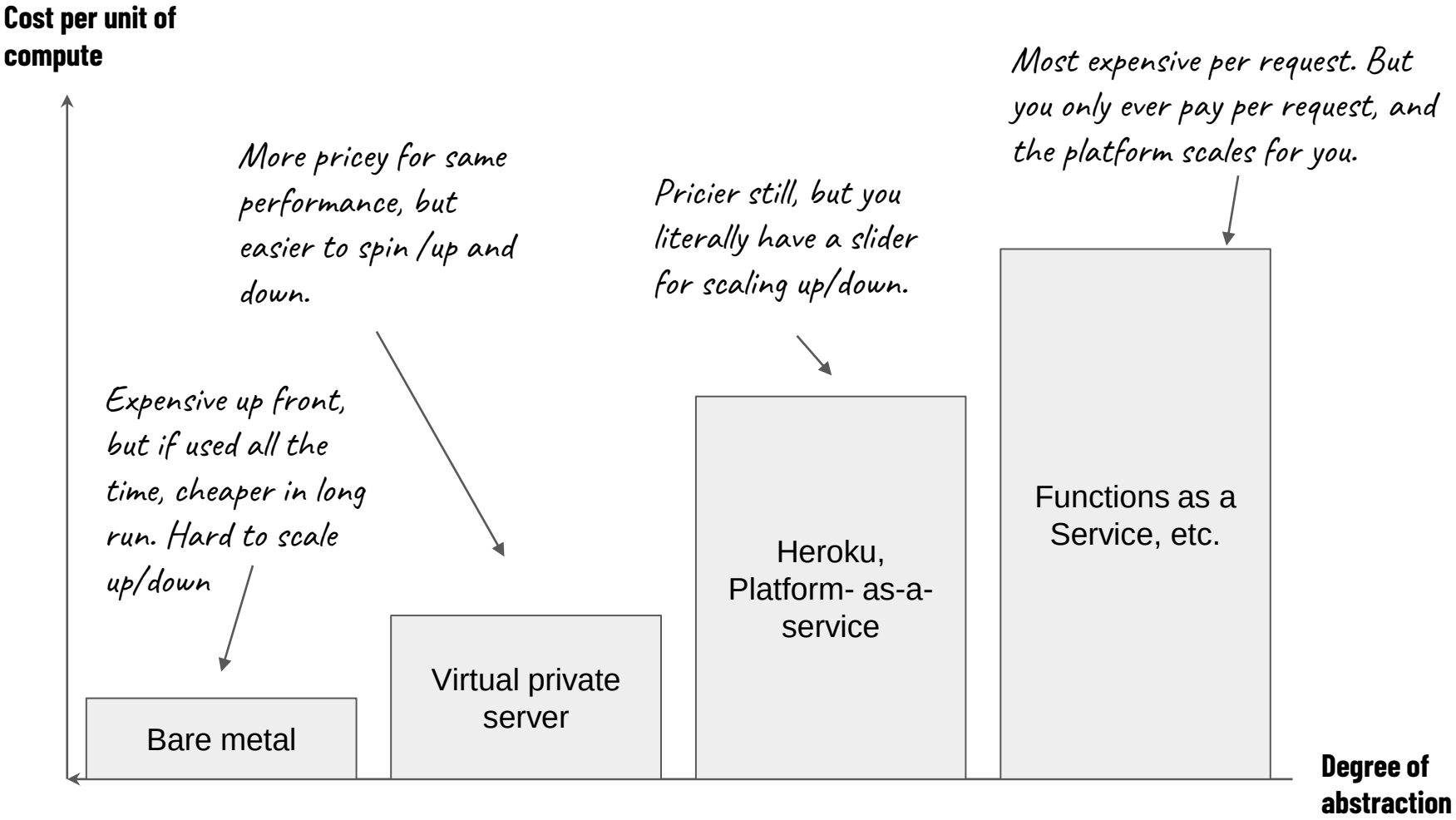

Cost per unit of compute
Most expensive per request. But you only ever pay per request, and the platform scales for you.
More pricey for same performance, but easier to spin /up and down.
Pricier still, but you literally have a slider for scaling up/down.
Expensive up front, but if used all the time, cheaper in long run. Hard to scale up/down
Functions as a Service, etc.
Heroku, Platform- as-a-service
Virtual private server
Bare metal
Degree of abstraction

*“many workloads are spiky or drop to zero for extended periods... applications used in the workplace may only be active for 40 of the 168 hours in a week.”*

Adrian Cockroft
@adrianco: AWS, ex Netflix

# Lessons from other fields

The power of POUR in the accessibility movement.

**P**erceivable

**O**perable

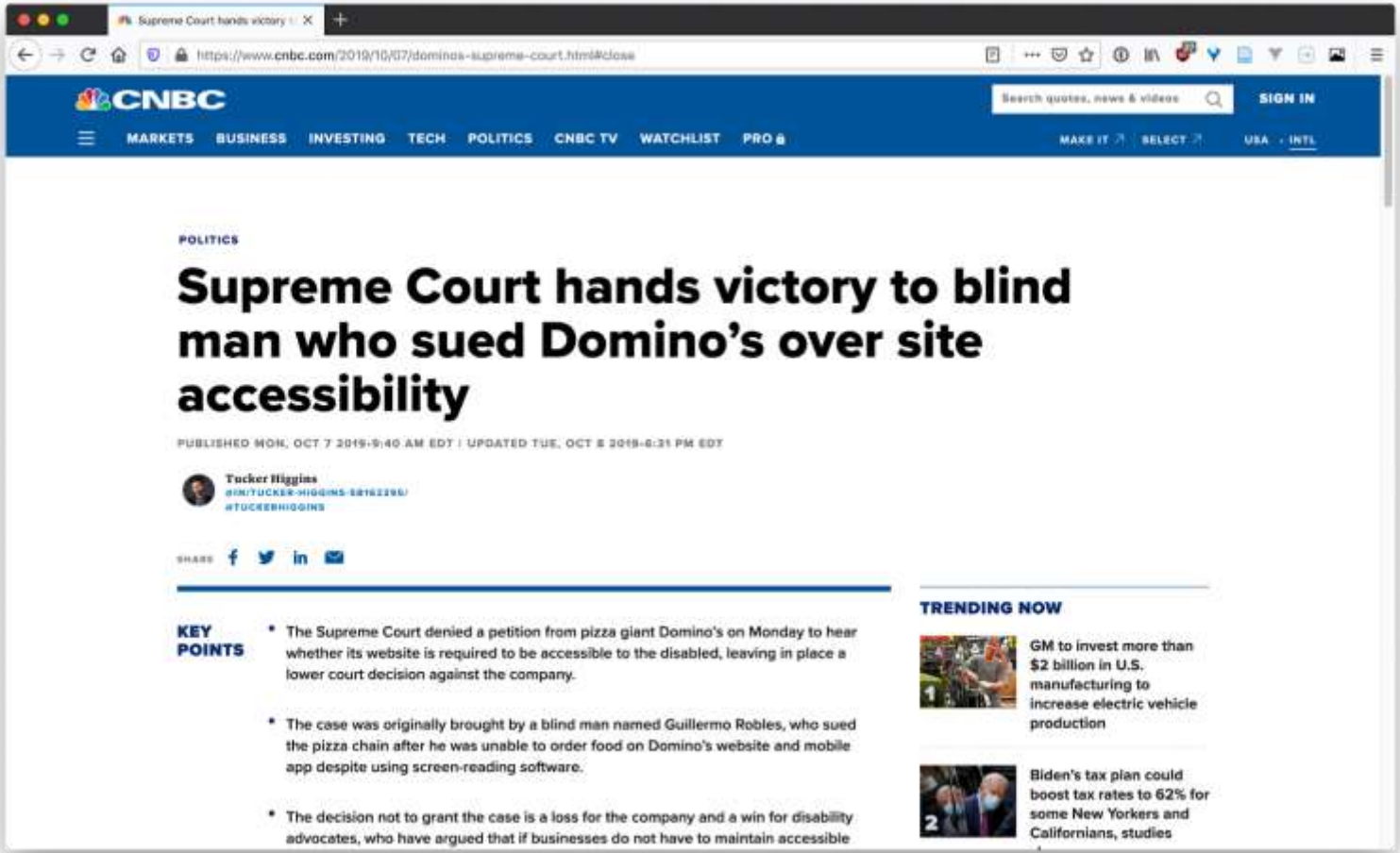
**U**sable

**R**obust

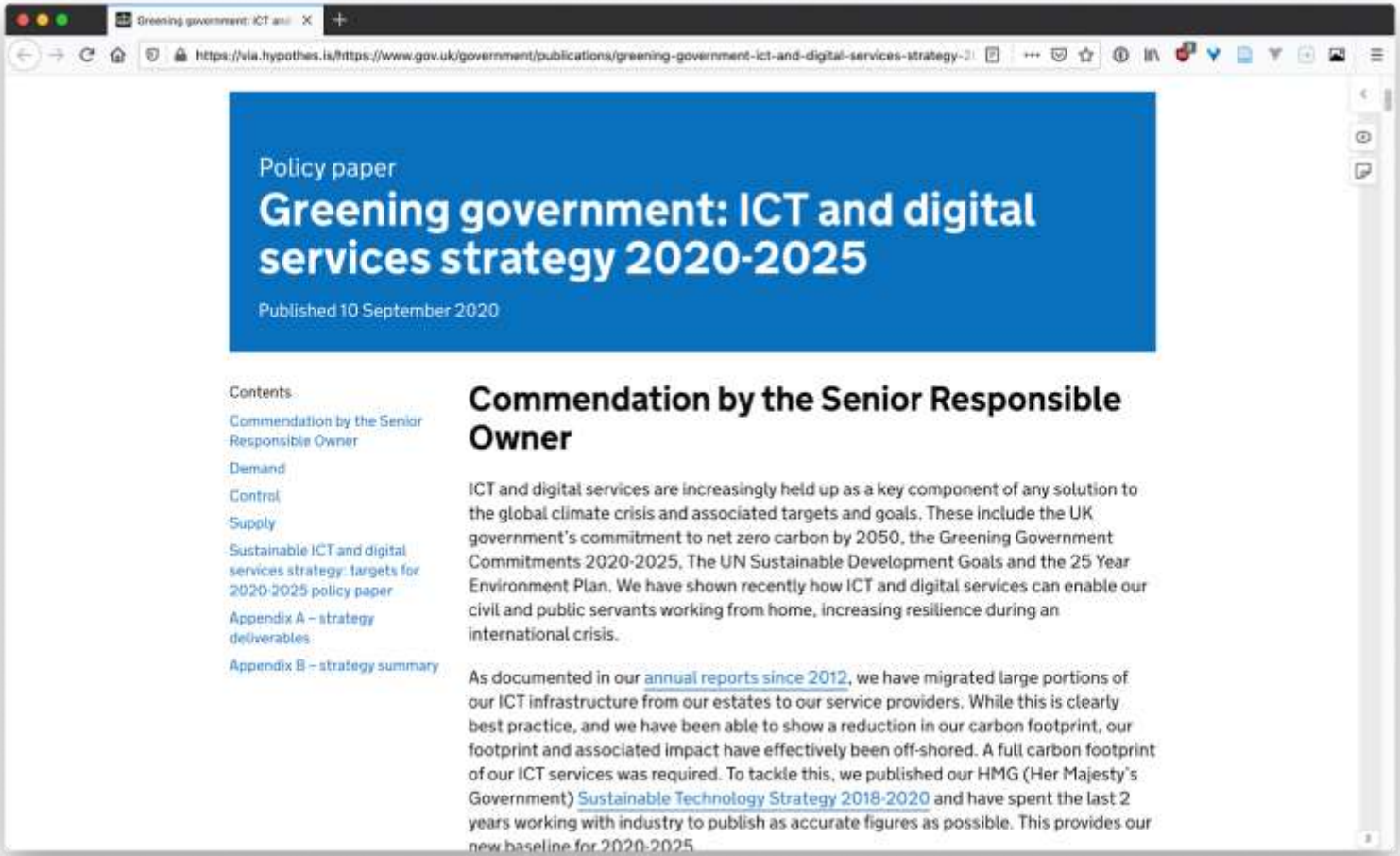
The 4 principles for accessibility WCAG (link)

> *The idea is to create a POUR web site, so to speak. The pun may be a bad one, but if it helps developers memorize the principles, then it has served its purpose.*

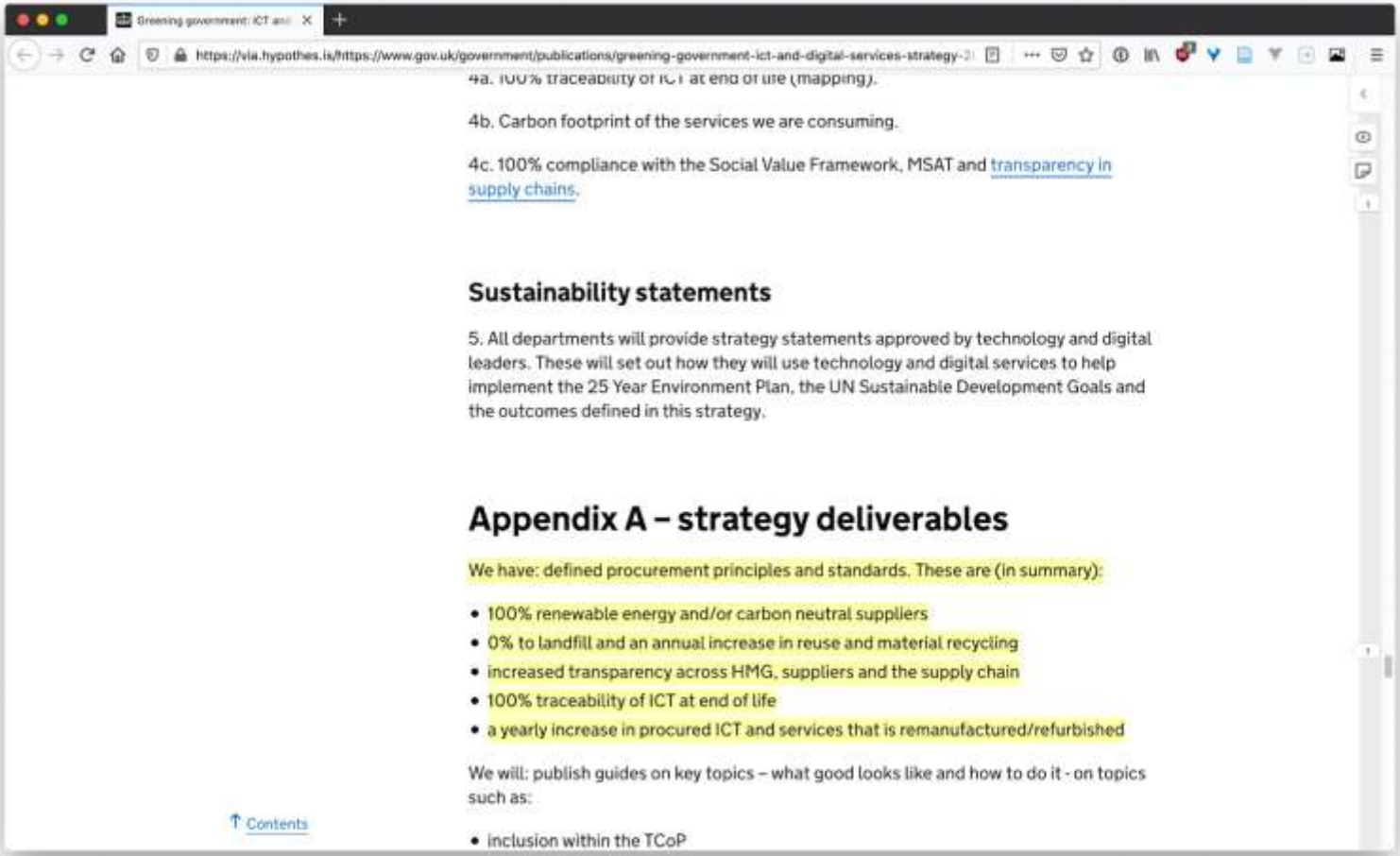
Constructing a POUR website (link)




Accessibility and inclusive design as a way to avoid risk (link)




Similar signals from public sector on sustainability as on accessibility (link)




Explicit commitments, and references to supply chain (link)

**G**reen

**O**pen

**L**ean

**D**istributed

A way to think about greening digital infrastructure. See also, principles.green (link)

# Green

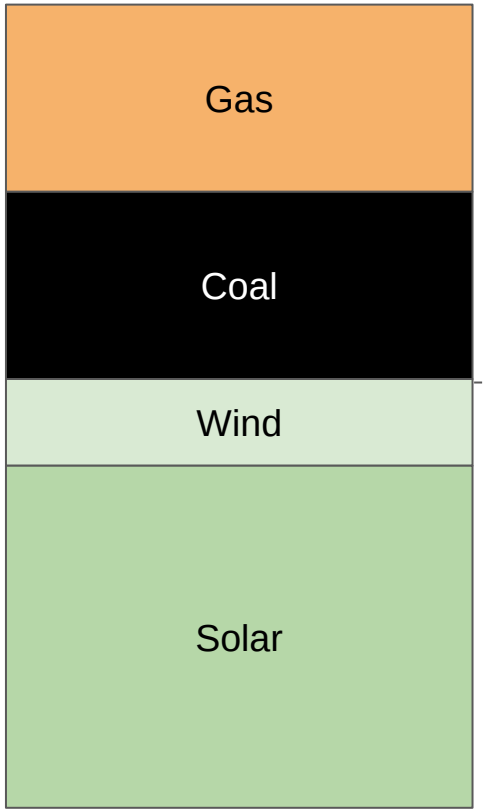
as in green energy, and low carbon power

Open

Lean

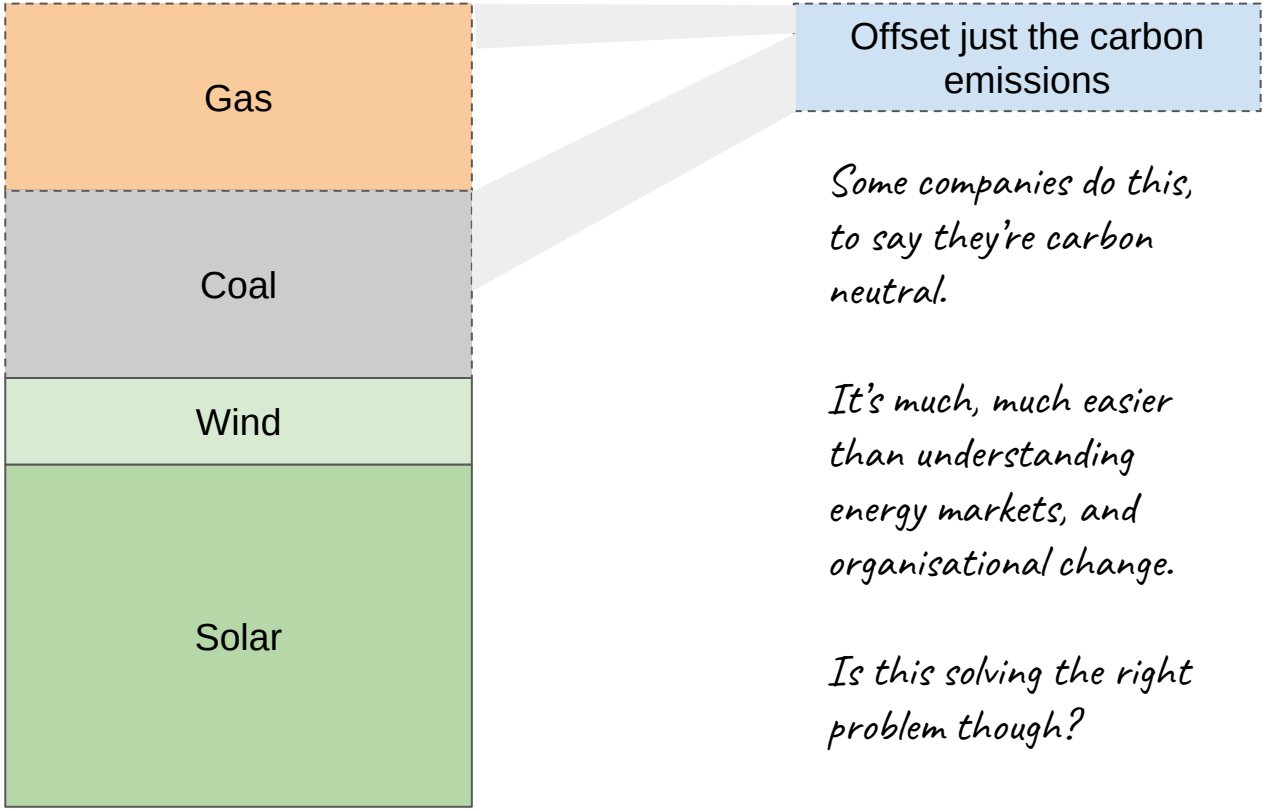
Distributed

# Running on green power when you use the grid




*What do we do about this?*

# Accounting for fossil fuel energy

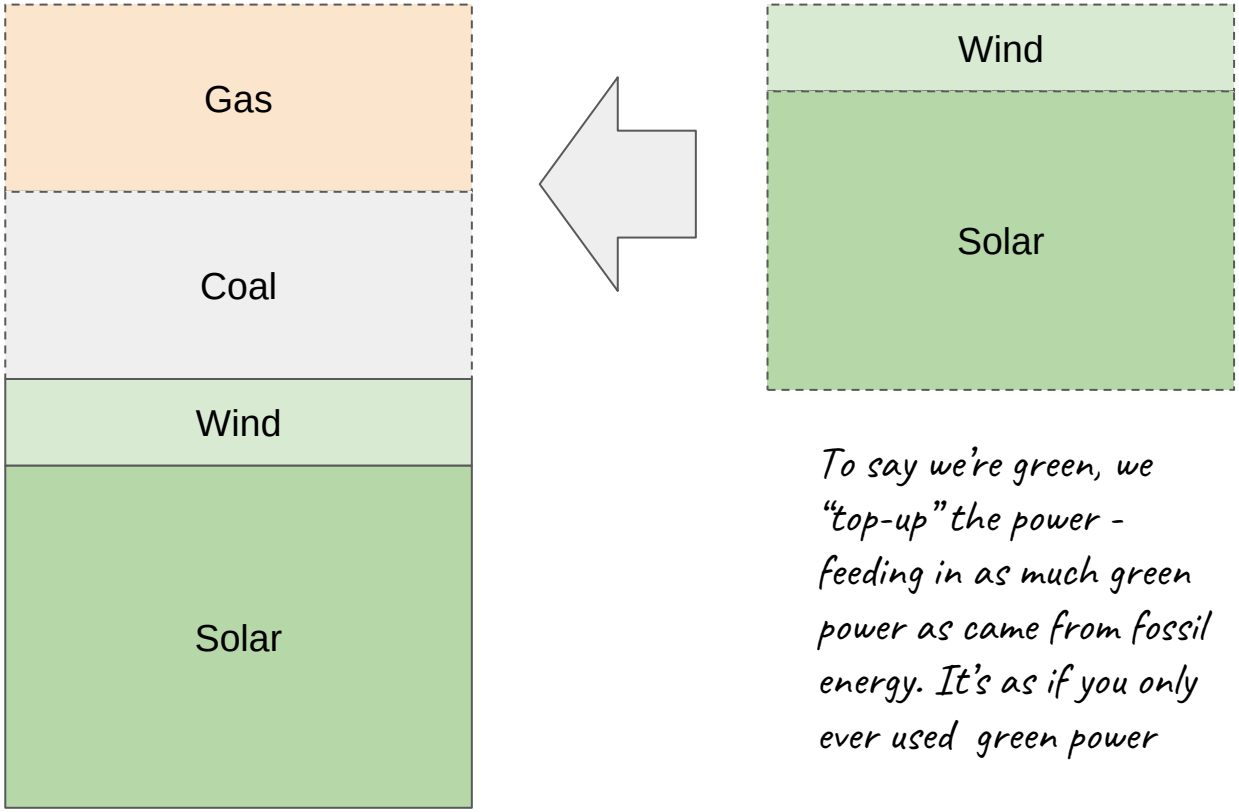



*Some companies do this, to say they're carbon neutral.*

*It's much, much easier than understanding energy markets, and organisational change.*

*Is this solving the right problem though?*

# Accounting for fossil fuel energy




To say we're green, we "top-up" the power - feeding in as much green power as came from fossil energy. It's as if you only ever used green power

Google and Microsoft do this right now, among others.

They do this on an annualised basis, so not every hour is balanced out to be 'fossil-free'.

# Accounting for fossil fuel energy, on an hour by hour basis

FIG. 2

**Hourly carbon-free energy performance at an example data center**

While Google buys large amounts of wind and solar power (symbolized by green spikes below), these resources are variable, meaning that our data centers still sometimes rely on carbon-based resources.


For now, if you're using the grid, there will still be times where you're running on fossil fuels.

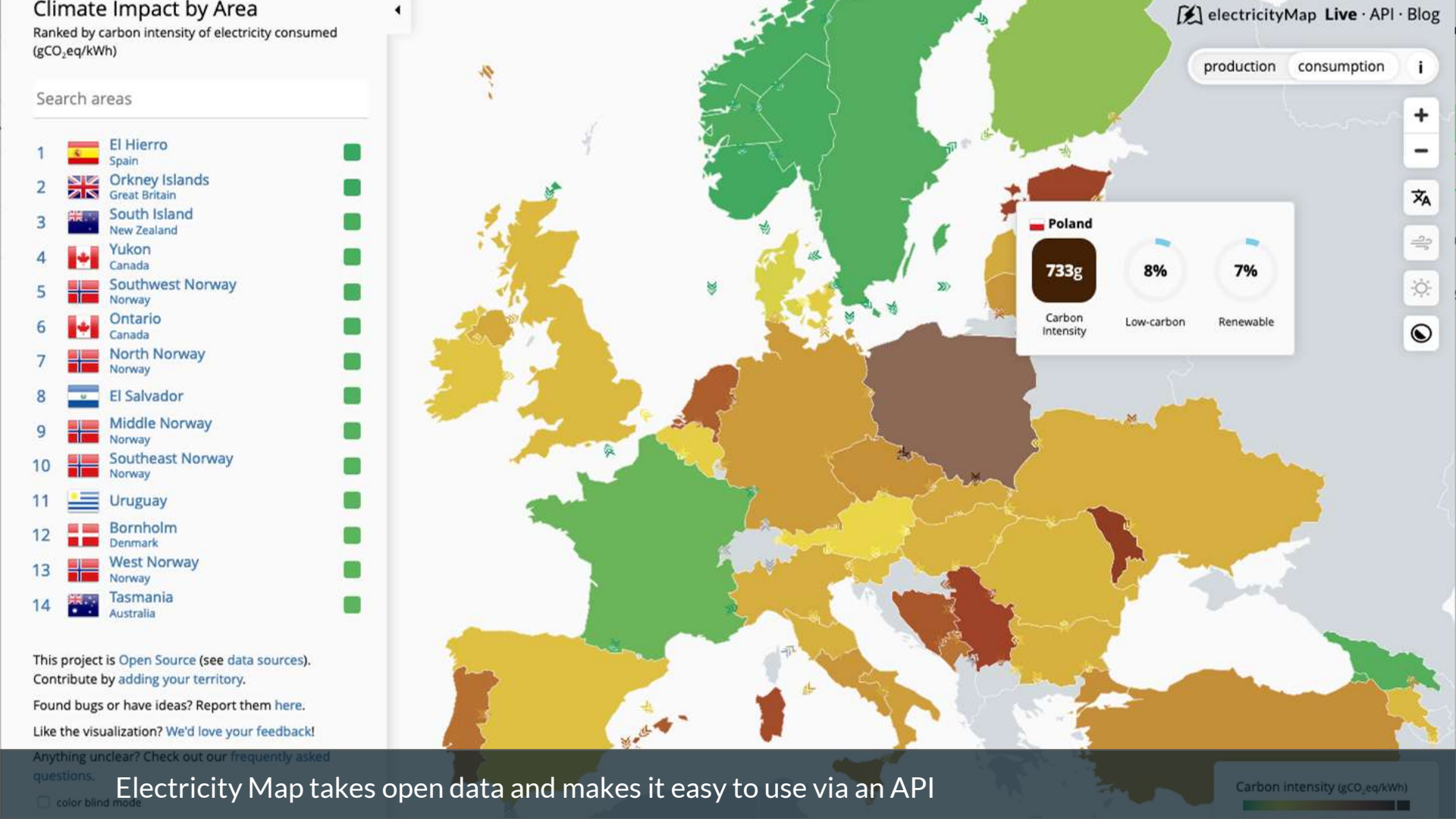
Green

**Open**

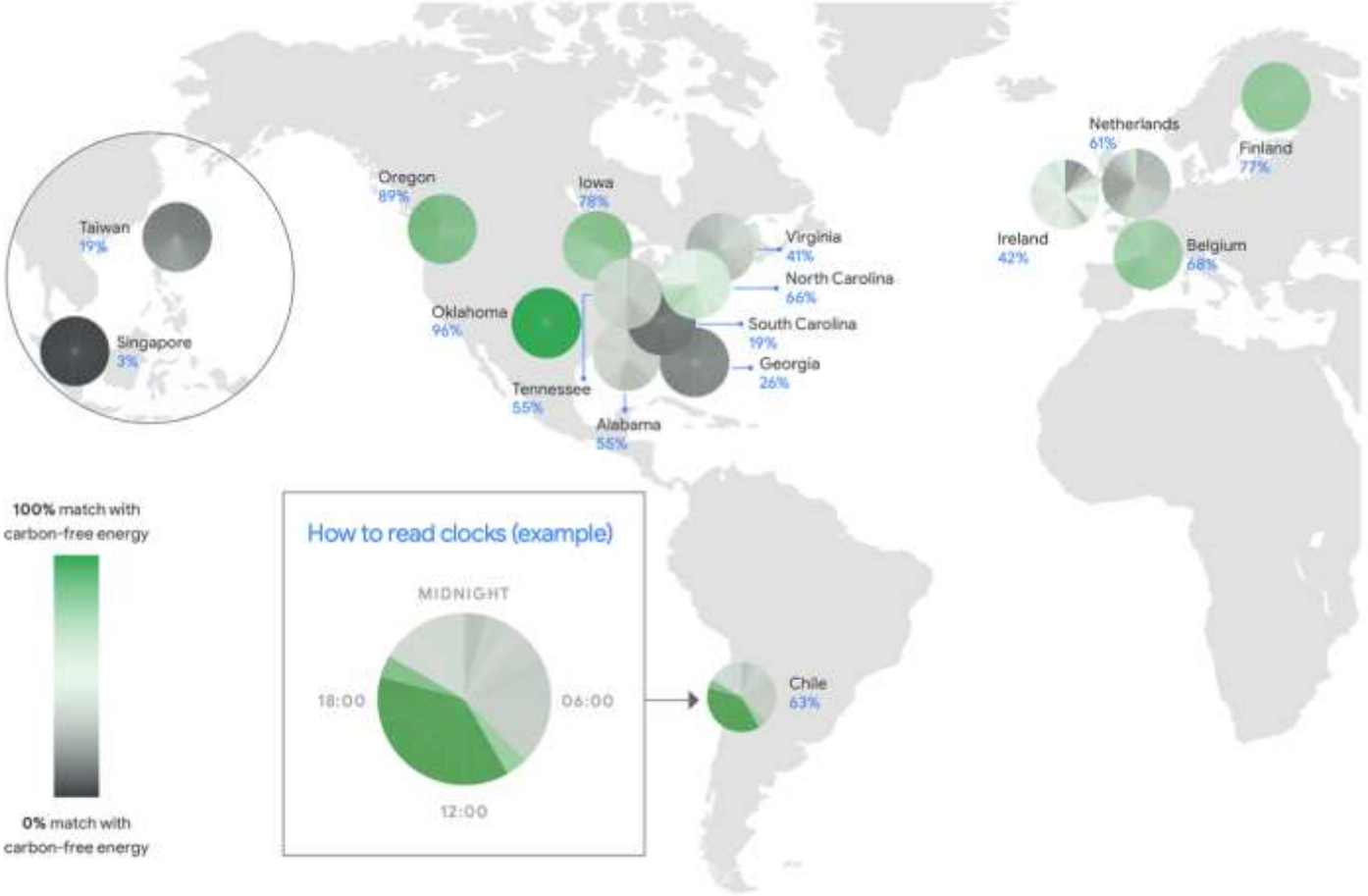
Lean

Distributed

**open data, open source & transparency**




Electricity Map takes open data and makes it easy to use via an API




Google’s Carbon clocks - transparency on datacentre carbon intensity

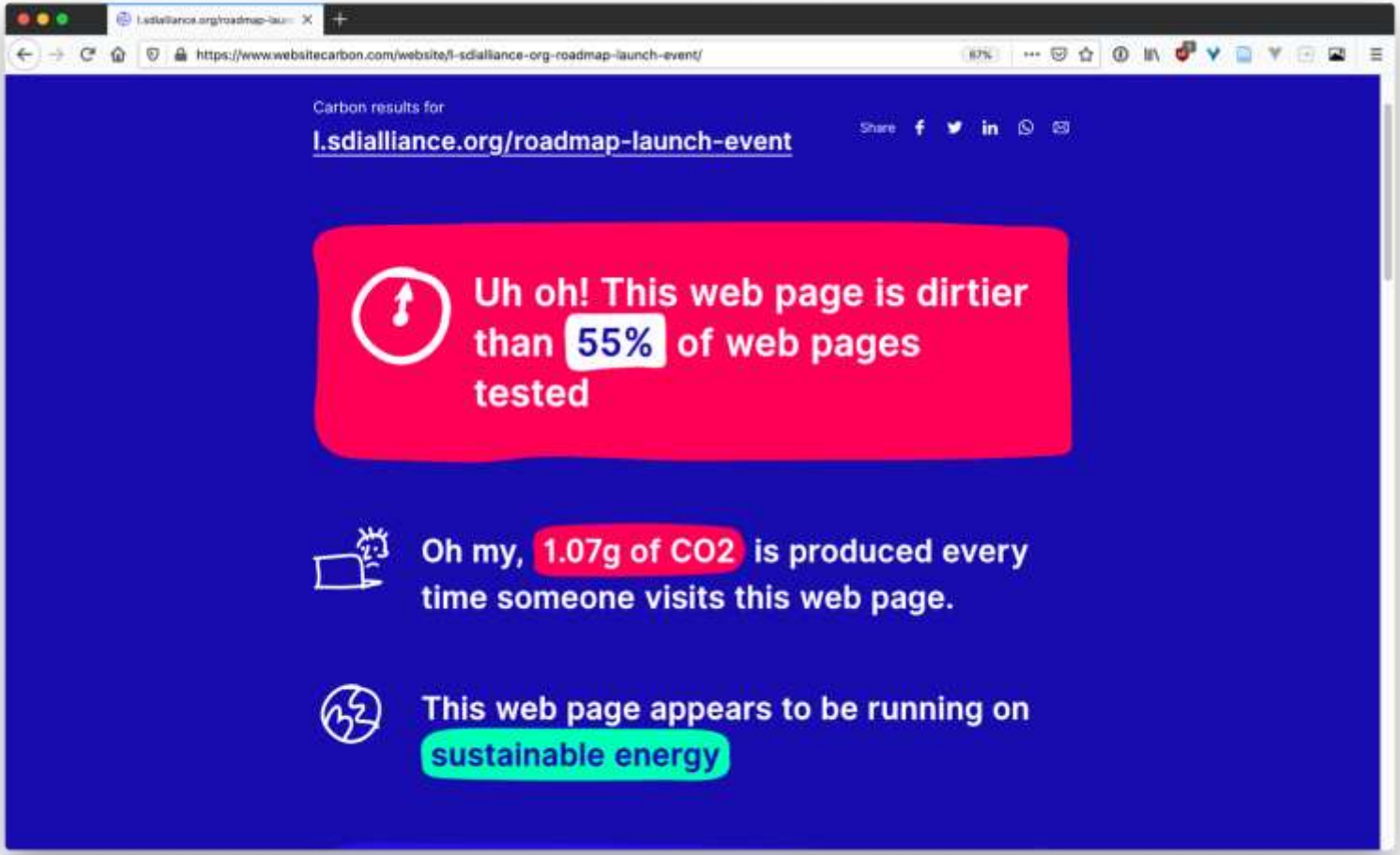
Green

Open

**Lean**

**make the carbon you emit count**

Distributed




Website carbon - quick figures for the carbon footprint of a website (link)

The coach helps you find performance problems on your web page using web performance best practice rules. And gives you advice on accessibility, privacy and best practices.


# Coach score

| | |
|---|---|
| Total score | 76 |
| Performance score | 71 |
| Privacy score | 80 |
| Accessibility score | 80 |
| Best practice score | 81 |

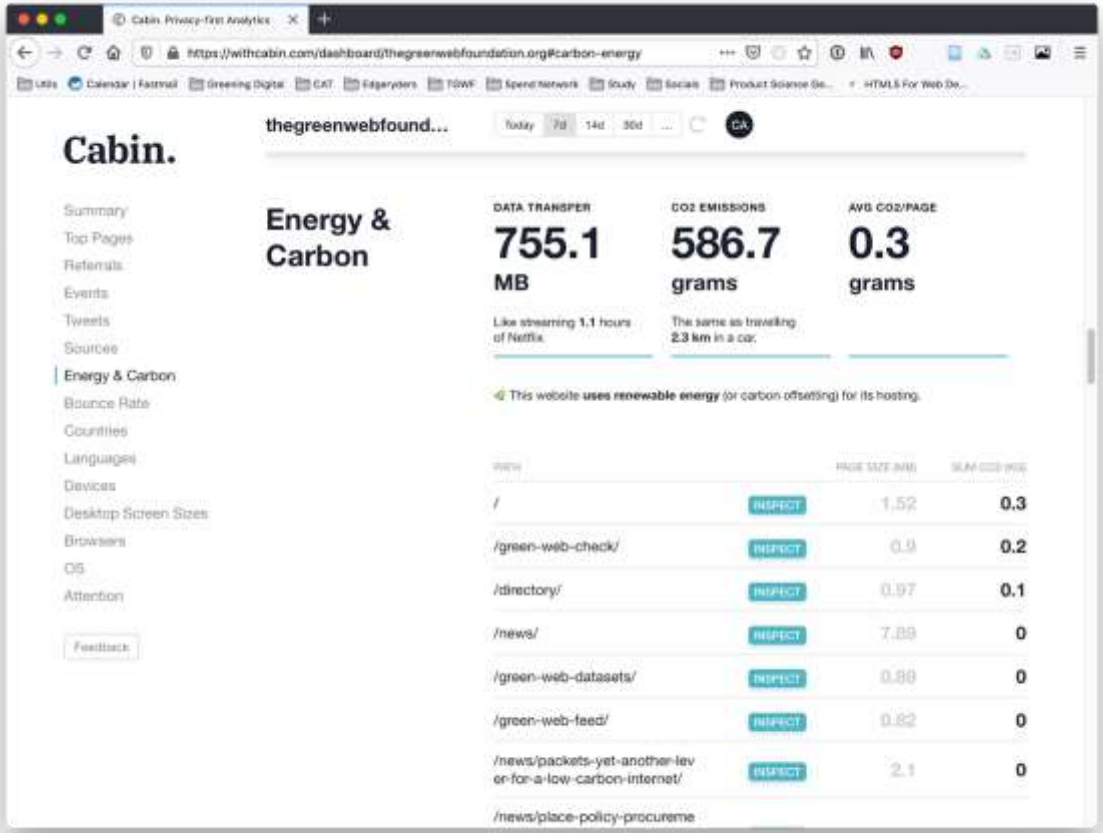
Coach - optimising the carbon footprint of websites (sitespeed.io)

# The sustainable web plugin #

We know using the internet means using electricity to power servers. And because most of that electricity comes from burning fossil fuels, it means every byte sent has a cost in carbon as well as power. The sustainable web plugin combines the latest in peer reviewed science and open data from the Green Web Foundation to help you build greener, more sustainable websites and applications!

We work out how much energy it takes to serve a site, then work out how much CO2 is emitted to generate the power needed that electricity, based on what information we have about where the power comes from.

Building a more sustainable web with sitespeed and the green web foundation (link)




Cabin - privacy protectin', carbon calculatin' web analytics (link)

# Matching supply of compute, to demand for compute

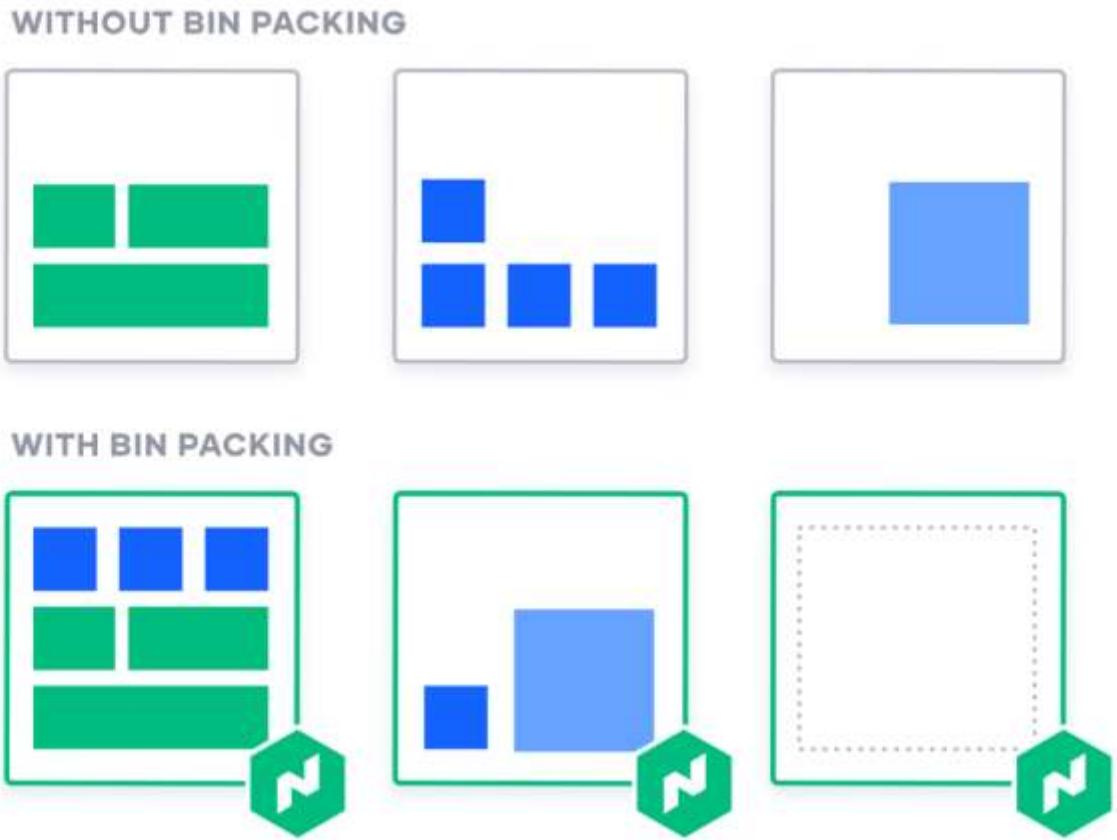
**Scale up** - get a bigger server

**Scale out -** add more servers

**Scale in** - add API compatible way to do the same work, faster or more efficiently

# Scale-out

add more servers




Smaller jobs, horizontally scaled - easier to increase utilisation. Not just for containers.

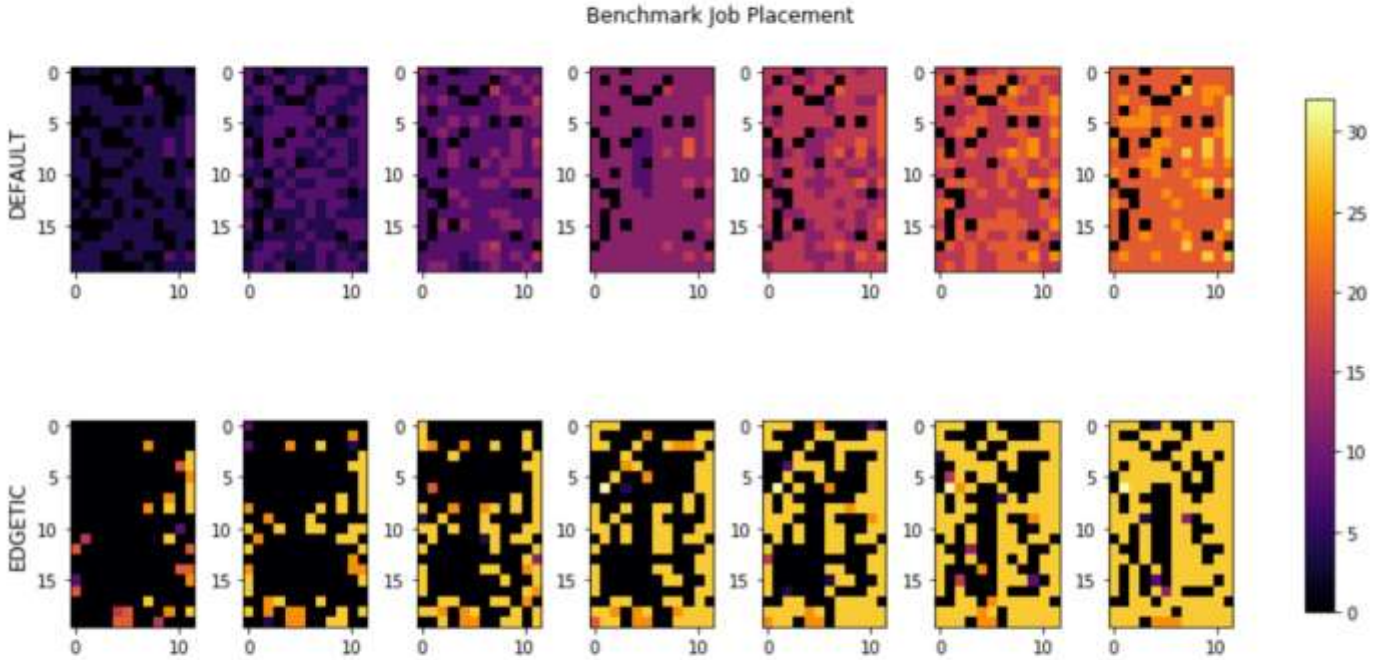



**Figure 10. Comparison of cluster server utilization per job batch, using the default Kubernetes scheduler and the Edgetic scheduler**

Even if you have the infrastructure - keeping more machines in a low power state helps.

# Scale-in

add API compatible way to do the same work, faster or more efficiently

Medium Zillow COMCAST SAMSUNG SDS

## The Scylla Advantage

We reimplemented Apache Cassandra from scratch using C++ instead of Java to increase raw performance, better utilize modern multi-core servers and minimize the overhead to DevOps. Then we added our Alternator API, enabling you to run Amazon DynamoDB workloads anywhere and at a much lower cost.

See what's new in Scylla Open Source 4.0


Scale in - at the software level with the likes of Syclla DB

swarm64

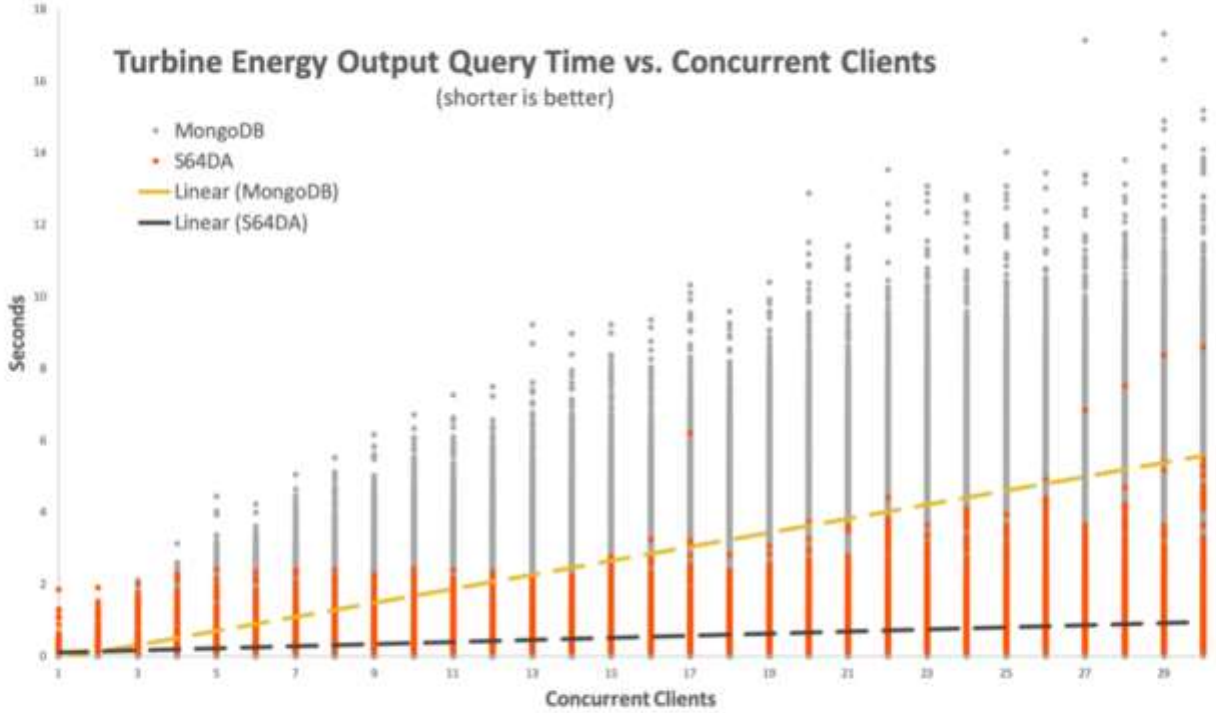
Products Resources Solutions Company Blog Free Trial

# Faster PostgreSQL performance

High-performance PostgreSQL extension for faster analytics and easier scaling.

Download the Swarm64 technical overview

Scale in - at the hardware level with Swarm64




Scale in - at the hardware level with Swarm64

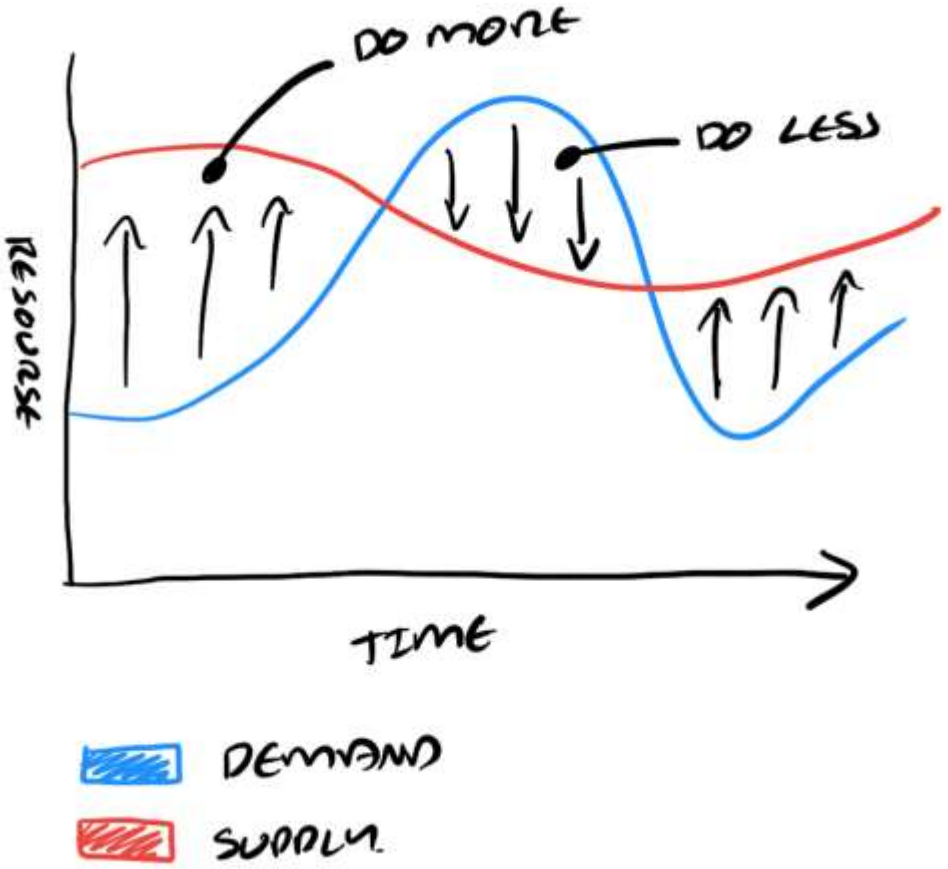
Green

Open

Lean

# Distributed

move work through time and space to avoid carbon emissions



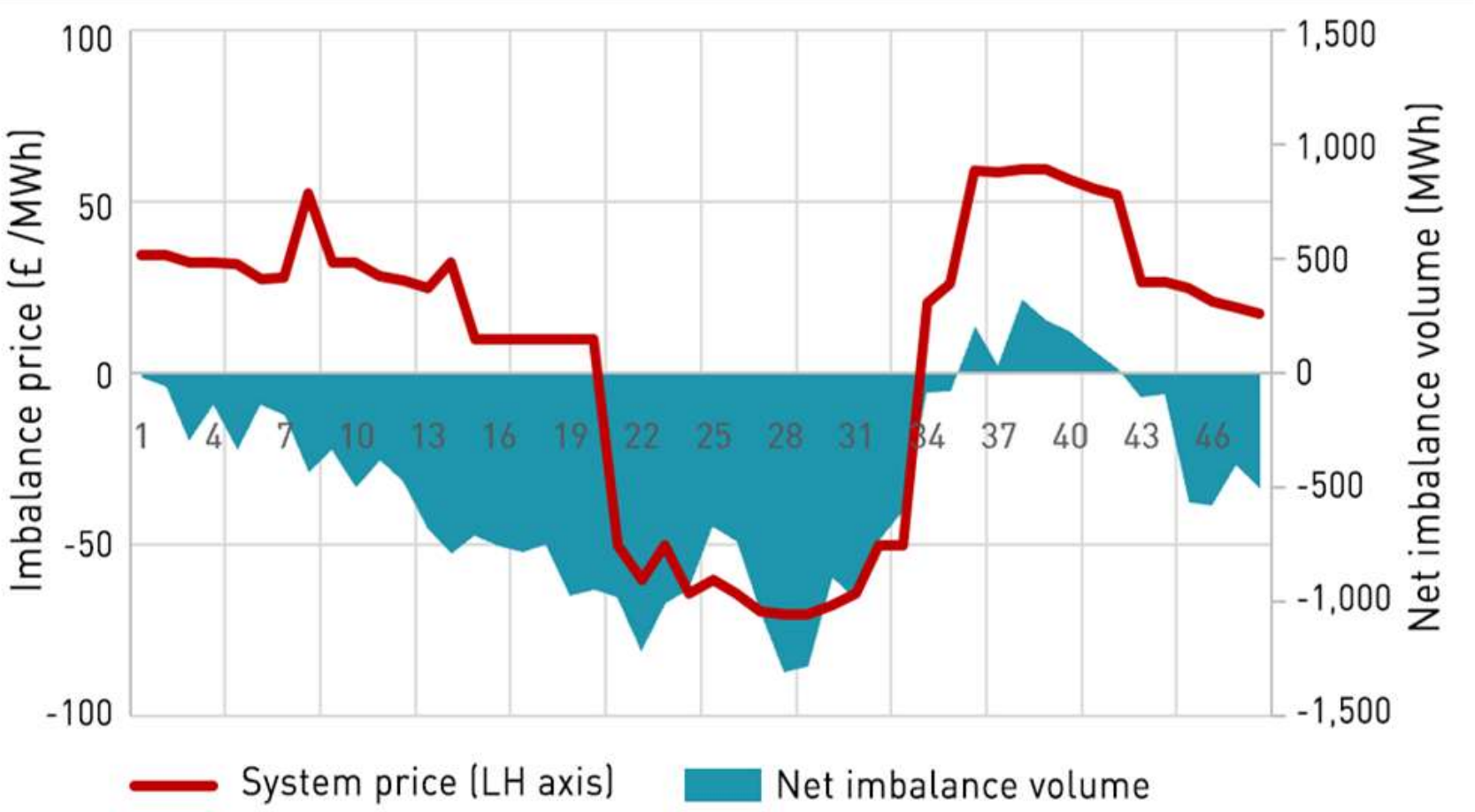

Not everything is equally urgent. Some work can wait for greener energy (link)


⚡ LOW GRID INTENSITY

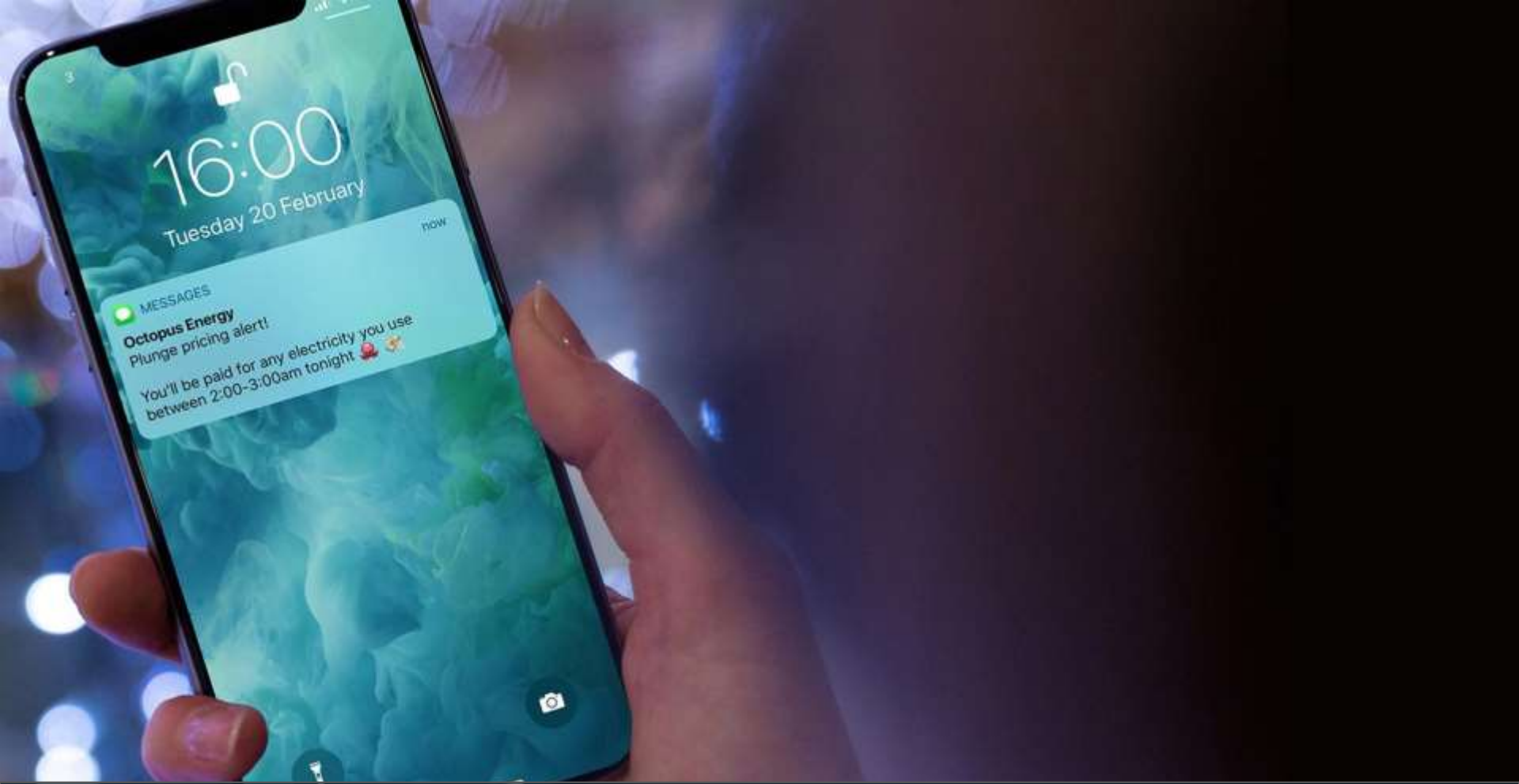

⚡ MEDIUM GRID INTENSITY


⚡ HIGH GRID INTENSITY

Carbon intensity as a creative constraint - Branch Magazine (link)




The duck curve. When there's more being generated than can be used, you can be paid to use energy (link)




Consumer facing demand pricing with Octopus Energy and their agile tariff (link)

## Conventional compute load

Execution of compute tasks throughout the day, regardless of carbon impact


How Google move compute loads through ***time*** to when energy is cheap and green (link)

**In summary:**

**Two levers for carbon reduction:** energy efficiency and carbon intensity

**For green, think GOLD**: Green, Open, Lean , Distributed.

**Energy infra and digital infra:** Patterns at the software layer let you take advantage of changes at the energy layer.

# Thanks!

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