

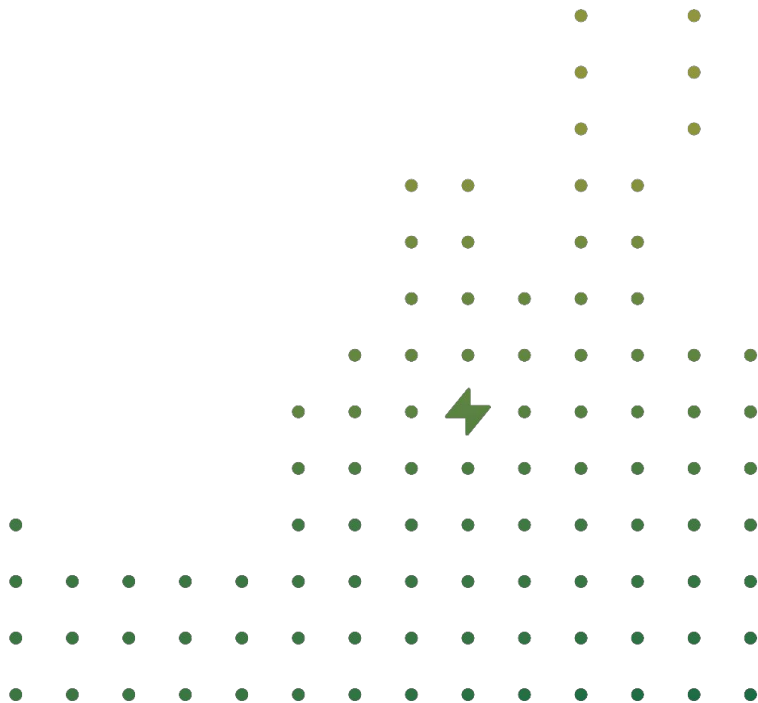


ELECTRICITY
MAPS

How to accelerate the green transition by digitalisation

www.electricitymaps.com

Olivier Corradi / @corradi



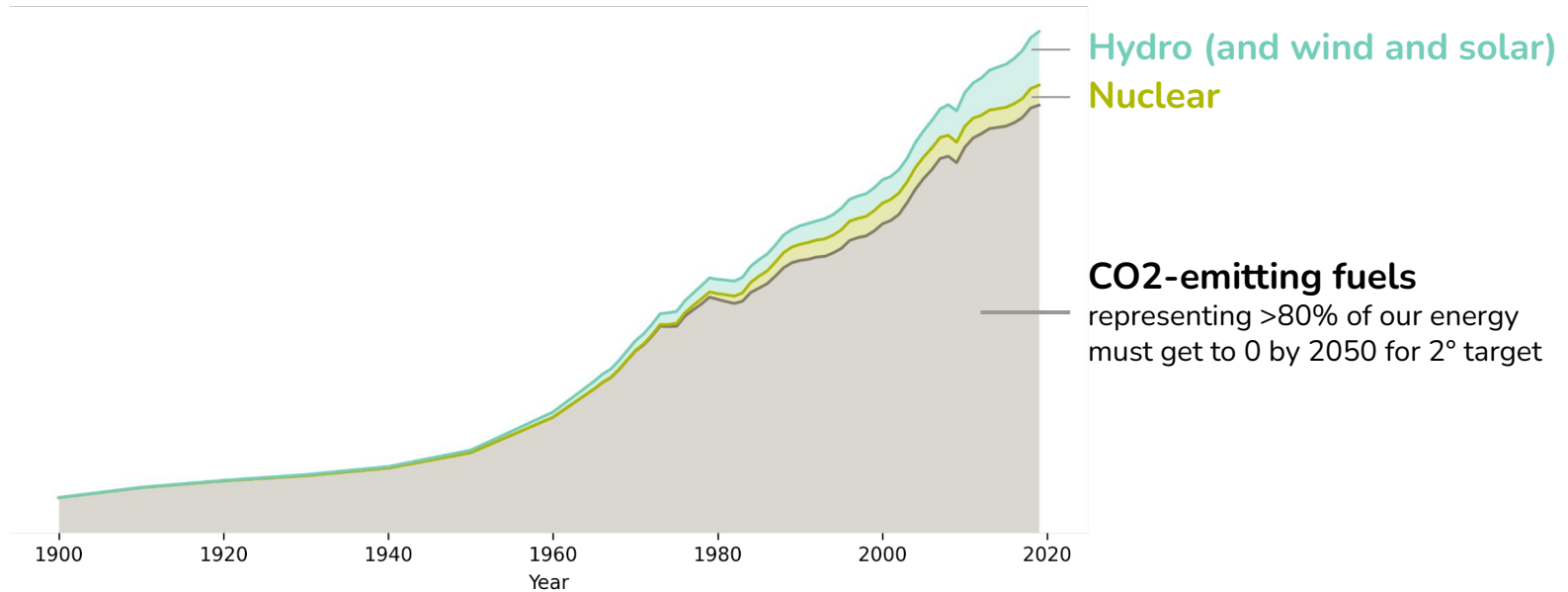
/whoami

Olivier Corradi

- MSc Mathematical Statistics @ DTU (Denmark)
- MSc Engineering @ Centrale Paris (France)
- IBM **Research** (Smart Grids)
- **Google** (Product Quality, Energy)
- VP Eng @ **snips** (AI startup, hired first 30+ employees, sold to Sonos)
- Founded ⚡ **ELECTRICITY MAPS** (previously Tomorrow) in 2016

Climate change is caused by fossil fuels

and our world is powered by them





Easy.

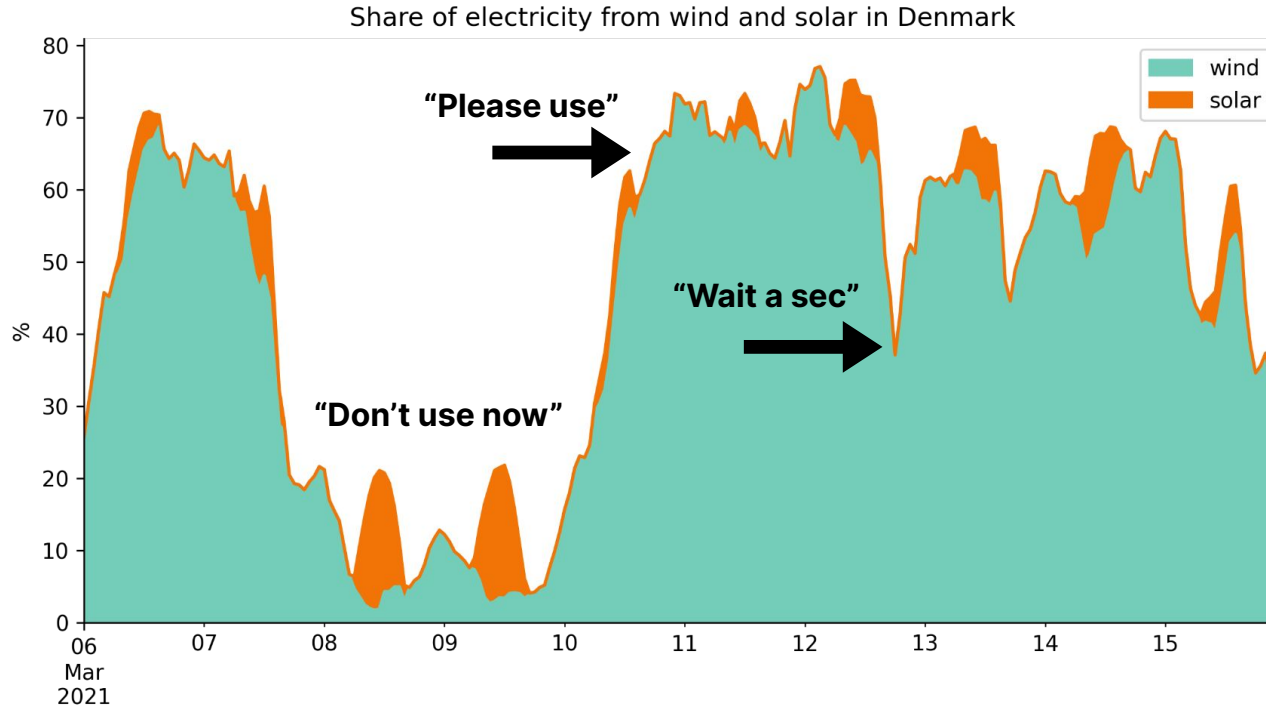
A cartoon character with a wide-open mouth, holding a power plug, set against a yellow starburst background. The character is white with large eyes and a pink shirt. The background consists of several yellow, pointed shapes radiating from behind the character.

ELECTRIFY

ALL THE THINGS!

(with clean electricity)

Clean electricity.. down to each hour



Our goal: **exploiting flexibility** in when and where
electricity consumption is done
to **reduce carbon emissions.**

Timing and location matter.

However, most companies account for their electricity footprint using **annual values!**

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Illustration: Shira Ibar for Bloomberg Green

Green | The Big Take

What Really Happens When Emissions Vanish

Companies say they've made climate progress. But the science says otherwise. Here's how creative math has fueled corporate claims.

By [Ben Elgin](#) and [Sinduja Rangarajan](#) +Follow

1 November 2022 at 01:00 CET

MANY OF THE WORLD'S LARGEST COMPANIES ARE DECLARING breakneck progress in the fight against climate change. While their environmental handiwork shows up on paper, these gains often fail to materialize in the atmosphere.

[Procter & Gamble Co.](#), vowed to cut its heat-trapping emissions in half by 2030, before announcing it had surpassed its target a decade early. [Cisco Systems Inc.](#) recently said it had exceeded a goal to

[nature](#) > [nature climate change](#) > [articles](#) >
article

Article | [Published: 09 June 2022](#)

Renewable energy certificates threaten the integrity of corporate science-based targets

[Anders Bjørn](#) , [Shannon M. Lloyd](#), ... [H. Damon Matthews](#) [+ Show authors](#)

[Nature Climate Change](#) **12**, 539–546
(2022) | [Cite this article](#)

Incentives to decarbonise the power grid

1

Generators burn fossil fuels directly (scope 1). They are thus exposed to a carbon tax (ETS in Europe) by law.

- directly affecting the spot market
- from 30€ to 100€ per ton of CO₂

2

Consumers cause emissions indirectly by consuming from generators (scope 2). They are voluntarily setting targets to decarbonise their supply (GreenhouseGas Protocol, SBTi)

- Voluntary targets are the main driver
- Science-Based Targets enables to align scope 1, 2 (and potentially scope 3) ambitions with a 1.5°C pathway



Different incentives to reach corporate targets

Targets can be **tracked differently** as there are **multiple ways to attribute emissions from generators to consumers**

	location-based	(yearly) market-based	24/7
What	Consumers can't choose the origin of their electricity, as it irreversibly mixes as it gets injected into the grid	Consumers can buy GOs/RECs to cover their annual consumption and thus become 100% renewable	Same as market-based but GOs/RECs need to be physical deliverable (temporal and spatial matching)
Impact	<ul style="list-style-type: none">✓ Incentivises flexibility✓ Incentivises optimal siting✗ No way to fund capacity investments✗ No way to fund storage investments✓ Credible traceability instrument	<ul style="list-style-type: none">✗ Incentivises flexibility✗ Incentivises optimal siting✓ Funds capacity projects¹✗ No way to fund storage investments✗ Credible traceability instrument	<ul style="list-style-type: none">✓ Incentivises flexibility✓ Incentivises optimal siting✓ Funds capacity projects¹✓ Funds storage and other grid projects✓ Credible traceability instrument

¹ if the purchase is additional

Note: avoided emissions, emissionality and carbon offsets do not allow attributing grid emissions to consumers, and thus are not eligible for corporate targets.

Read more at <https://www.electricitymaps.com/guides/accounting-guide>

“24/7” commitments of large cloud providers

“By 2030 Google is aiming to run our business on carbon-free energy
everywhere, at all times.”

Sundar Pichai, Google, 2020

“By 2030 Microsoft will have 100 percent of our electricity consumption,
100 percent of the time, matched by zero carbon energy”

Lucas Joppa, Microsoft, 2021

Electricity Maps' mission

**organise the world's electricity data
to drive the transition towards
a truly decarbonised electricity system.**

Electricity Maps in 2016

Initially a data visualization, inspired by previous Master Thesis with DTU, DONG, iPower

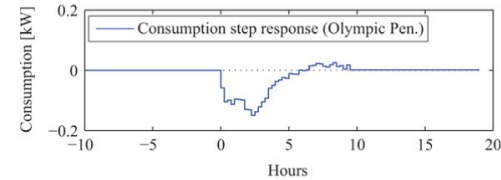
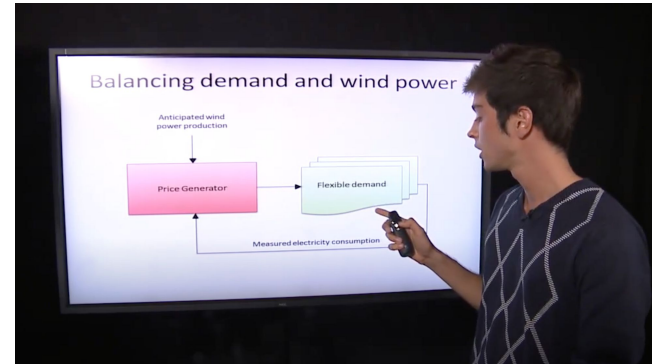
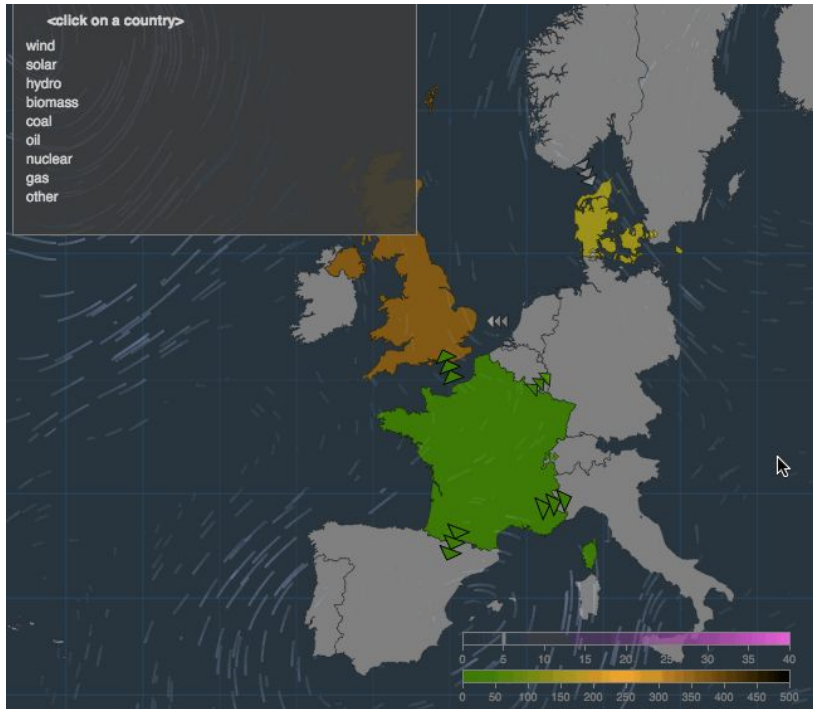


Fig. 5. Response of consumption to a price step after removing the consumption to price feedback. A model complexity of $n_r = n_p = n_z = 40$ lags (10 hours) yields a coefficient of determination of 75%. The selected model shows a slight rebound after 6 h, which in our opinion is negligible. However, situations where a significant rebound is present cannot be excluded, as seen later in Fig. 10. In this sense, the step response has a significant duration of 5–6 h.

Electricity Maps provides unified and real-time access to the **world's** electricity data

Global coverage

Harmonizing 100+ data sources to provide coverage for 180+ zones across the world (US, EU, LATAM, Oceania..), making us the data providers with the largest coverage.

High availability, robust data

Proprietary anomaly control algorithms and fallback models ensure we deliver high-quality data even in cases of delayed or incorrect source data. We guarantee that no missing data will be present for zones covered by our SLAs.



Trustworthy CO2 methodology

Transparent methodology based on peer-reviewed literature and openly published on our [wiki](#). Data cited 100+ times in scientific literature. Global readership of our [blog posts](#). Our [app community](#) contributes to our methodology and scrutinises our data.

Comprehensive

One single place from which to get all the data needed to differentiate your app for an increasingly climate-aware audience: historical, real-time and forecasted data. Marginal and average. Power mix and CO2. Soon: prices.

USA Iso New England Inc.

23 Jan 2023, 09:00

268 g

Carbon Intensity (gCO₂eq/kWh)

53%

Low-carbon

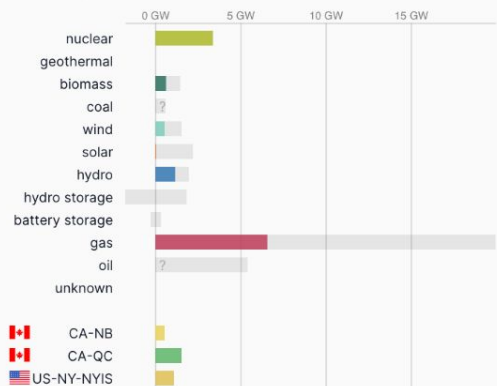
28%

Renewable

Electricity consumption

Carbon emissions

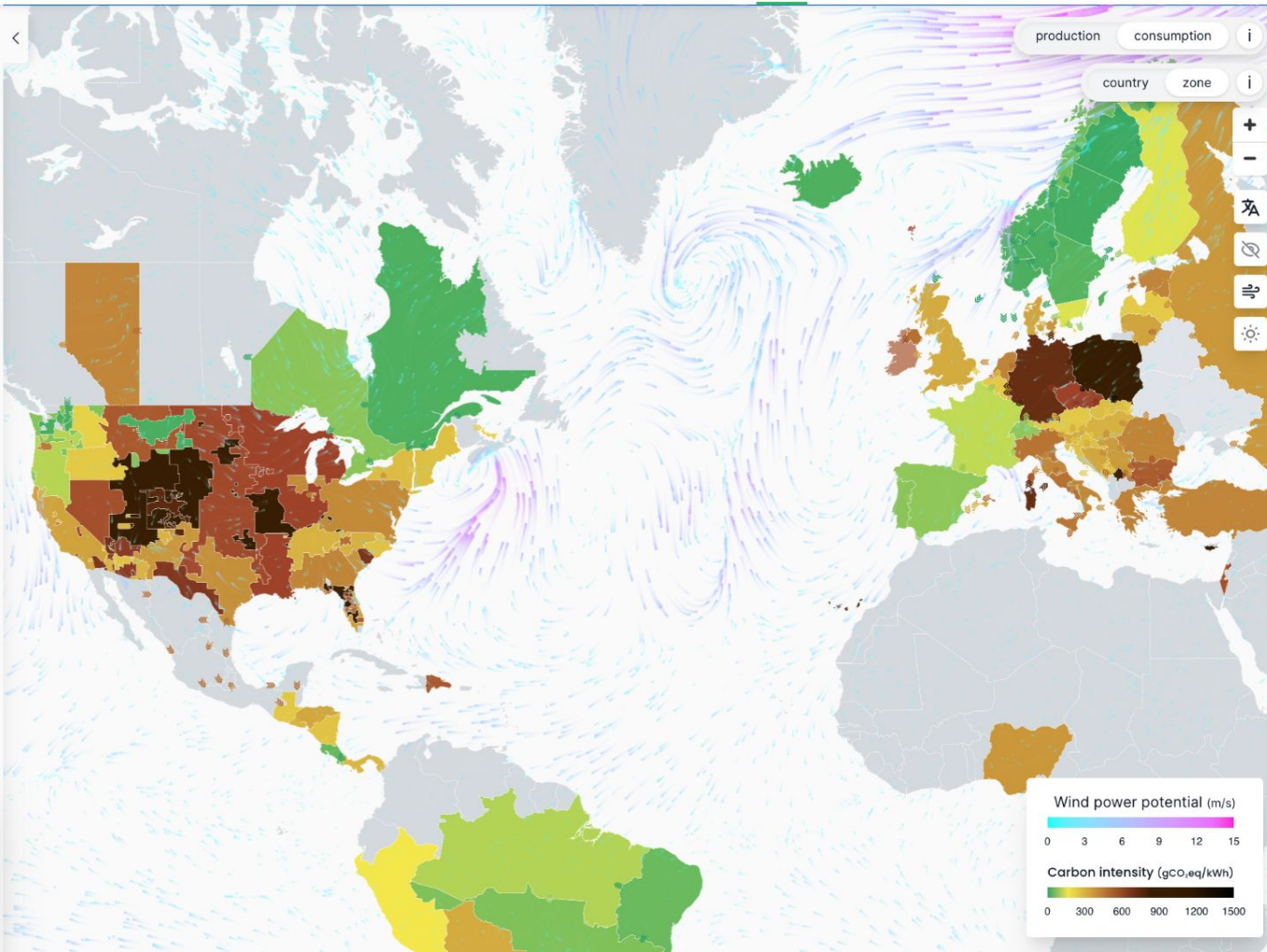
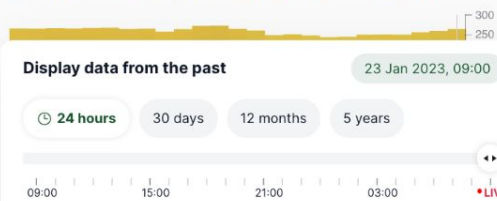
Electricity production by source



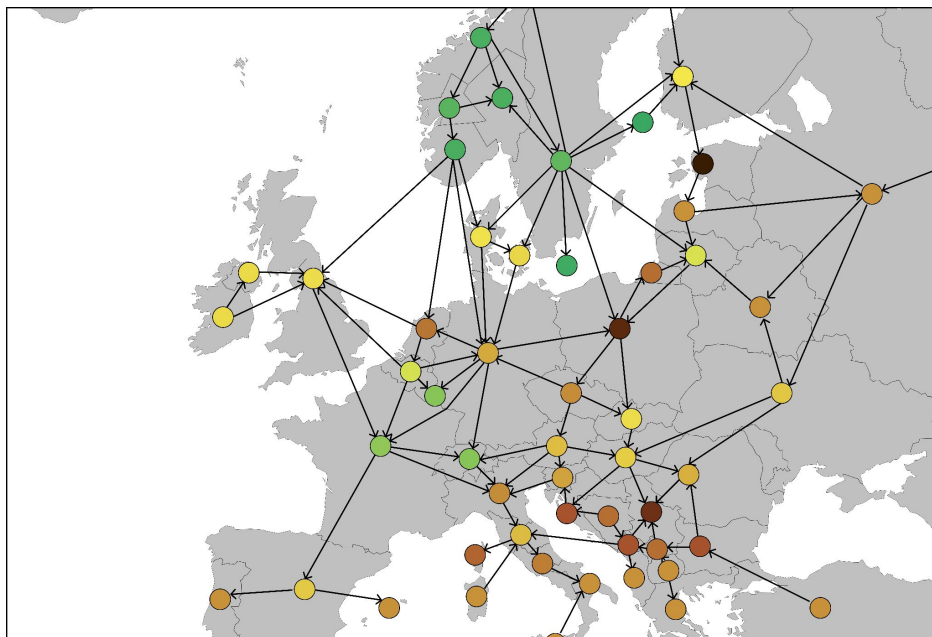
- CA-NB
- CA-QC
- US-NY-NYIS

Carbon intensity in the last 24 hours

Get hourly historical, live, and forecast data with Electricity Maps API



Our API enables to schedule ahead



electricityMap

Forecasted carbon intensity | performance report

Germany (DE)

Generated 2021-09-13

Timeframe	MAE	Average carbon intensity	MAE/average carbon intensity	R ²
Last 31 days	30 gCO ₂ eq/kWh	321 gCO ₂ eq/kWh	9%	0.72

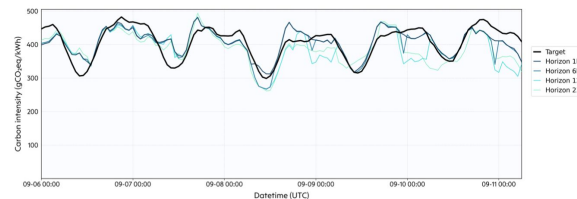


Figure 1: Comparison of the historical carbon intensity (Target) with forecasted carbon intensity for multiple horizons (Horizon h).

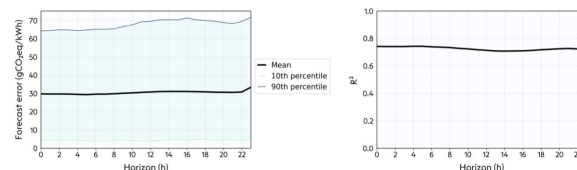
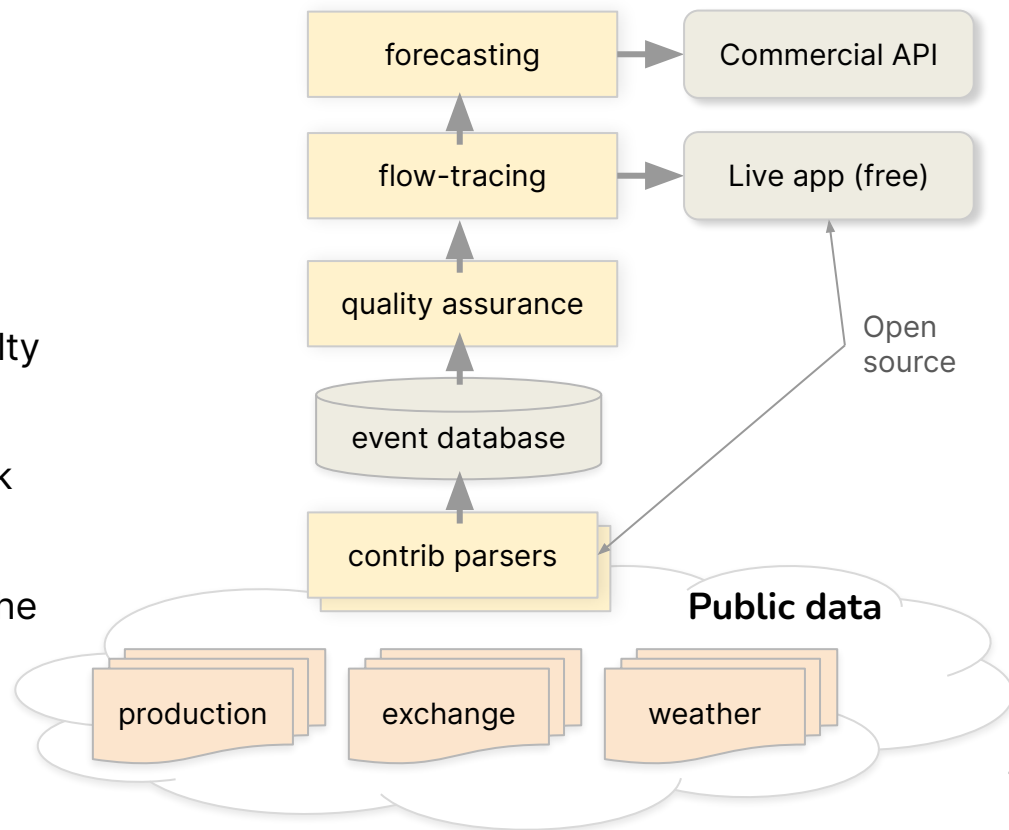


Figure 2: Evolution of the forecast performance as a function of the horizon.

Technology and data pipeline

- With the help of our community, we **identify** where public data is available
- Contributors can write **open source parsers** that fetches data from these providers
- Our **data quality algorithms** detect faulty or missing data, and estimates them
- Our **flow-tracing algorithm** traces back the physical the origin of electricity
- Our **AI** learns from the data to predict the future behaviour of the grid



Data center flexibility



The Keyword

Latest stories

Product updates

Company news



DATA CENTERS AND INFRASTRUCTURE

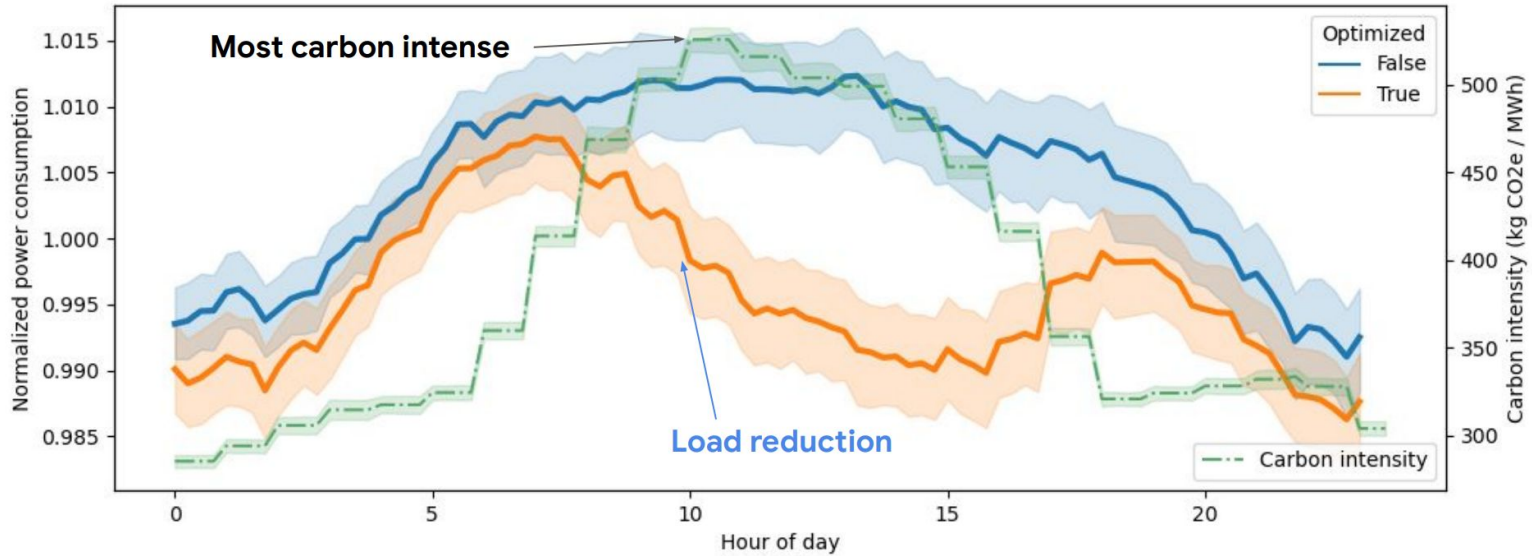
Our data centers now work harder when the sun shines and wind blows



Ana Radovanovic
Technical Lead for
Carbon-Intelligent
Computing

Addressing the challenge of climate change demands a transformation in how the world produces and uses energy. Google has been carbon neutral [since 2007](#), and 2019 marks the third year in a row that we've matched our energy usage with [100 percent renewable energy purchases](#). Now, we're

Early results



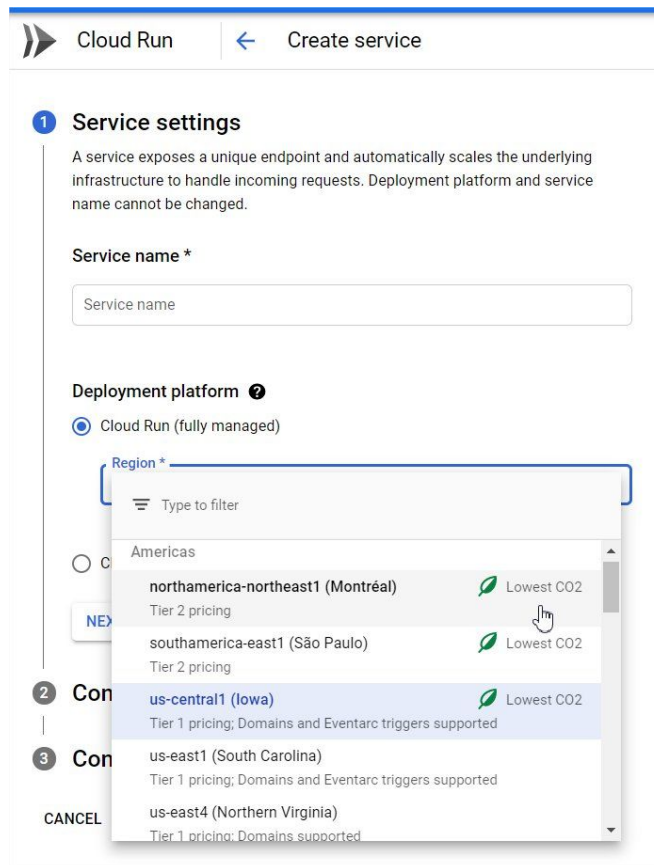
The effect of load shaping optimization on cluster power consumption, showing reduction in power consumption during period of higher carbon intensity

Read more at

<https://www.performance2021.deib.polimi.it/wp-content/uploads/2021/11/Carbon-Aware-Computing-@-Google-and-Beyond.pdf>

On the users' side

Carbon footprint is a key factor when deciding which **data center location** to use

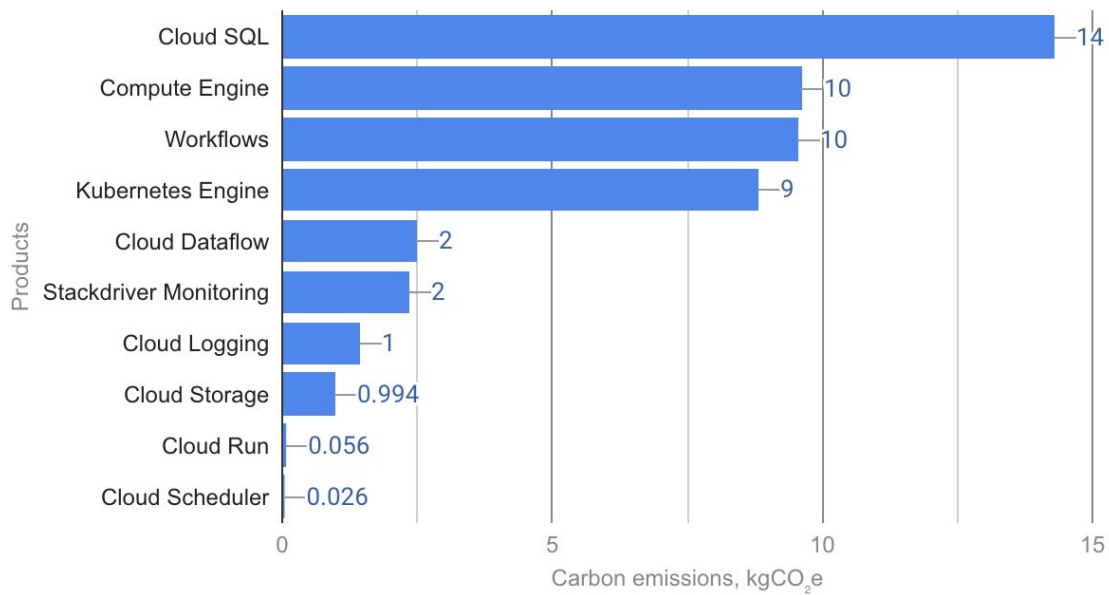


The screenshot shows the 'Create service' wizard in Google Cloud. The 'Service settings' step is active, showing a description of a service and a text input for the 'Service name'. Below this, the 'Deployment platform' is set to 'Cloud Run (fully managed)'. A 'Region' dropdown menu is open, displaying a list of regions with their carbon footprint indicators. The regions listed are:

- Americas
 - northamerica-northeast1 (Montréal) - Lowest CO2, Tier 2 pricing
 - southamerica-east1 (São Paulo) - Lowest CO2, Tier 2 pricing
 - us-central1 (Iowa) - Lowest CO2, Tier 1 pricing; Domains and Eventarc triggers supported
 - us-east1 (South Carolina) - Tier 1 pricing; Domains and Eventarc triggers supported
 - us-east4 (Northern Virginia) - Tier 1 pricing; Domains supported

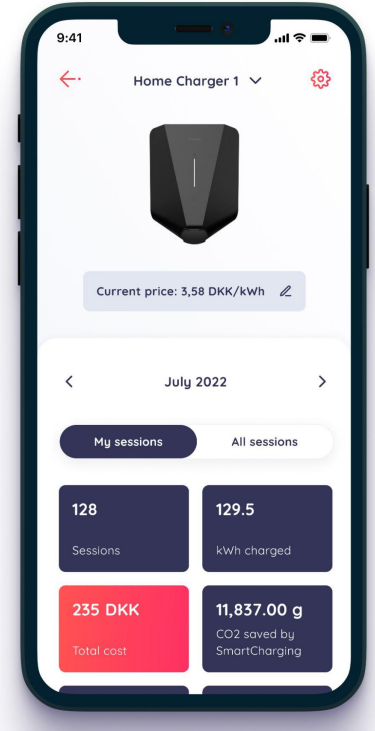
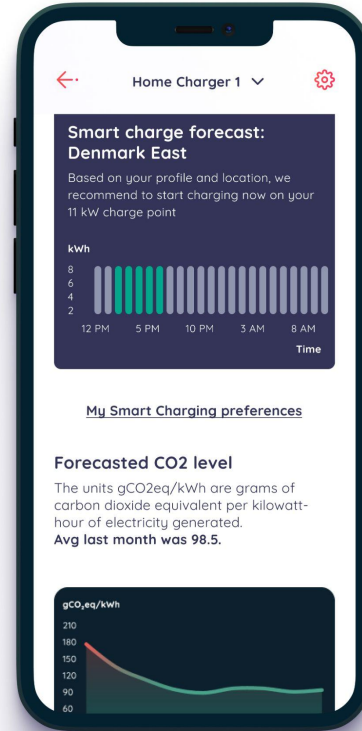
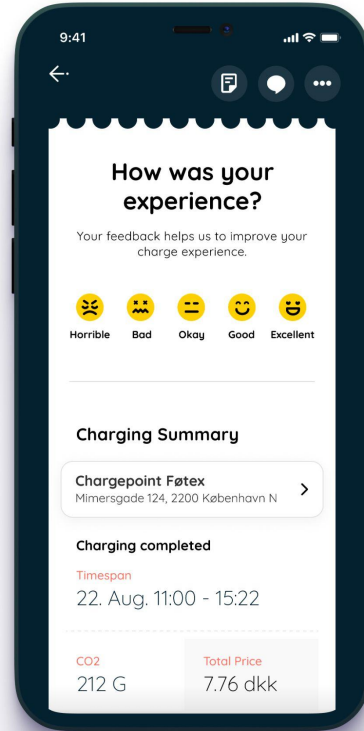
Cloud footprint *per service*

Gross carbon emissions by product in November 2021 Chart view ▼



Monta

How is the data used:
→ Smart Charging
functionality: choice between
co2, price, renewables
→ analytics for individual
charges and months



Andel Energi (SEAS-NVE)

How is the data used:

→ forecast for upcoming hours

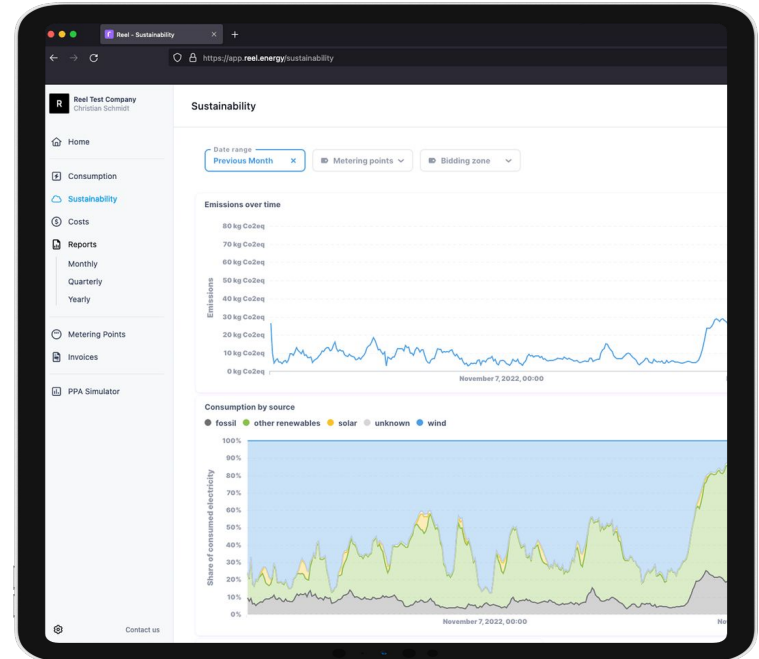
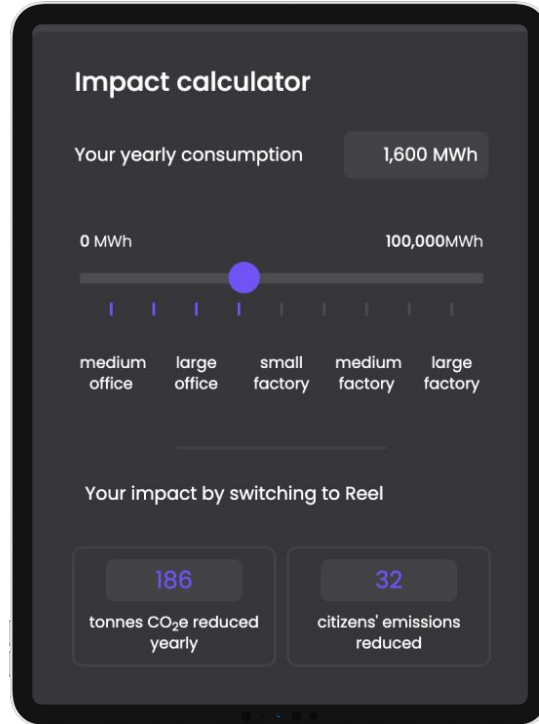
→ incentivizing customers to change behavior

→ analytics for electricity consumption



Reel

How is the data used:
→ Clean energy procurement
→ Analytics and reports



MinStrøm

(Free collaboration)

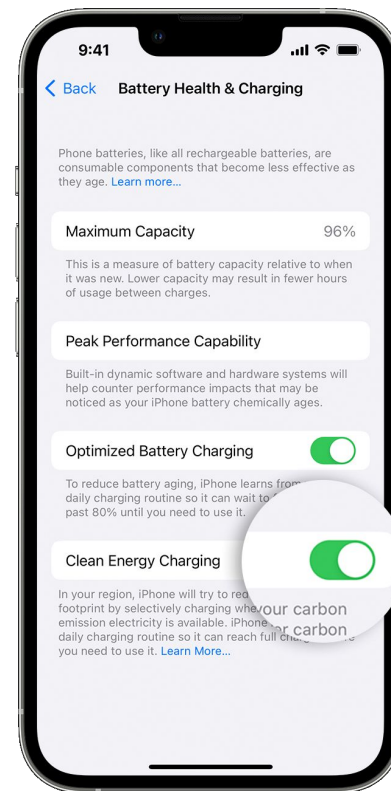
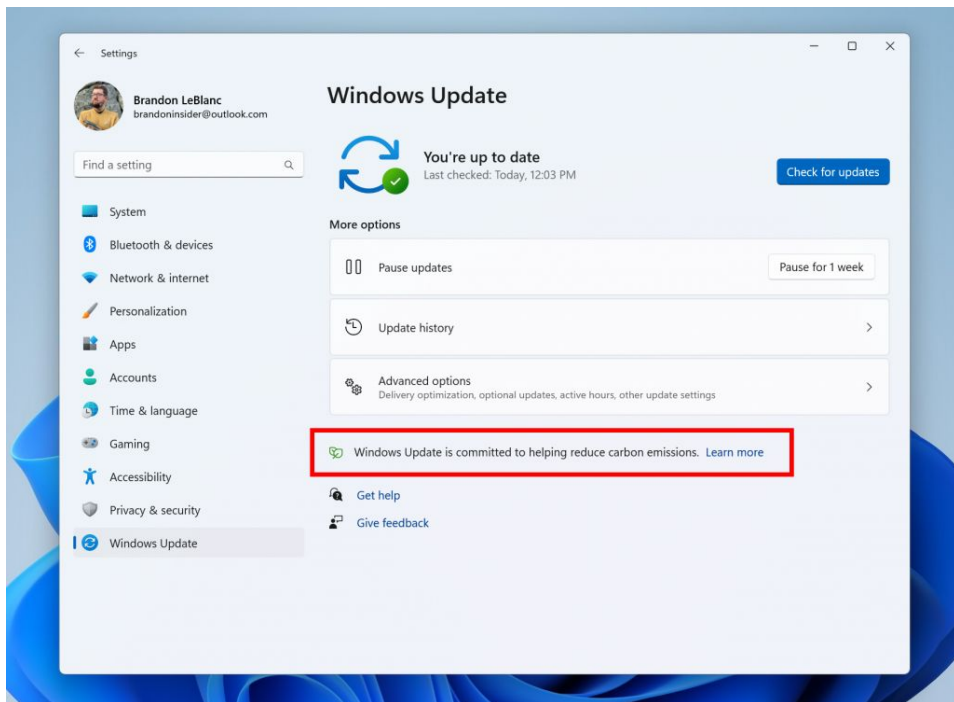
How is the data used:

→ Analytics for private users

→ Advocacy



We're only scratching the surface..



Our vision of success in 10 years:

Clean electricity is supplied by all electricity grids of the world, at all times of the year



Timing and location matter.

Companies now account for their electricity footprint
using ~~annual values~~ **granular grid data**.

Their products enable the **decarbonisation** of the grid.



Thank you for listening

Electricity Maps

electricitymaps.com

