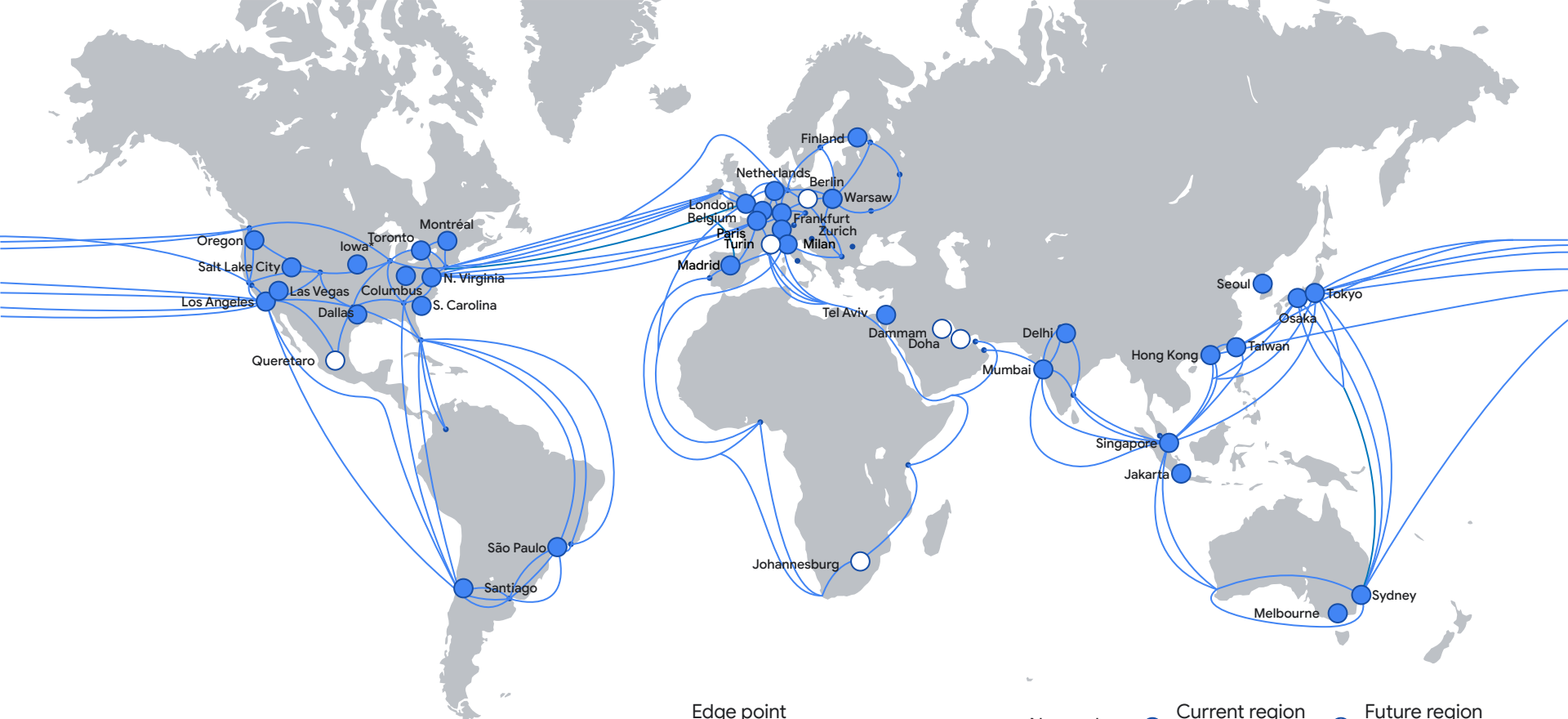Google

Sustainability

Anne-Elisabeth Caillot
Responsable practice Infrastructure Modernisation
Google Cloud France
@anneecaillot

Google Cloud Platform

Edge point of presence · Network · Current region with 3 zones · Future region with 3 zones

35 Cloud Regions (6 additional in the roadmap)
18 TWh of electricity consumption (>2GW of power consumption)

Google Cloud

Google Cloud Environmental Journey

24/7 CFE - Net Zero - Water RE
(Eliminating carbon emissions and water impact)

100% Renewable Energy
(Reducing carbon emissions)

Data Centers Energy Efficiency
(Reducing energy consumption and e-waste)

Since 2008

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Google Environmental Journey

Data Centers Efficiency
(Reducing energy consumption and e-waste)

Since 2008

Data Centers Efficiency

Custom designed servers
- Increase Energy Efficiency and Lifetime

Custom designed chips (TPU/VPU/NPU)
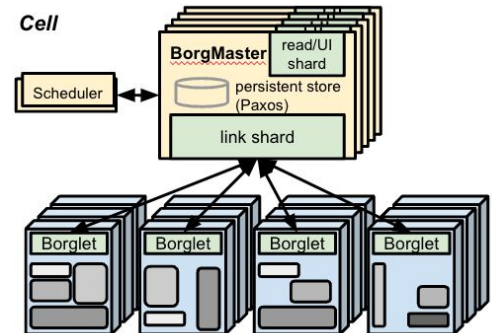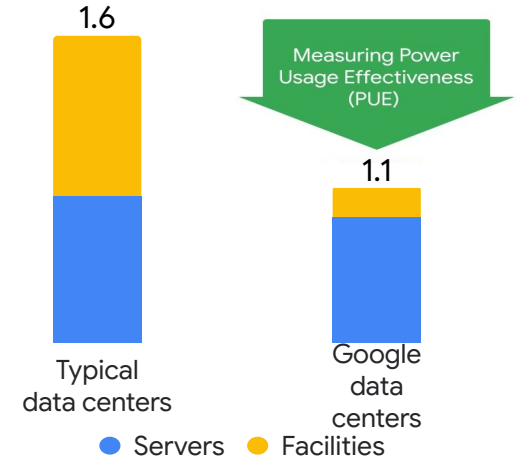- Increase Energy Efficiency

48V DC server power supplies
- Reduce energy conversion losses

ML-driven cooling
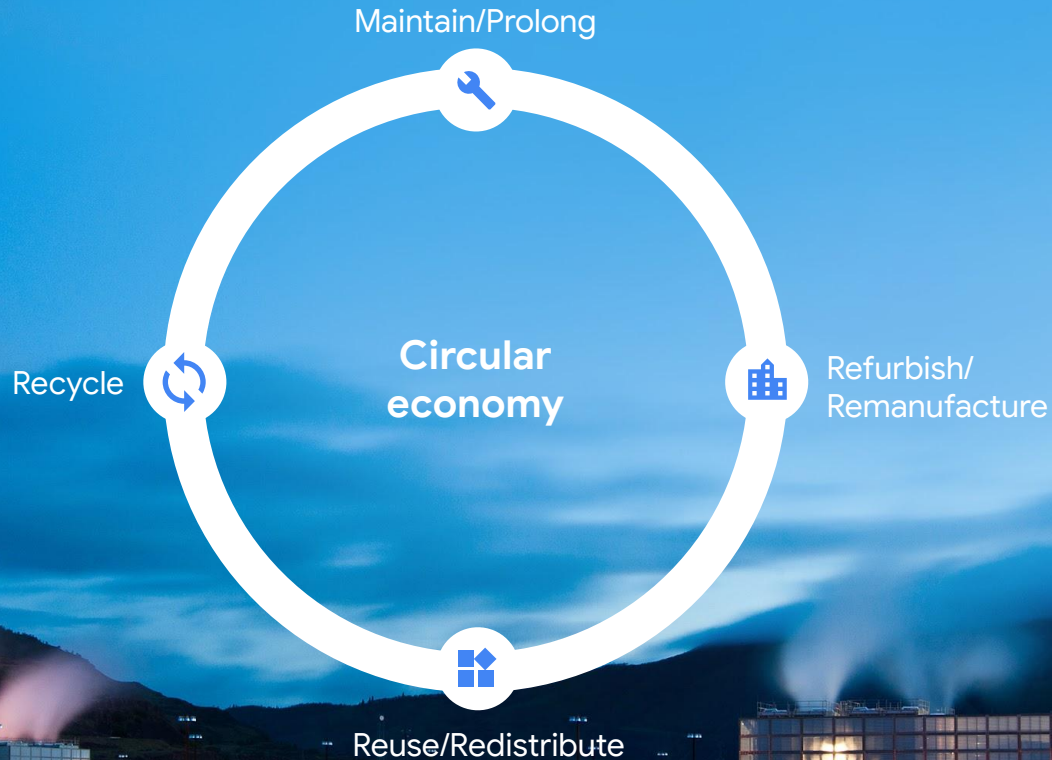- Reduce Energy consumption of cooling

Containerised Microserviced Software Stack
- More workloads per servers to increase their utilisation rate
- Foundational shared services to increase efficiency
- Abstraction of servers generations to increase servers lifetime

1.6

Measuring Power
Usage Effectiveness
(PUE)

1.1

Typical
data centers

Google
data
centers

● Servers ● Facilities

Cell

BorgMaster read/UI
shard

Scheduler

persistent store
(Paxos)

link shard

Borglet Borglet Borglet Borglet

87%

landfill diverted rate from our global data center operations

Maintain/Prolong

Circular economy

Refurbish/Remanufacture

Recycle

Reuse/Redistribute

Google

Google Environmental Journey

100% Renewable Energy
(Reducing carbon emissions)

Data Centers Energy Efficiency
(Reducing energy consumption and e-wastet)

Since 2008

Since 2017

More than
60 renewable
energy projects
Worldwide
~7GW

400 MW

100 MW

● Wind   ● Solar

Electricity consumption

2013	2014	2015	2016	2017	2018	2019	2020	2021
35%	37%	48%	61%	100%	100%	100%	100%	100%

Google

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Our Third Decade of Climate Action
24/7 Carbon-Free Energy by 2030

In September 2020, we announced our goal to to run our business on carbon-free energy everywhere, at all times, at all of our data centers and campuses around the world, by 2030.

Our 24/7 CFE strategy focuses on three areas:
1. **Transactions**: Buy more and different types of clean energy deployed locally
2. **Technology**: Accelerate energy technology innovation
3. **Policy**: Advocating for policy changes to decarbonize electricity grids

Google

100% Renewable Energy still relies on fuel-based electricity

Carbon-free energy supply

Gaps in carbon-free energy

January 1

December 31

data center hour by hour
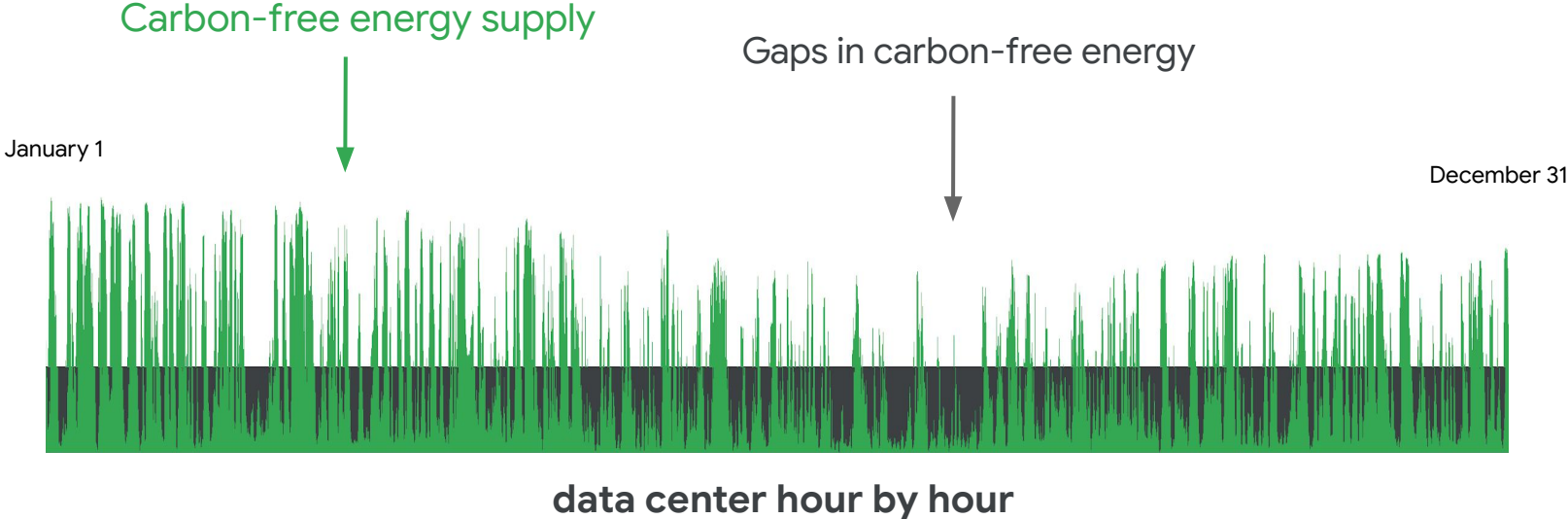
Scenario: every hour of electricity use at Chile data center

Without solar and wind PPAs, less than half our energy use in Chile would be matched with carbon-free sources on an hourly basis

Status Quo (without Google PPAs)

January 1   **42% carbon-free energy**   December 31

Midnight
Morning
Noon
Afternoon
Evening

0% match with carbon-free energy   **100%** match with carbon-free energy

Google

Actual: every hour of electricity use at Chile data center
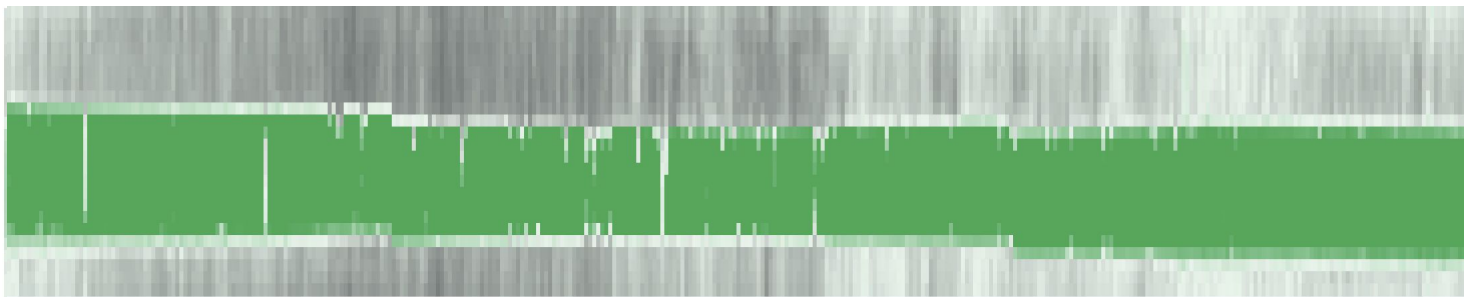Google's first solar PPA in Chile significantly increased our data center's carbon-free matching

Actual (with 80 MW Google solar)

January 1   **63% carbon-free energy**   December 31

- Midnight
- Morning
- Noon
- Afternoon
- Evening

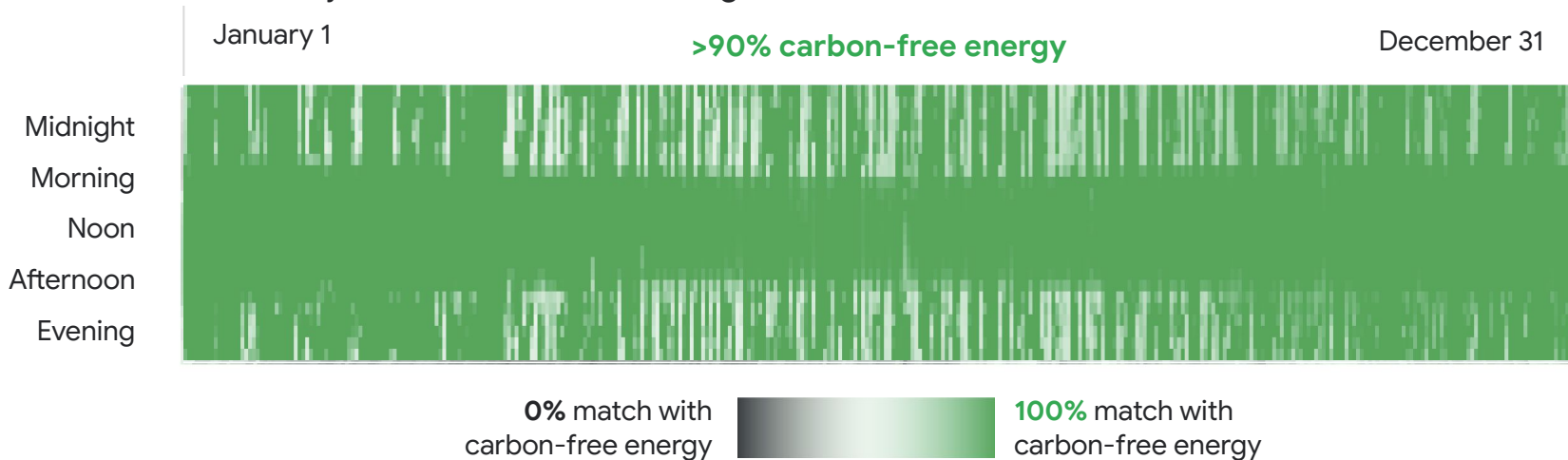**0%** match with carbon-free energy   **100%** match with carbon-free energy

Google

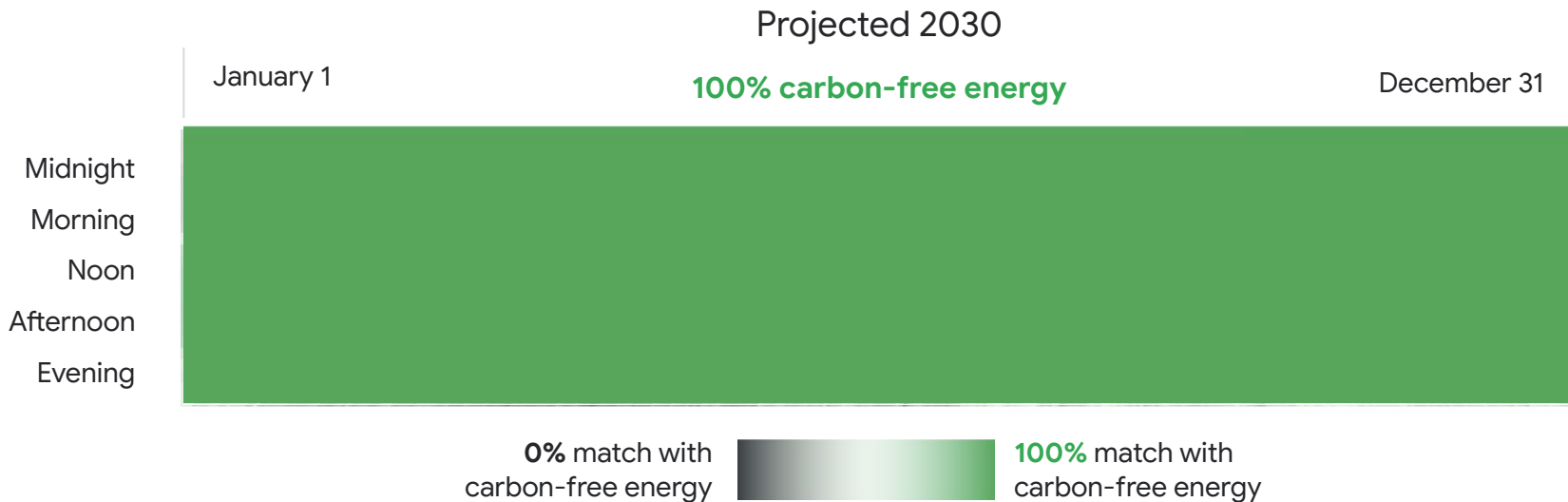# Projected: every hour of electricity use at Chile data center

A new solar + wind PPA will fill in the gaps, enabling us to match almost 100% of our electricity use with carbon-free resources on an hourly basis

Projected (with 80 MW Google solar + new 35 MW solar + new 90 MW wind)

January 1   >90% carbon-free energy   December 31

Midnight
Morning
Noon
Afternoon
Evening

0% match with carbon-free energy   **100%** match with carbon-free energy

Google

Projected 2030: 100% carbon-free energy at all times

A new solar + wind PPA will fill in the gaps, enabling us to match almost 100% of our electricity use with carbon-free resources on an hourly basis (+storage)

Projected 2030

January 1	**100% carbon-free energy**	December 31

Midnight
Morning
Noon
Afternoon
Evening

0% match with carbon-free energy　　　　　　**100%** match with carbon-free energy

Using batteries with Renewable Energy

24-hour snapshot
Data from Chile data center on a day in August

● Grid carbon-based energy

● Grid carbon-free energy (CFE)

● Google-contracted solar energy

● Excess Google-contracted solar energy
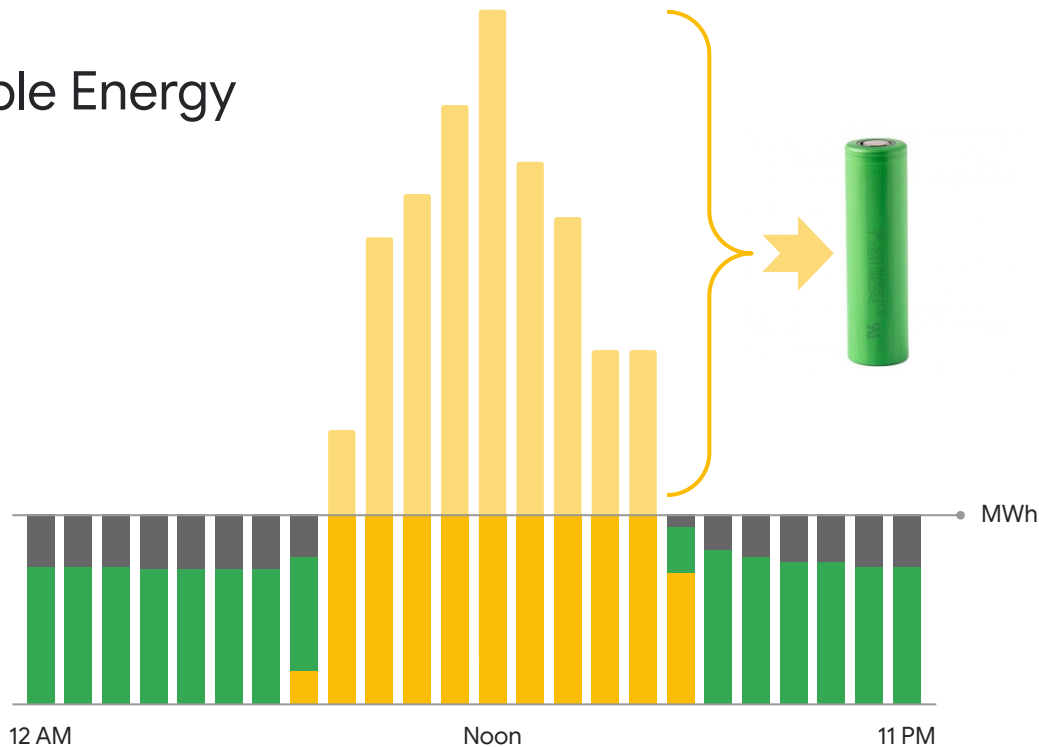
MWh

12 AM   Noon   11 PM

Google Cloud

Source: 24x7 White Paper

Google

Using batteries with Renewable Energy

24-hour snapshot

Data from Chile
data center on a
day in August

● Grid carbon-based energy

● Grid carbon-free energy (CFE)

● Google-contracted solar energy

● Battery energy from excess solar energy

MWh

12 AM   Noon   11 PM

Google Cloud

Google
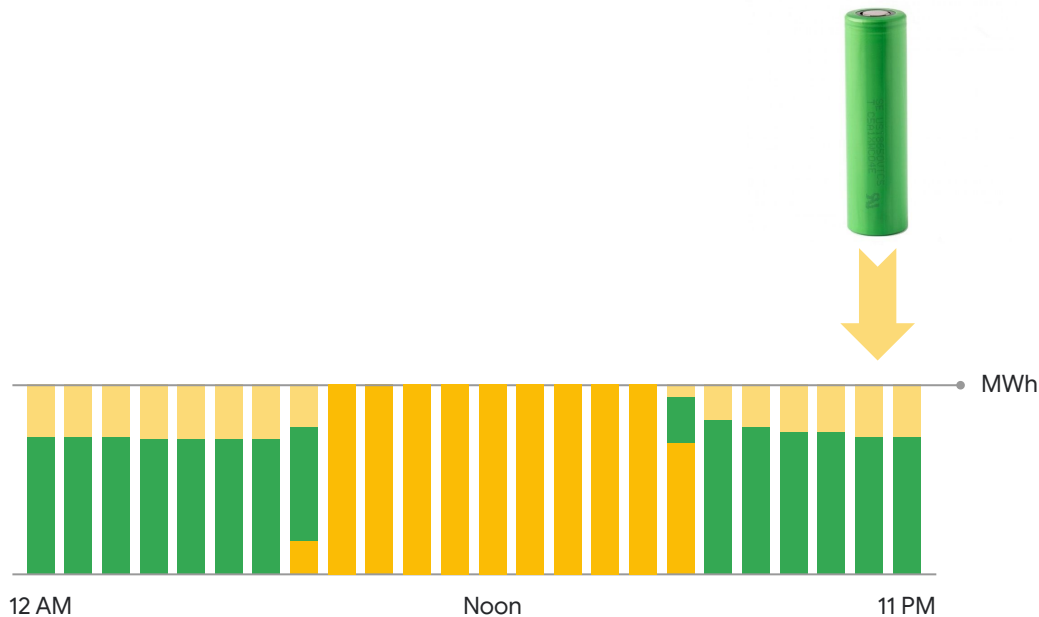
Next-gen technology shifting compute across locations

By shifting compute across location as well as time, we're able to further reduce the carbon intensity of our applications around the clock and around the globe.
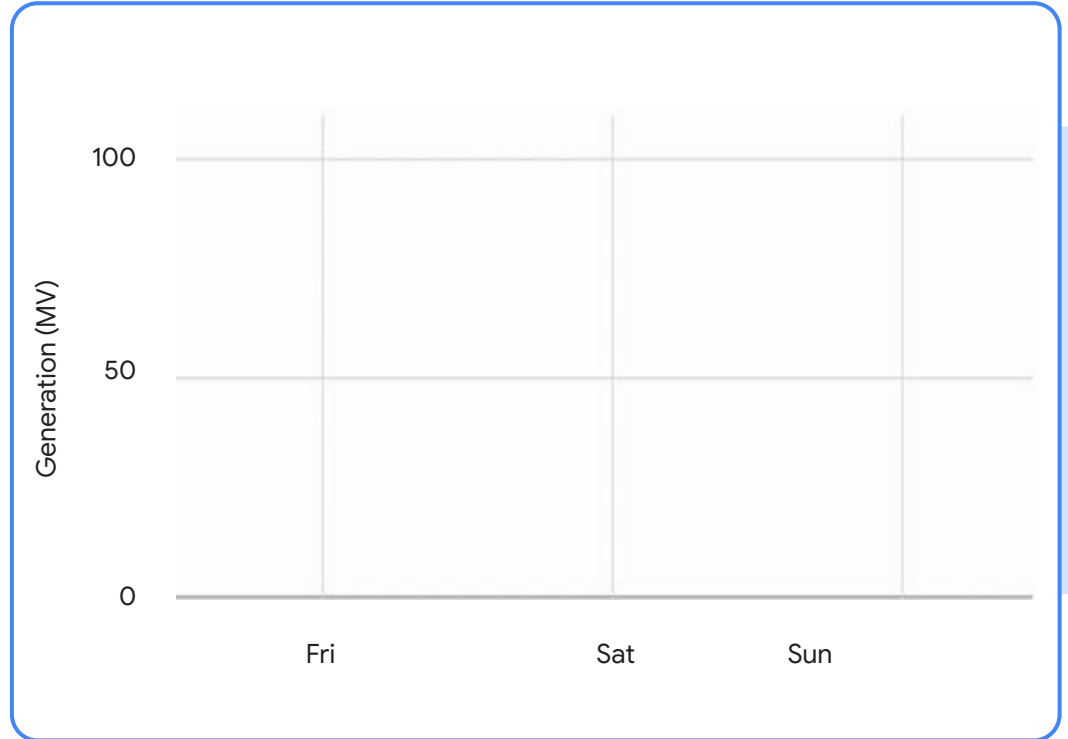
Technical investment

Next-gen technology
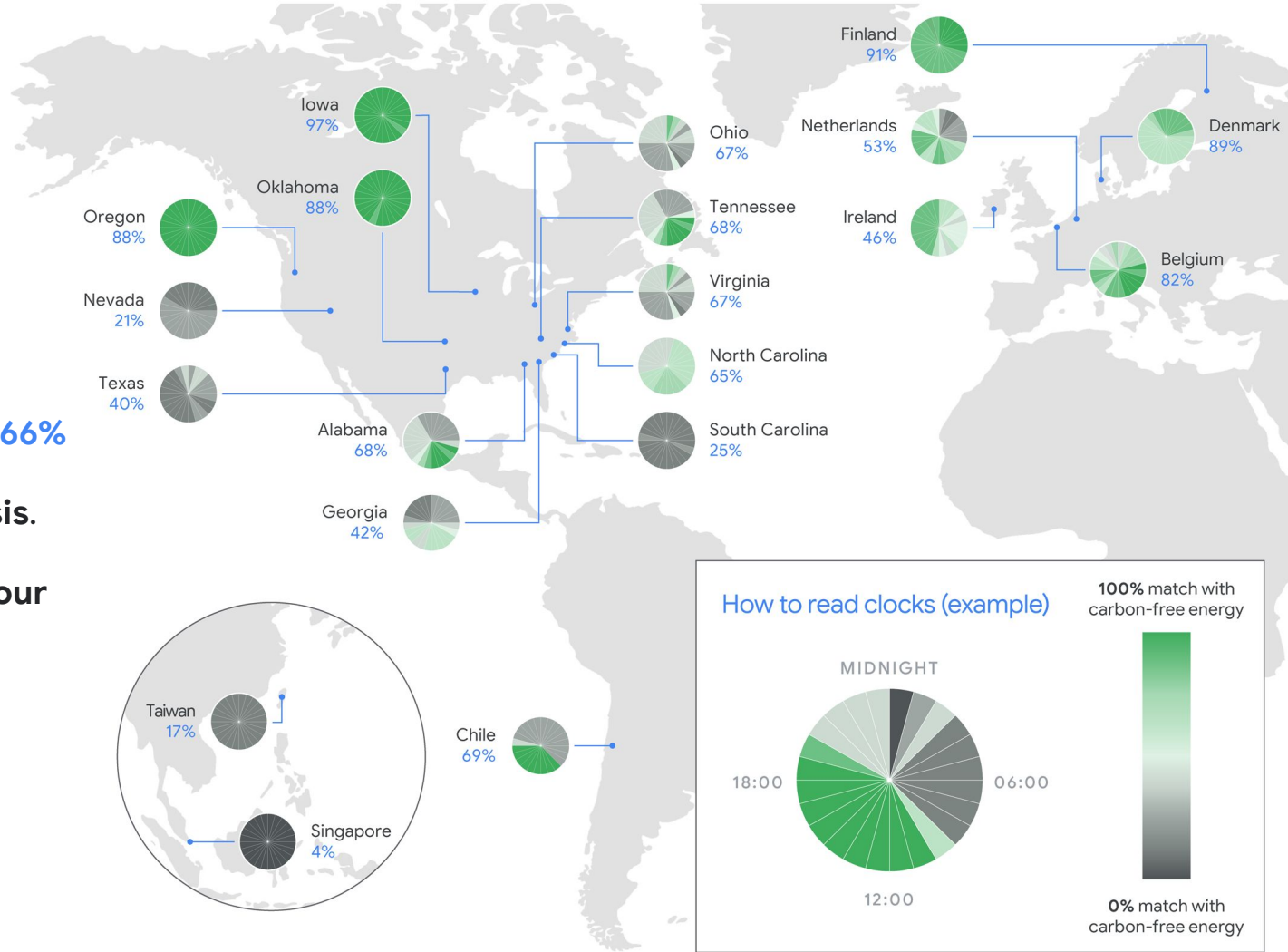
First-of-its-kind energy deal

The DeepMind system uses a neural network to predict wind power output **36 hours** ahead

● Predicted

● Actual

In 2021, Google reached 66% carbon-free energy globally on an hourly basis.

In the same year, five of our data centers operated at or near 90%.

Finland 91%
Netherlands 53%
Denmark 89%
Ireland 46%
Belgium 82%
Iowa 97%
Oklahoma 88%
Oregon 88%
Nevada 21%
Texas 40%
Ohio 67%
Tennessee 68%
Virginia 67%
North Carolina 65%
South Carolina 25%
Alabama 68%
Georgia 42%
Taiwan 17%
Singapore 4%
Chile 69%

How to read clocks (example)

100% match with carbon-free energy

MIDNIGHT

18:00   06:00

12:00

0% match with carbon-free energy

POLICY
Spurring a Global Movement

U.N. 24/7 Carbon-free Energy Compact

Global group of companies, governments, and organizations actively engaged in accelerating the technologies, policies, tools, ideas, and advocacy that will collectively realize 24/7 CFE for all. 42 signatories and counting...

Buyer's Associations

CEBA: ~ 300 energy customers and partners committed to achieving a 90% carbon-free U.S. electricity system by 2030.

RE-Source: pushes for the removal of regulatory and administrative barriers to corporate renewable energy procurement in Europe

Momentum: Others Adopting 24/7 CFE goals

U.S. Federal Government, Microsoft, Ironmountain, City of Des Moines, +

⚡ GoCarbonFree247.com ⚡

CEBA

⚡ cebuyers.org ⚡

RE-Source

⚡ resource-platform.eu ⚡

NEWS BRIEF
24/7 Carbon-Free Energy Is the New Net-Zero

Des Moines, Iowa, joins Google in aiming for 24/7 carbon-free electricity—a target that necessitates managing energy loads in buildings.

Our Third Decade of Climate Action
120% Water REplenishment by 2030

In September 2021, Google announced a pledge to a [water stewardship target](#) to replenish more water than we consume, on average, by 2030 and support water security in communities where we operate.

Our water stewardship strategy focuses on three areas:

1. **Enhancing our stewardship of water** resources across Google office campuses and data centers,
2. **Replenishing our water use** and improving watershed health and ecosystems in water-stressed communities, and
3. **Sharing technology and tools** that help everyone predict, prevent and recover from water stress

Google Cloud Environmental Footprint

Data Centers Energy Efficiency
(Reducing energy consumption and e-waste)

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Google Cloud gives you the tools

to optimize your region selection

Region carbon data:

cloud.google.com/sustainability/region-carbon

Region picker:

cloud.withgoogle.com/region-picker/

In context of the Cloud Console and Docs: 🌿 Low CO₂
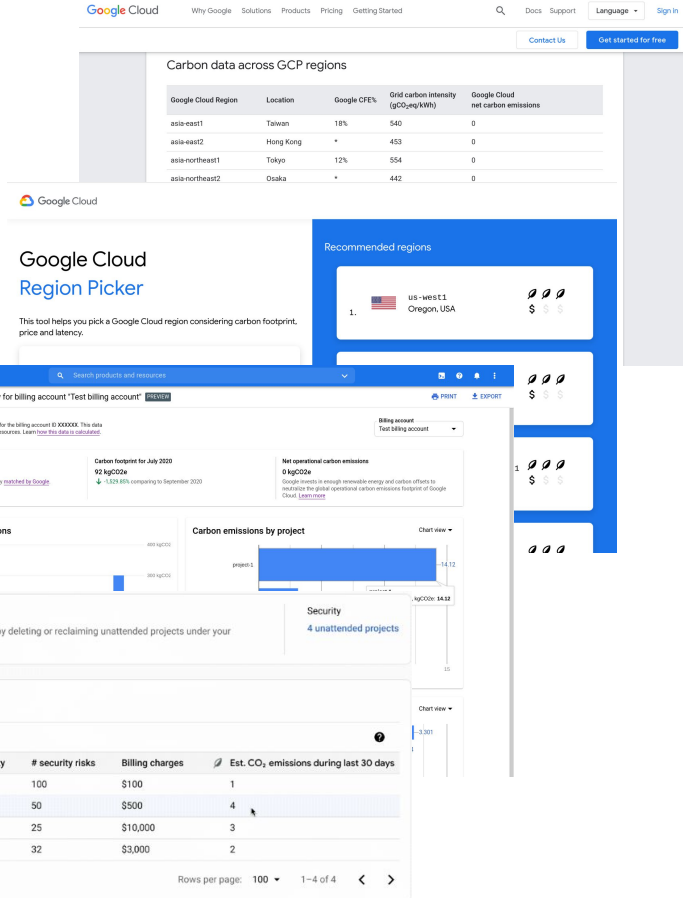
to report on your gross carbon emissions

Carbon Footprint

cloud.google.com/carbon-footprint/

to advise on reducing your carbon emissions

Active Assist

https://cloud.google.com/recommender
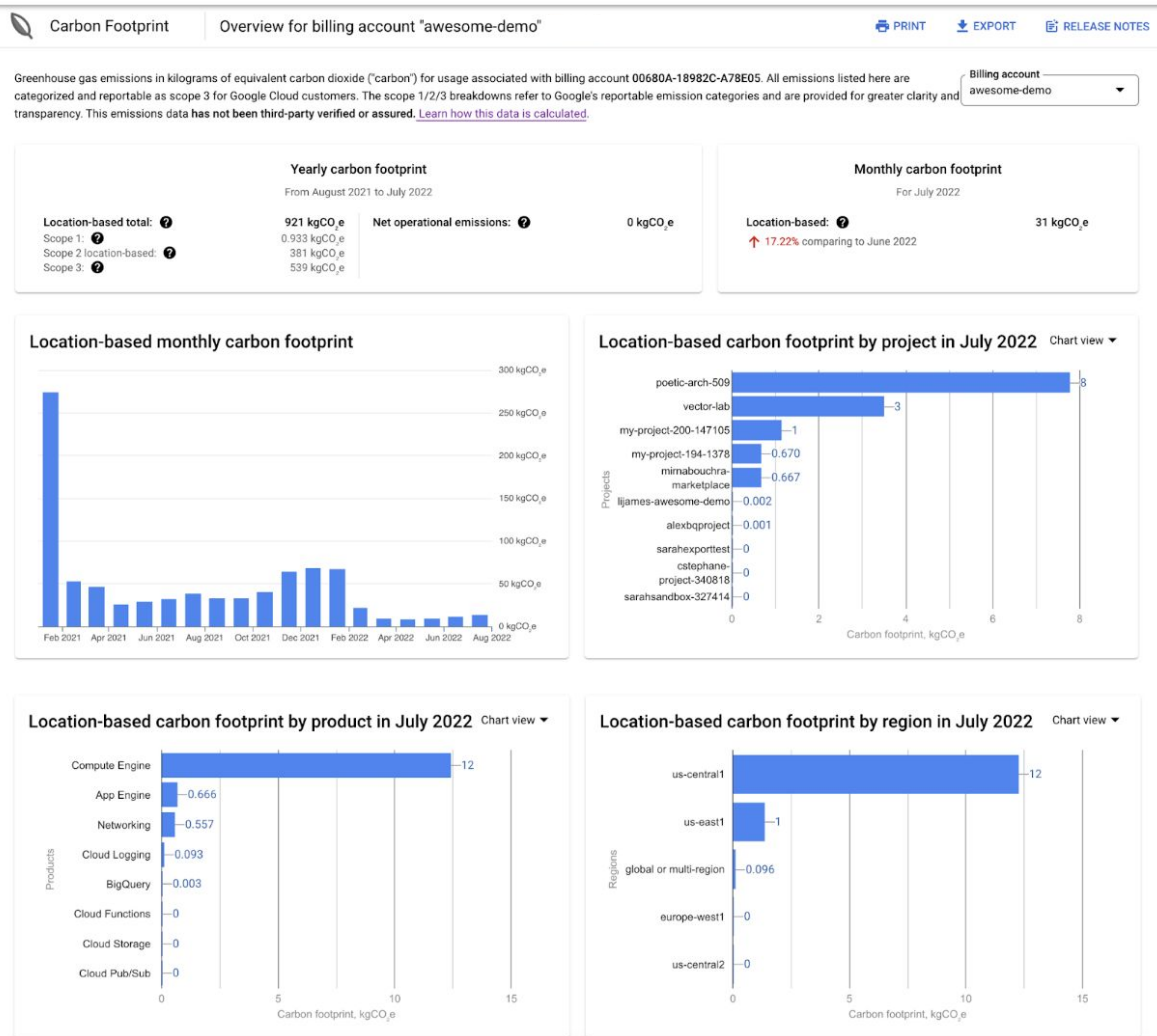
GCP Carbon Footprint

Data broken down by:

➜ project
➜ region
➜ product
➜ month

Data export to BigQuery.

Scope 1, Scope 2 location-based, Scope 3

Planned H1'23:
Scope 2 market-based + carbon offsets

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