

# Google



Google Search

I'm Feeling Lucky

## Products with >1 billion users

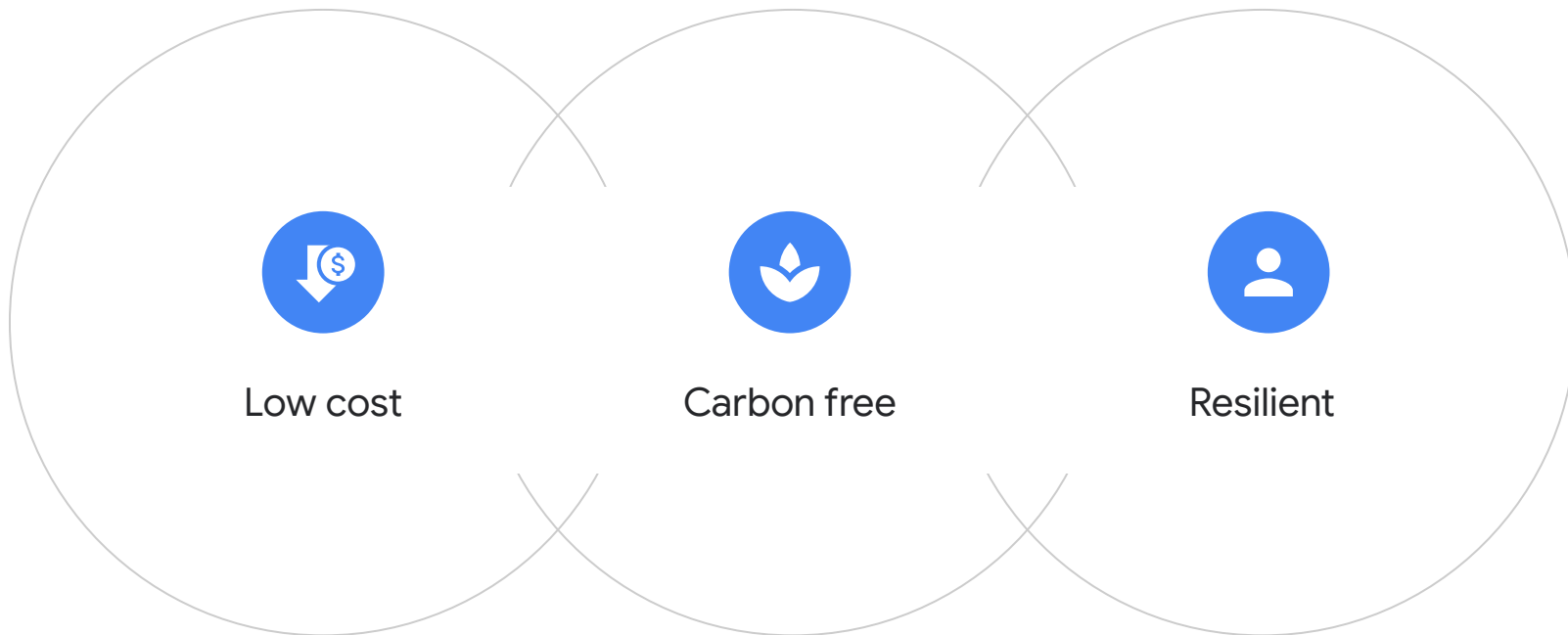


## Electricity fuels data centers

Reliable electricity supply enables us to deliver Google services without interruption



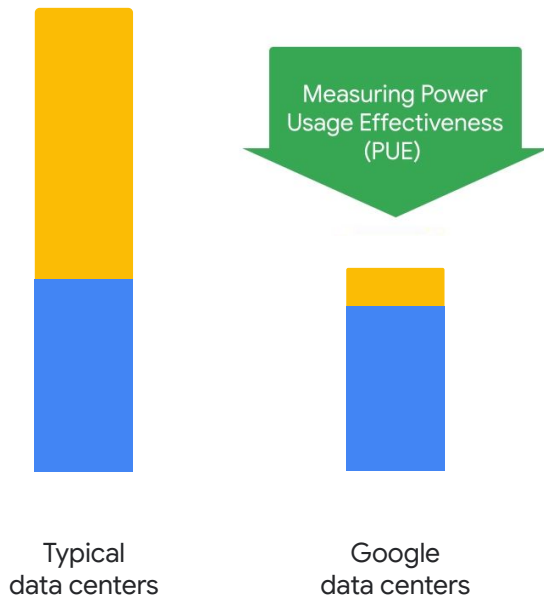
# Our objectives



## Efficiency

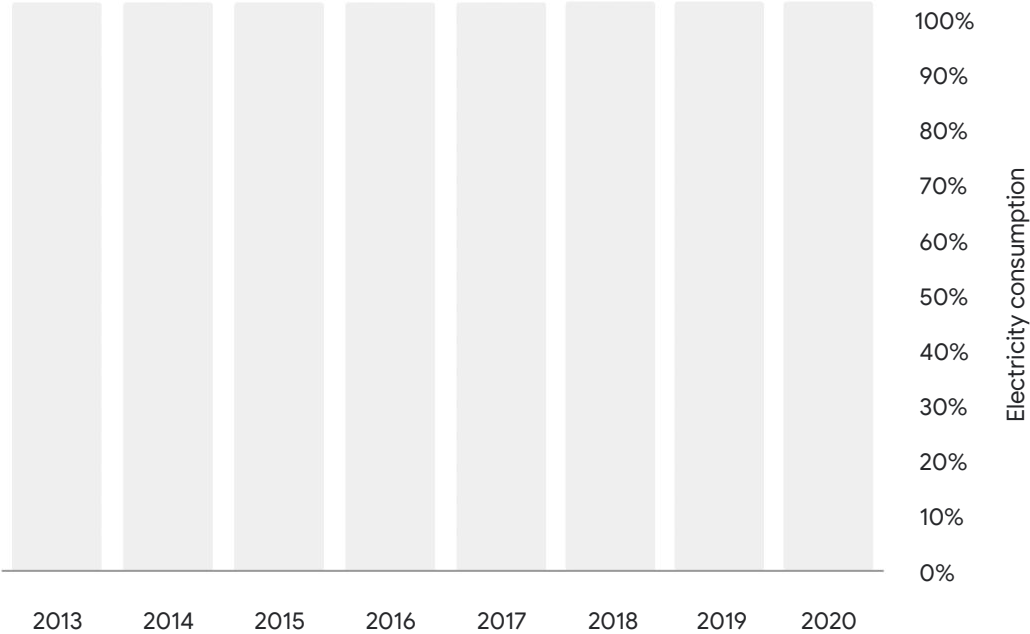
Google data centers are **2X** more energy efficient than a typical data center

● Servers    ● Facilities



# Renewable energy purchasing compared with total electricity use

- Total electricity consumption
- Renewable energy



# Hourly carbon clocks for a September day

100% match with  
carbon-free energy



0% match with  
carbon-free energy

How to read clocks (example)



Chile  
63%

Oregon  
89%



Iowa  
78%



Virginia  
41%



North Carolina  
66%



South Carolina  
19%



Georgia  
26%



Oklahoma  
96%



Tennessee  
55%



Alabama  
55%



Ireland  
42%



Netherlands  
61%



Finland  
77%



Belgium  
68%



Taiwan  
19%



Singapore  
3%

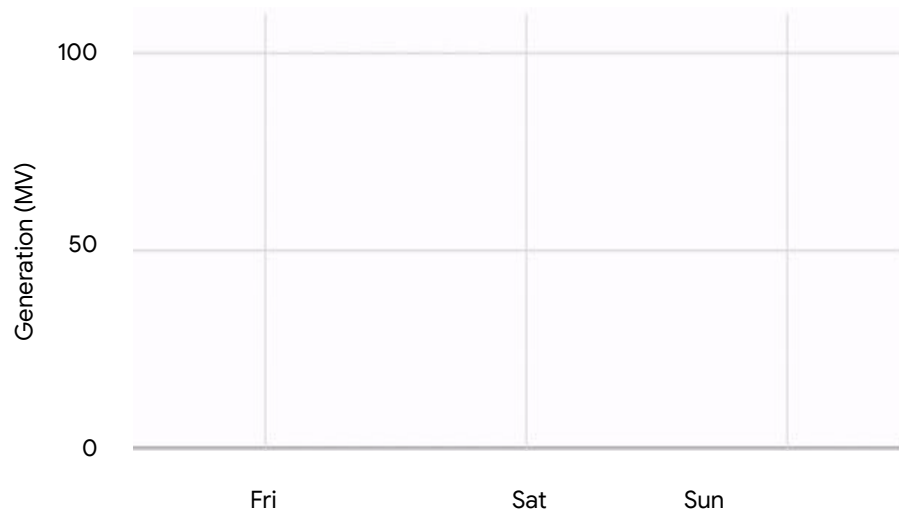


## Technology for renewables

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

● Predicted

● Actual



Cleaner backup power to  
enable 24/7 CFE

## First-ever

battery backup system for  
generator replacement at  
a hyperscale data center

## Flexible capacity

provided to grid, paving the  
way toward a clean energy  
future



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# A timely new approach for certifying carbon-free energy

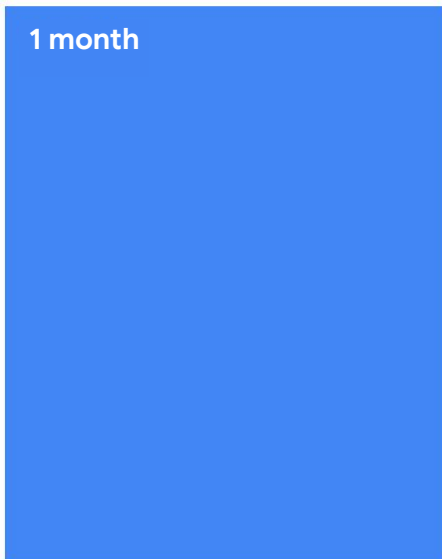
Time-based Energy Attribute Certificates (**T-EACs**) incentivize production exactly when and where it's most needed



Google-contracted  
**wind** production in  
the Midwestern U.S.

**RECs**

1 month



**T-EACs**

Morning

Noon

Evening

Day 01

Day 15

Day 31



Min wind

Max wind

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# Carbon-intelligent load-shifting

Reducing data center carbon footprints by shifting flexible compute tasks to align with greener hours on the grid

## Conventional compute load

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

