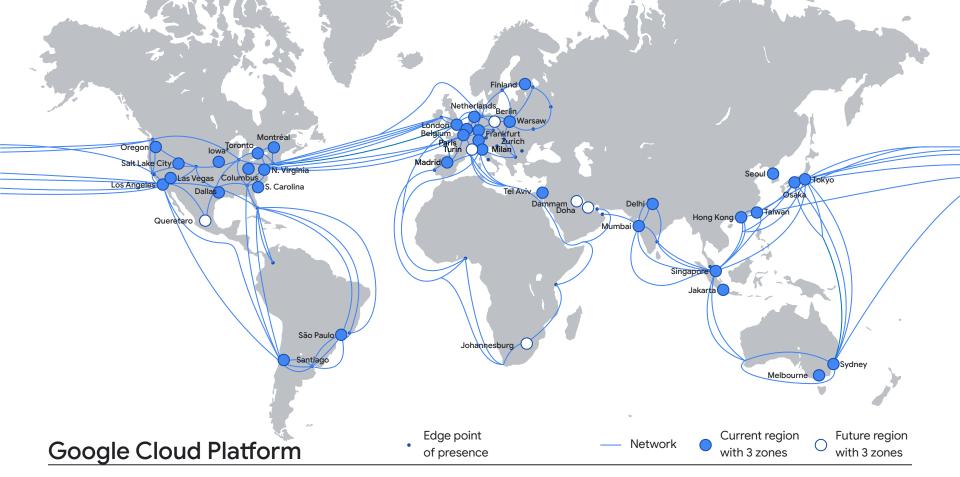
Google

Sustainability



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

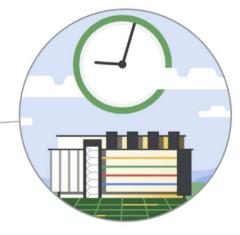


35 Cloud Regions (6 additional in the roadmap) 18 TWh of electricity consumption (>2GW of power consumption)

Google Cloud Environmental Journey

24/7 CFE - Net Zero - Water RE

(Eliminating carbon emissions and water impact)



Data Centers Energy Efficiency

(Reducing energy consumption and e-waste)



Since 2008

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100% Renewable Energy

(Reducing carbon emissions)

Google Environmental Journey

Data Centers Efficiency

(Reducing energy consumption and e-waste)



Since 2008

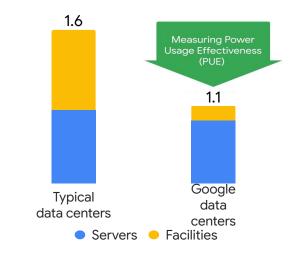
Data Centers Efficiency

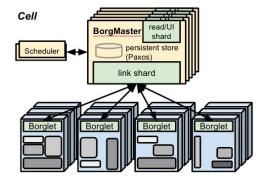
Custom designed servers

- 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







Google Environmental Journey

100% Renewable Energy (Reducing carbon emissions)

Data Centers Energy Efficiency

(Reducing energy consumption and e-wastet)

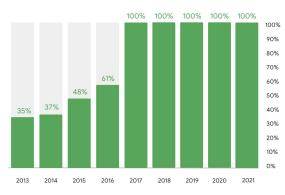


Since 2008



Since 2017

More than 60 renewable energy projects Worldwide ~7GW



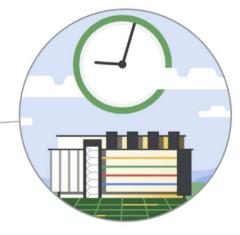
Pool

Google

Google Cloud Environmental Journey

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(Eliminating carbon emissions and water impact)



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100% Renewable Energy

(Reducing carbon emissions)

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

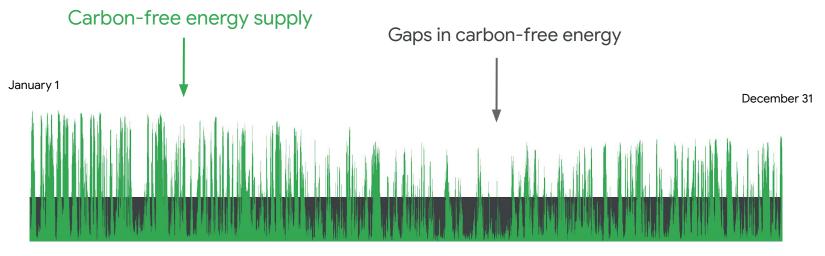
In September 2020, we announced our goal to to run our business on carbon-free energy everywhere, at all times, at all of our data centers and campuses around the world, by 2030.

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



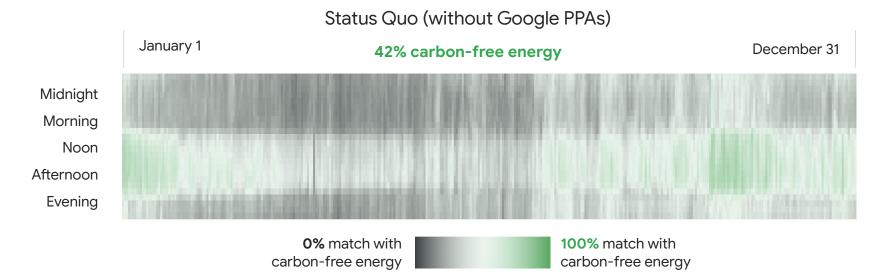
100% Renewable Energy still relies on fuel-based electricity



data center hour by hour

Scenario: every hour of electricity use at Chile data center

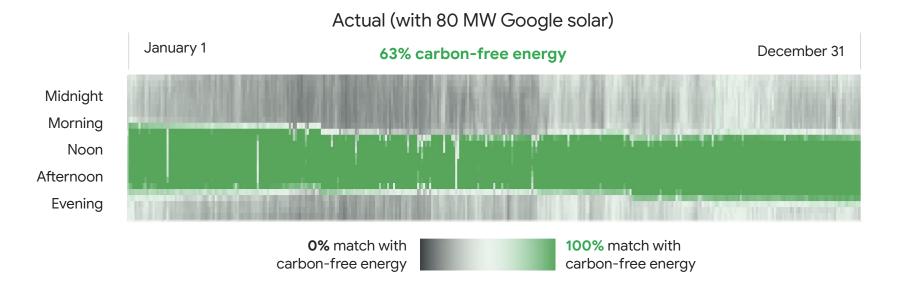
Without solar and wind PPAs, less than half our energy use in Chile would be matched with carbon-free sources on an hourly basis





Actual: every hour of electricity use at Chile data center

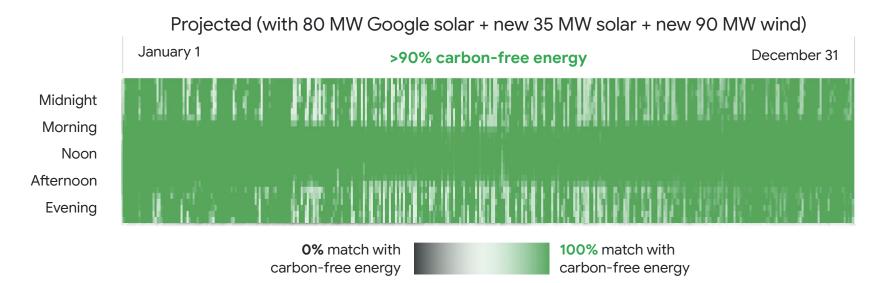
Google's first solar PPA in Chile significantly increased our data center's carbon-free matching



Google

Projected: every hour of electricity use at Chile data center

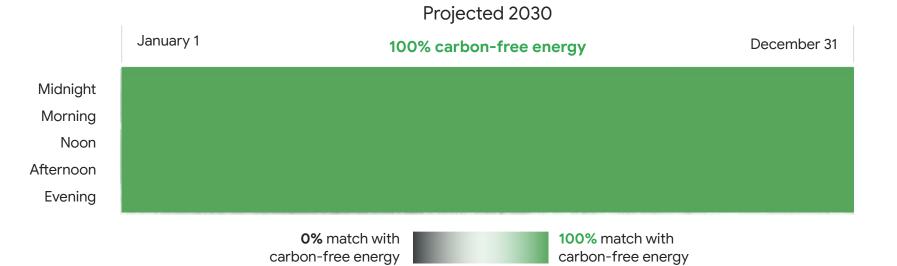
A new solar + wind PPA will fill in the gaps, enabling us to match almost 100% of our electricity use with carbon-free resources on an hourly basis



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)

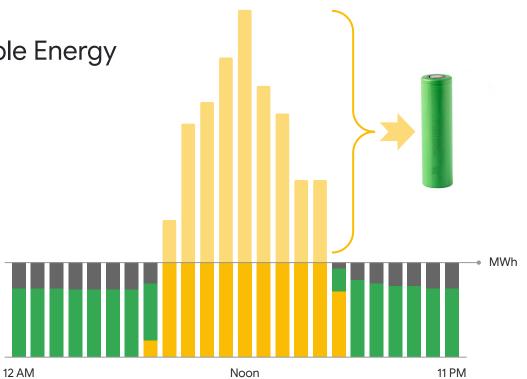




Using batteries with Renewable Energy

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



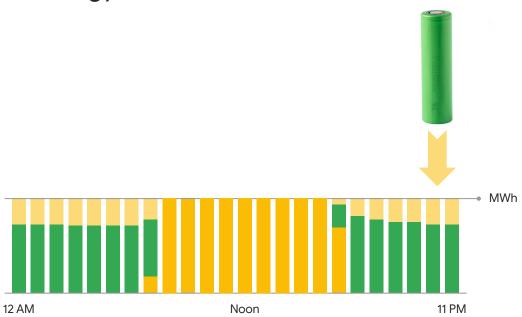




Using batteries with Renewable Energy

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







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.

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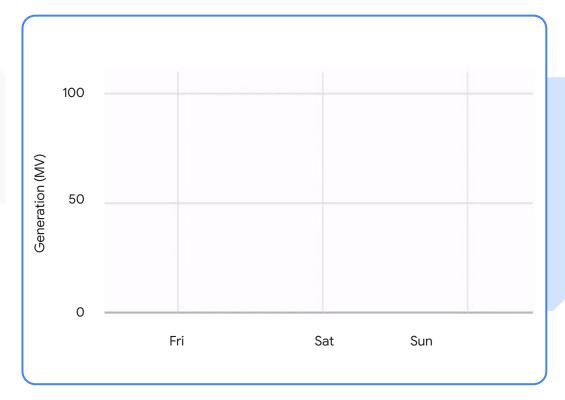
Next-gen technology

First-of-its-kind energy deal

The DeepMind system uses a neural network to predict wind power output <u>36 hours</u> ahead

Predicted

Actual



Finland 91% lowa 97% Netherlands Denmark Ohio 89% 53% 67% Oklahoma 88% Tennessee Oregon 88% Ireland 68% 46% Belgium Virginia Nevada 67% 21% North Carolina 65% Texas 40% In 2021, Google reached 66% Alabama South Carolina 68% 25% carbon-free energy globally on an hourly basis. Georgia 42% In the same year, five of our 100% match with How to read clocks (example) carbon-free energy data centers operated at or near 90%. MIDNIGHT Taiwan Chile 69% 06:00 18:00 Singapore 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, +



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 <u>water stewardship targe</u>t 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:

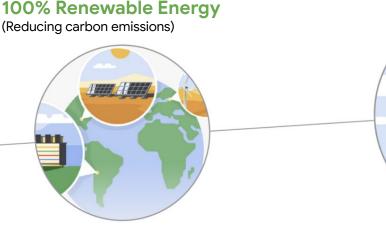
- 1. Enhancing our stewardship of water resources across Google office campuses and data centers,
- 2. **Replenishing our water use** and improving watershed health and ecosystems in water-stressed communities, and
- 3. Sharing technology and tools that help everyone predict, prevent and recover from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



Google Cloud Environmental Footprint

24/7 CFE - Net Zero - Water RE

(Eliminating carbon emissions and water impact)



Data Centers Energy Efficiency

(Reducing energy consumption and e-waste)



Since 2008

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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: \checkmark Low CO₂



Onattended Projects

Recommendations Enter property name or value Recommendation

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

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				Cal	roon data acri	JSS GCP IE	gions				
				Goo	gle Cloud Region	Location	Google CFE%	Grid carbon intensity (gCO ₂ eq/kWh)	Google Cloud net carbon er		
				asia	reast1	Taiwan	18%	540	0		
					-east2	Hong Kong	·	453	0		
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PRINT 🛨 EXPORT 📑 RELEASE NOTES

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GCP Carbon Footprint

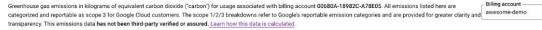
Data broken down by:

- → project
- region
- → product
- → month

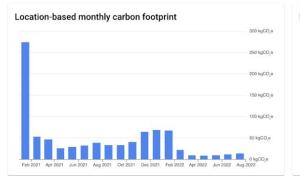
Data export to BigQuery.

Scope 1, Scope 2 location-based, Scope 3

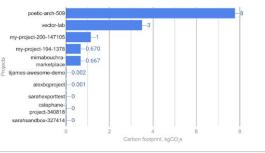
Planned H1'23: Scope 2 market-based + carbon offsets

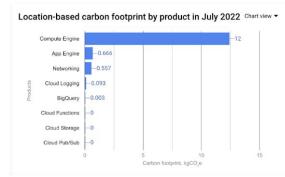


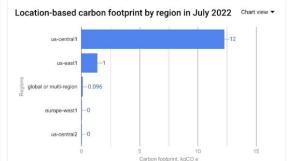
	Yearly carb From August 20	Monthly carbon foot For July 2022	print		
Location-based total: Scope 1: Scope 2 location-based: Scope 3:	921 kgCO ₂ e 0.933 kgCO ₃ e 381 kgCO ₉ e 539 kgCO ₉ e	Net operational emissions: 🕢	0 kgCO ₂ e	Location-based: 17.22% comparing to June 2022	31 kgC0 ₂ e



Location-based carbon footprint by project in July 2022 Chart view -



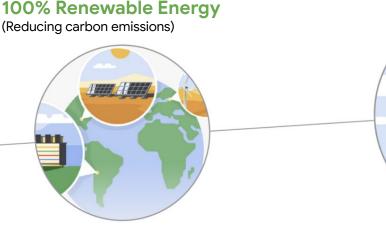




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