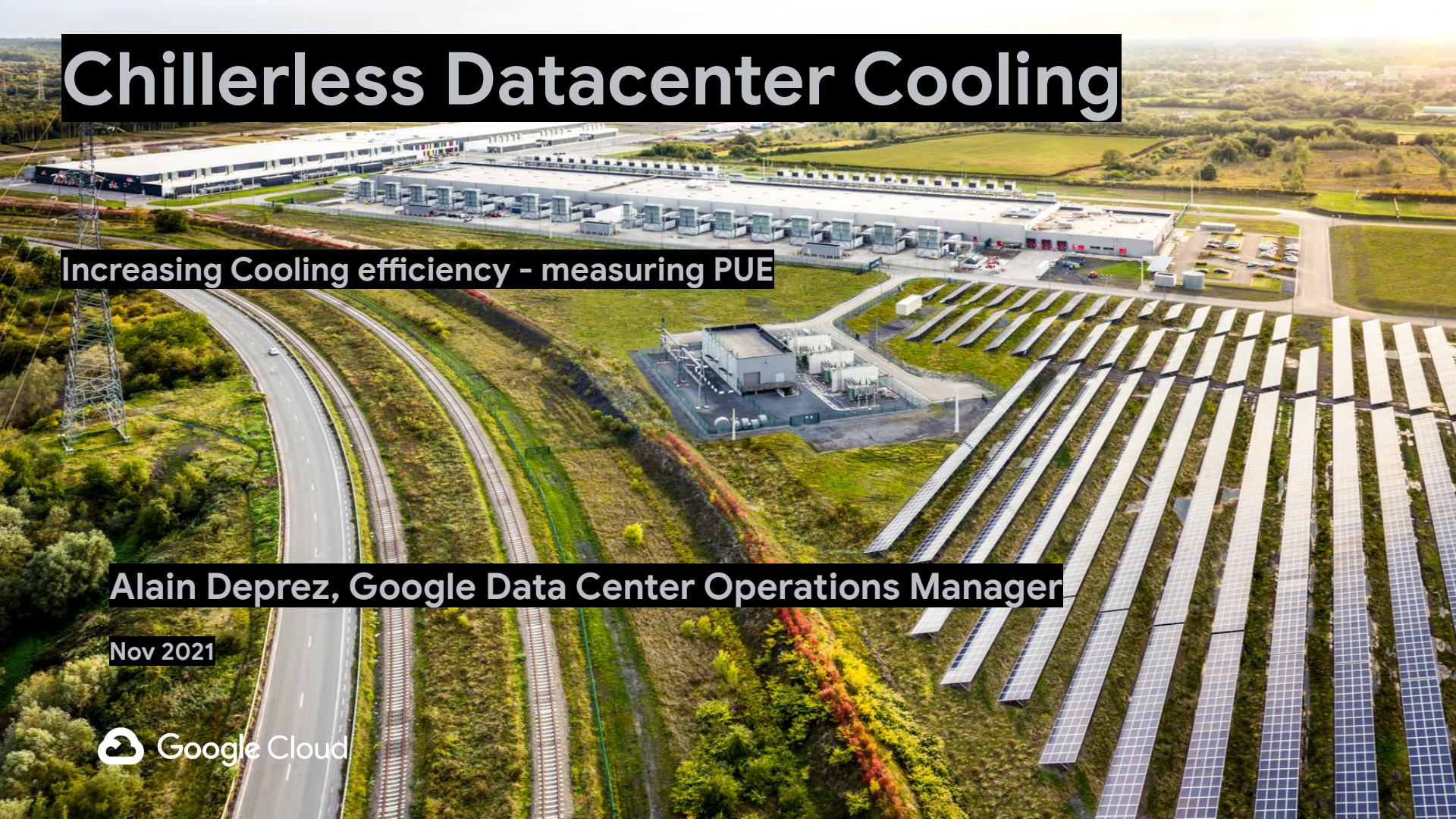
Chillerless Datacenter Cooling



Increasing Cooling efficiency - measuring PUE

Alain Deprez, Google Data Center Operations Manager

Nov 2021

Google Cloud

Google Search I'm Feeling Lucky

It all runs in our data centers

Google Cloud

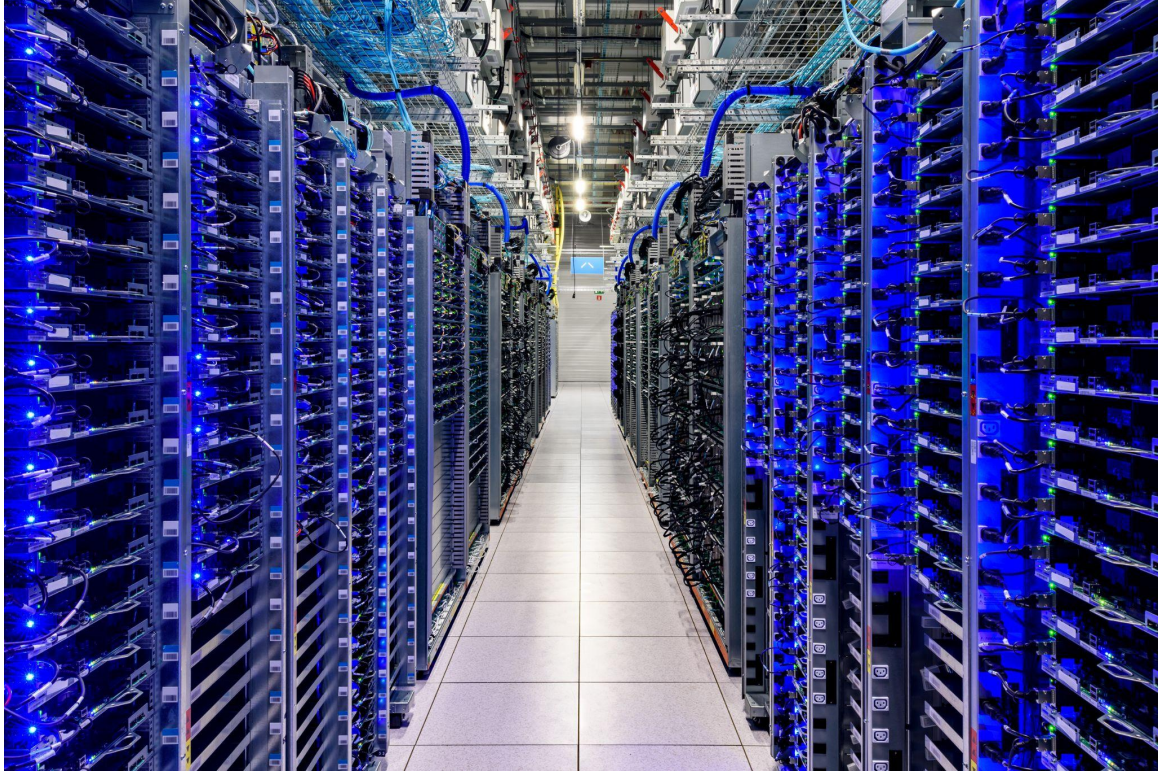

Google

Datacenters and cooling

Server power is converted into heat

Servers need to be in temperature range to keep their performance

Datacenters need cooling.



Google Cloud

Different ways to perform Datacenter cooling

1. Air cooled systems
2. Direct expansion refrigeration systems
3. Air-Water coils with water loop and chillers
4. Air-Water coils with water loop using cooling towers
5. Air-Water coils includes water loop using sea water
6. Air-Water coils with dry coolers

Google Cloud

How to select a suitable cooling system?

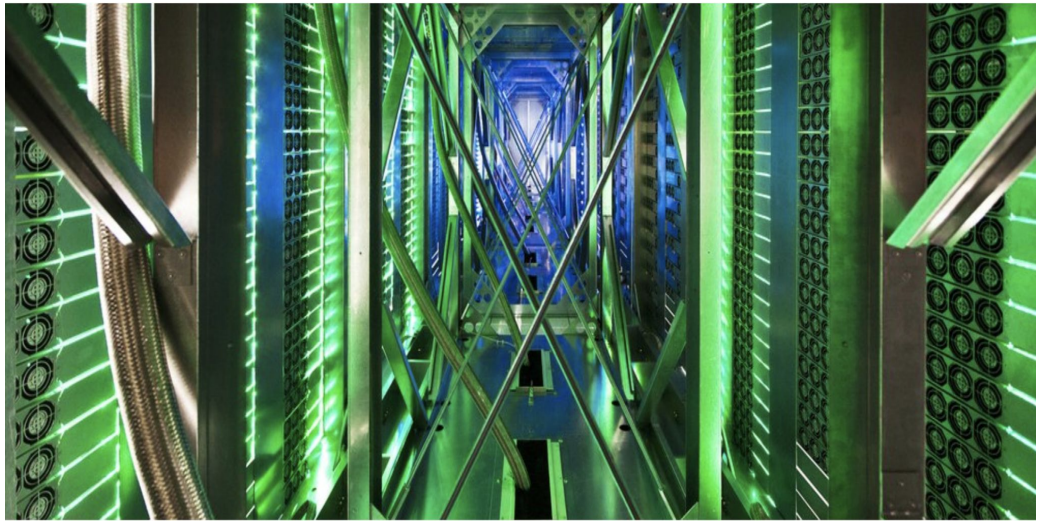
“There’s no one-size-fits-all model at Google. Each data center is designed for highest performance and efficiency for that specific location. We don’t rest on our laurels.” (Joe Kava)

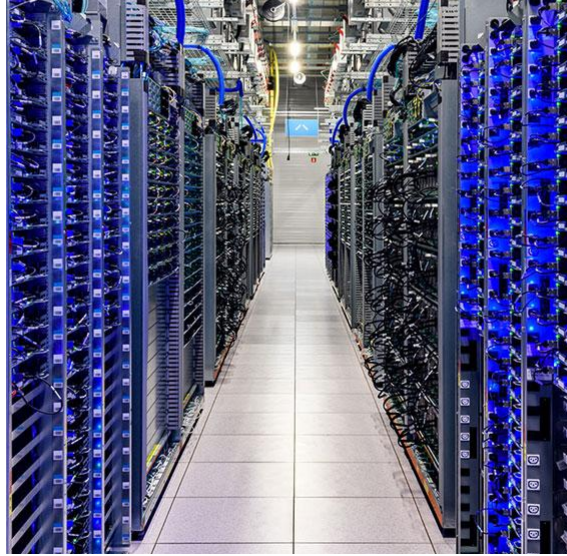
- Define an acceptable temperature range
- Compare with local dry bulb temperature historical records

Google Cloud

How to select a suitable cooling system?

- Define the number of hours you can be above the range
- Select you cooling system
- Datacenter specific: Apply best practice to segregate Cold and Hot aisles (picture shows the hot aisle)



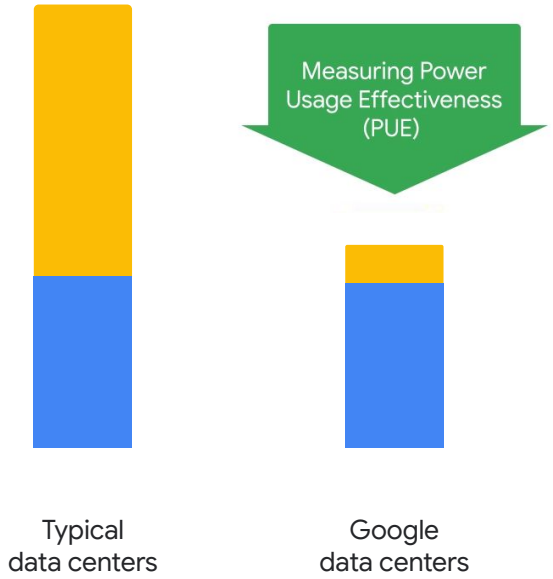


Why Saint-Ghislain datacenter is energy efficient?

1. Efficiency by design of the DC

Google data centers are 2X more energy efficient than a typical data center by specific design

● Servers ● Facilities



1. Efficiency by design of the DC

Choosing the optimal temperature

- “Cold” aisle temperature is 28°C vs. 18/20°C in conventional DC
- We design and build our own servers
- Chillerless cooling in Saint Ghislain

2. Efficiency by continuous power monitoring

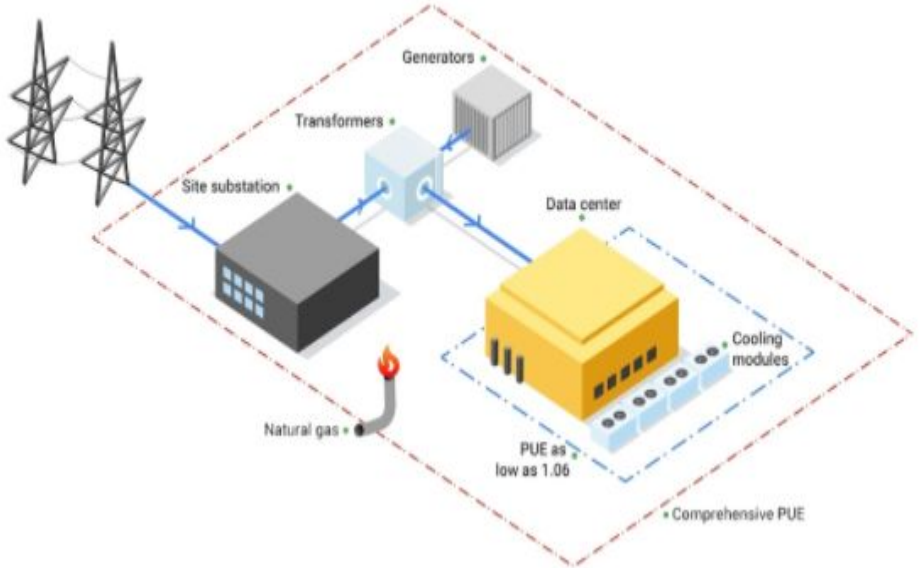
Everything is monitored 24/7 and weekly assessed by the team

Measuring power consumptions enables to measure effectiveness

PUE = Total power / IT power

Total power: at the main substation

Server power: at the server power supply

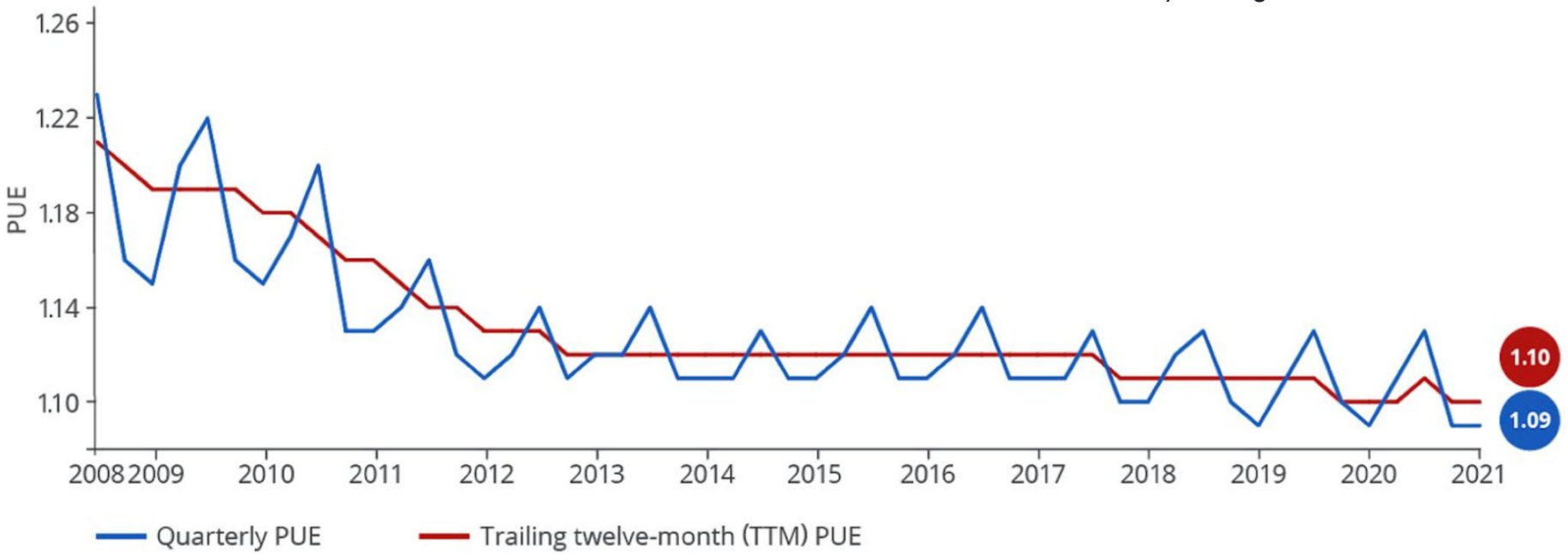


Google

Continuous PUE Improvement

Average PUE for all data centers

Industry average PUE: **1.67**



Source: Google Environmental Report

Google

3. Efficiency by innovation in DC operation

Google applied machine learning to cooling system operations.

As you would expect with an ML-based system, we see continuous improvement as the model learns more about the DC's behavior.

Google's machine learning enables the analysis of massive amounts of operational data center data to create actionable recommendations and automated controls -- leading to a 30% reduction in energy consumed..

Fully automated ML control improves plant efficiency by 30%

Google

4. Efficiency by equipment maintenance

Ensuring optimal heat transfer: q= m x c x Δt

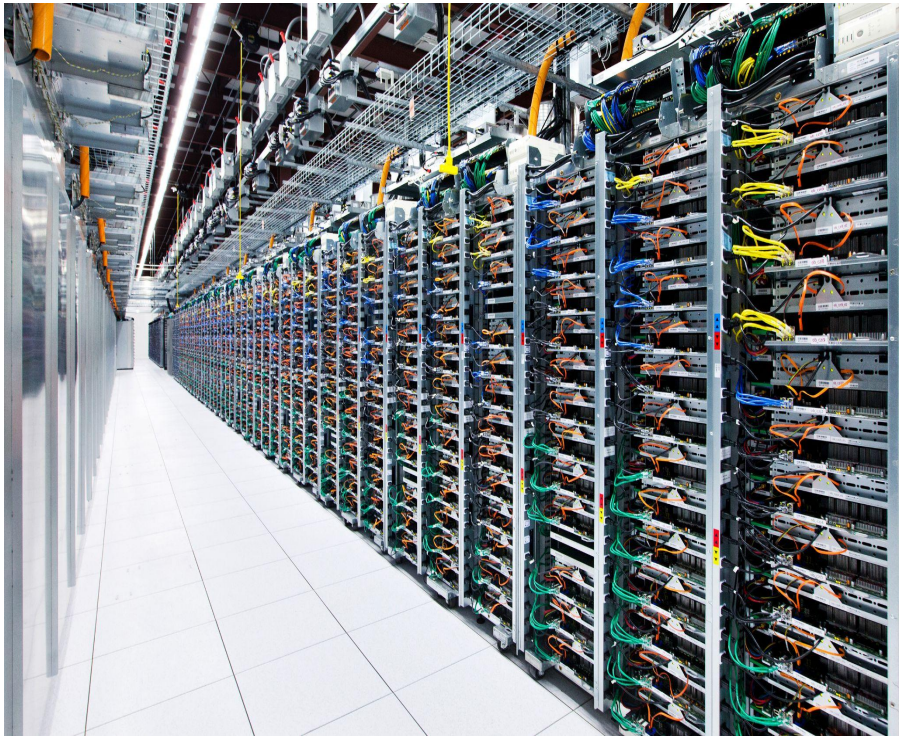
Ensure highest Δt !

Cold/hot aisle segregation =no air by-pass

Manage change configuration (blanking panels)

Heat exchanger monitoring (pressure differential)

Cooling tower monitoring (water chemistry)



Google

5. Efficiency by continuous improvement - Branch agreement

Google joined the branch agreement which allowed to identify some areas of improvements but also setting a framework and annual reporting to asses progresses.

A few examples of projects which allowed energy consumption reduction:

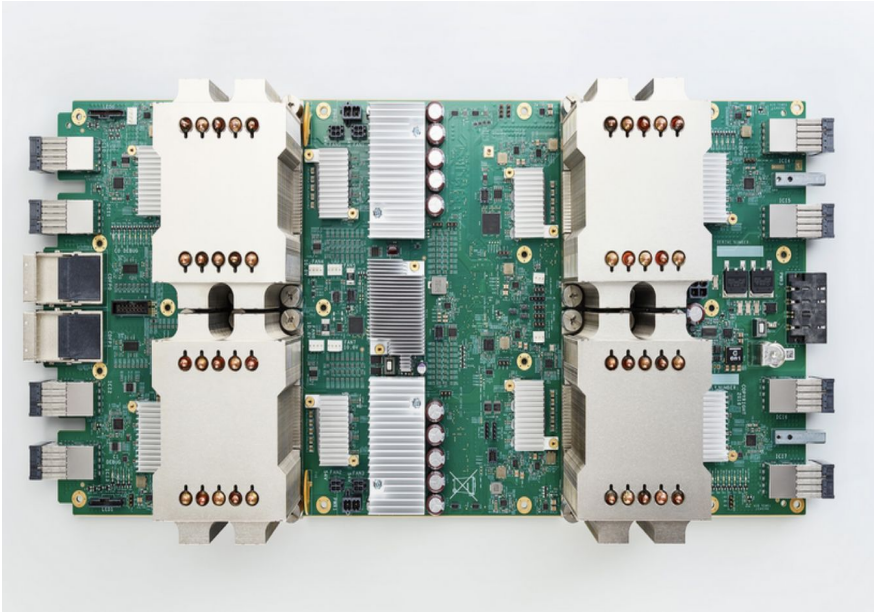
- Campus wide LED lighting
- Highly efficient Air handling unit & fans replacement
- Stand-by generators temperature setpoints changes
- PV farm
- ....

5. Efficiency by improvement of the IT infrastructure

Compared with five years ago, we now deliver around **seven times** as much computing power with the same amount of electrical power.

Essentially, we're getting a lot more searches, Gmail, and YouTube videos out of the same amount of energy.

Much of this improvement has come from innovations with accelerators, such as our Tensor Processing Units (TPUs) — highly efficient chips that we designed specifically for machine learning applications.



google.com/datacenters

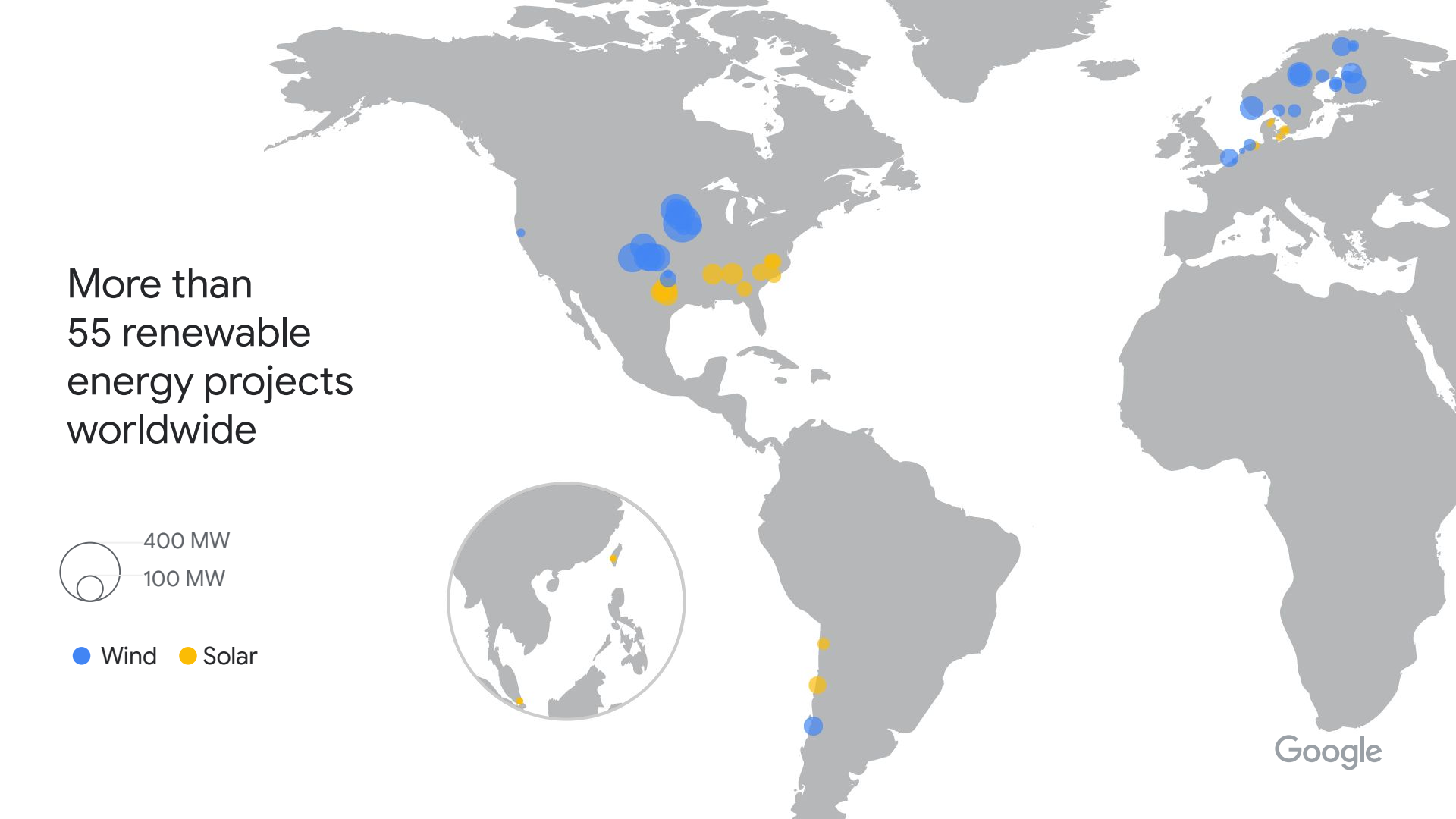
Listen to Google's
6-episode podcast about data centers
to learn more. 🎧 → **goo.gle/WTIL**

Other useful links:

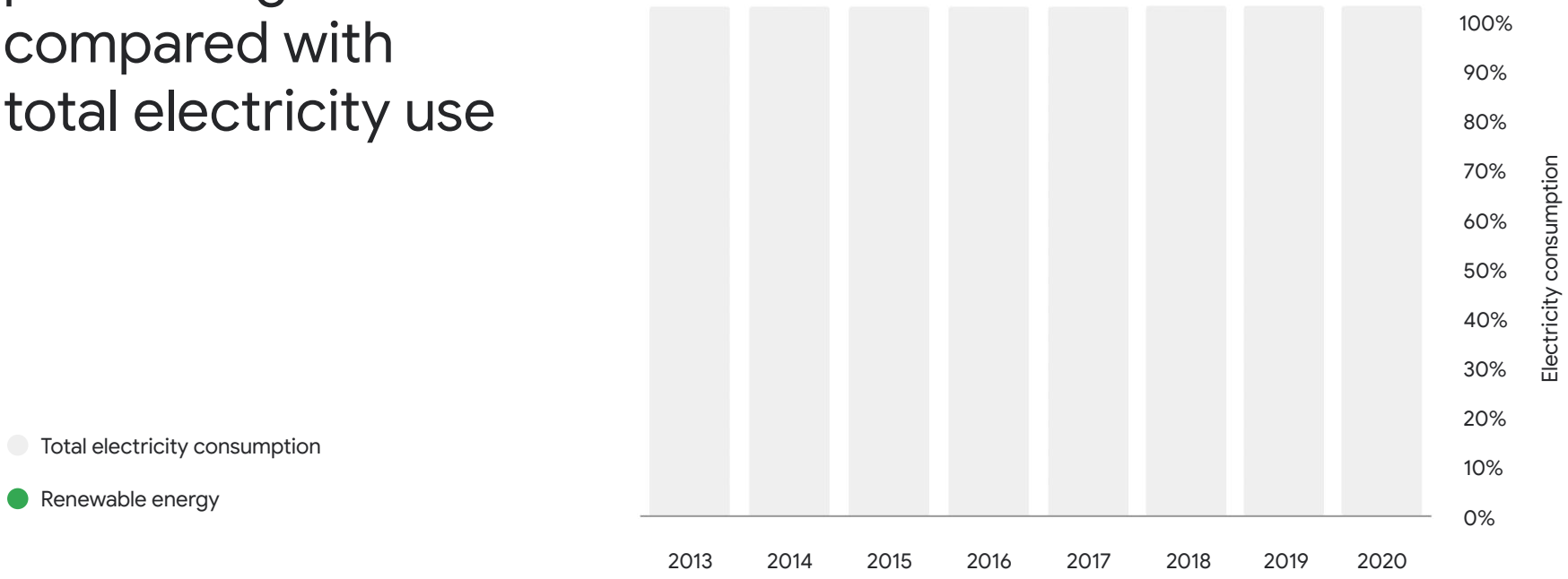
https://www.google.com/intl/it_ALL/about/datacenters/best-practices.html
https://www.google.com/about/datacenters/efficiency/
https://www.google.com/about/datacenters/innovations/

BACKUP SLIDES


Sustainability
is built in


More than
55 renewable
energy projects
worldwide
400 MW
100 MW
Wind
Solar
Google

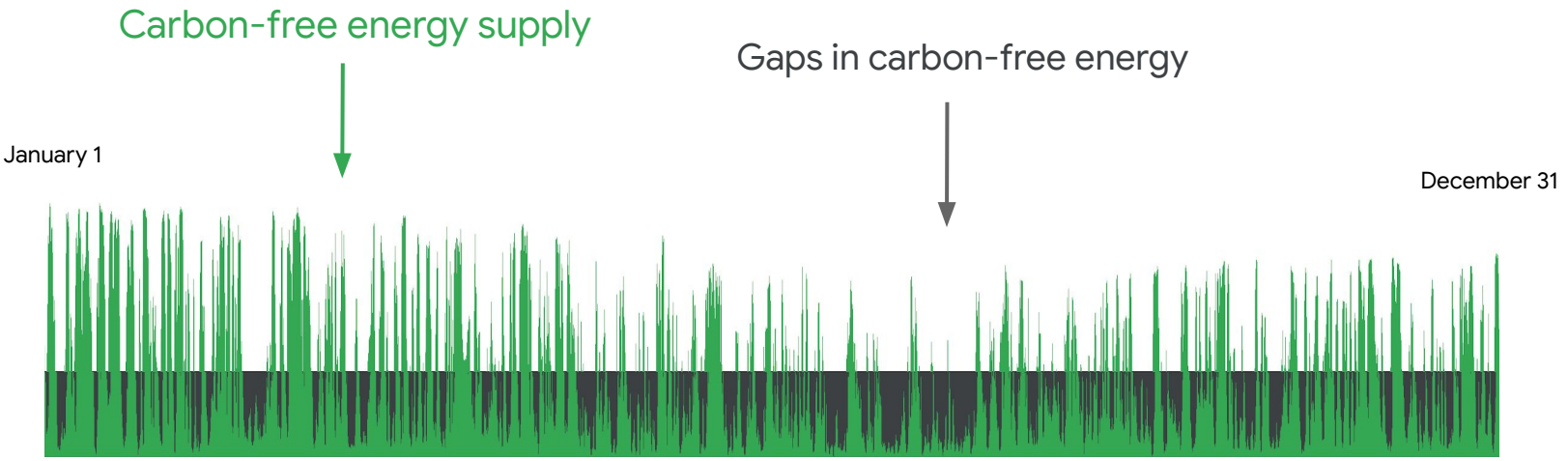
Renewable energy purchasing compared with total electricity use



Google

...but 100% RE does not fundamentally solve the problem

Due do the variability associated with renewables, we still rely heavily on coal and gas from the grid during periods of low wind or solar



Iowa data center hour by hour (2018)

Google’s energy journey

Carbon Neutrality

(Offsetting emissions)

Since 2007

Google has purchased enough high-quality carbon offsets and renewable energy to bring our net operational emissions to zero.

100% Renewable Energy

(Reducing emissions)

Since 2017

Google has matched its global, annual electricity use with wind and solar purchases. However, our facilities still rely on carbon-based power in some places and times.

24/7 Carbon-free Energy

(Eliminating emissions)

By 2030

Google intends to match its operational electricity use with nearby (on the same regional grid) carbon-free energy sources in every hour of every year.

Key strategies

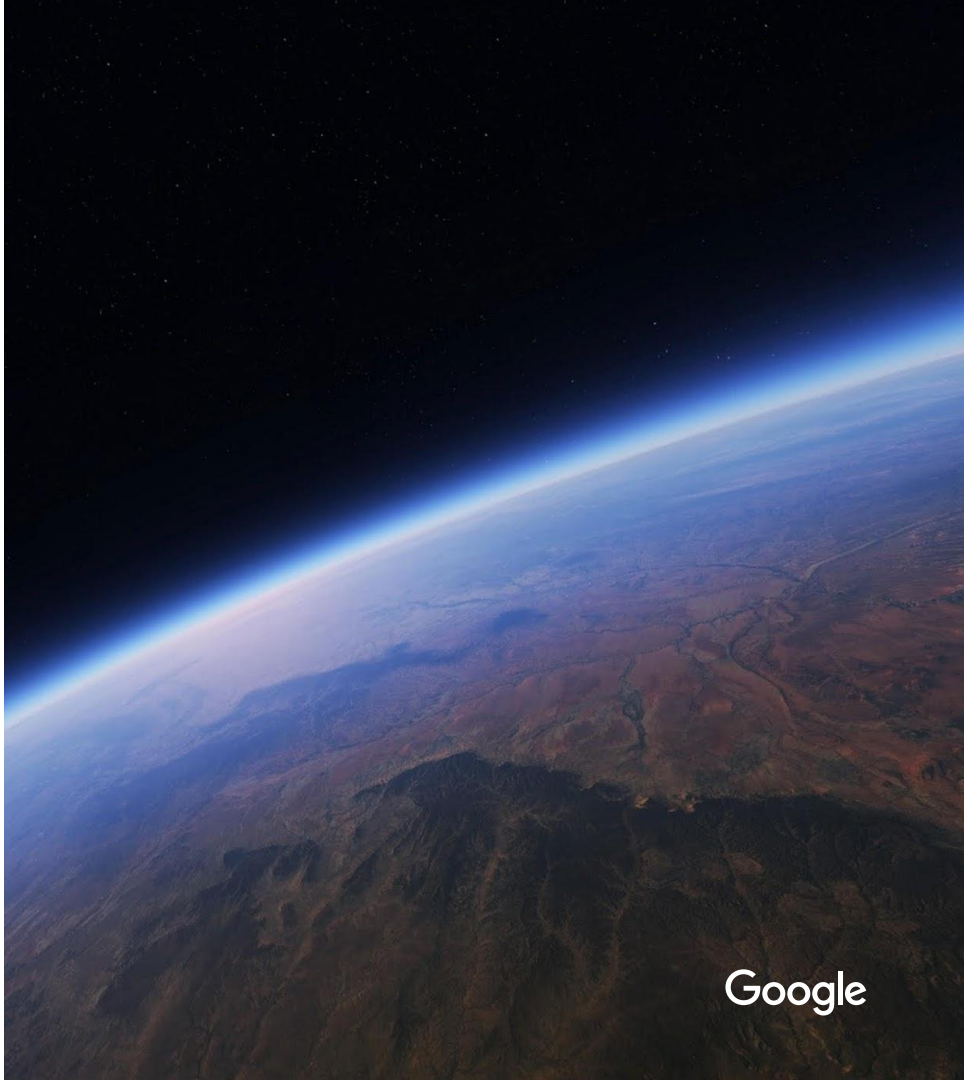
Moving toward 24/7 clean energy

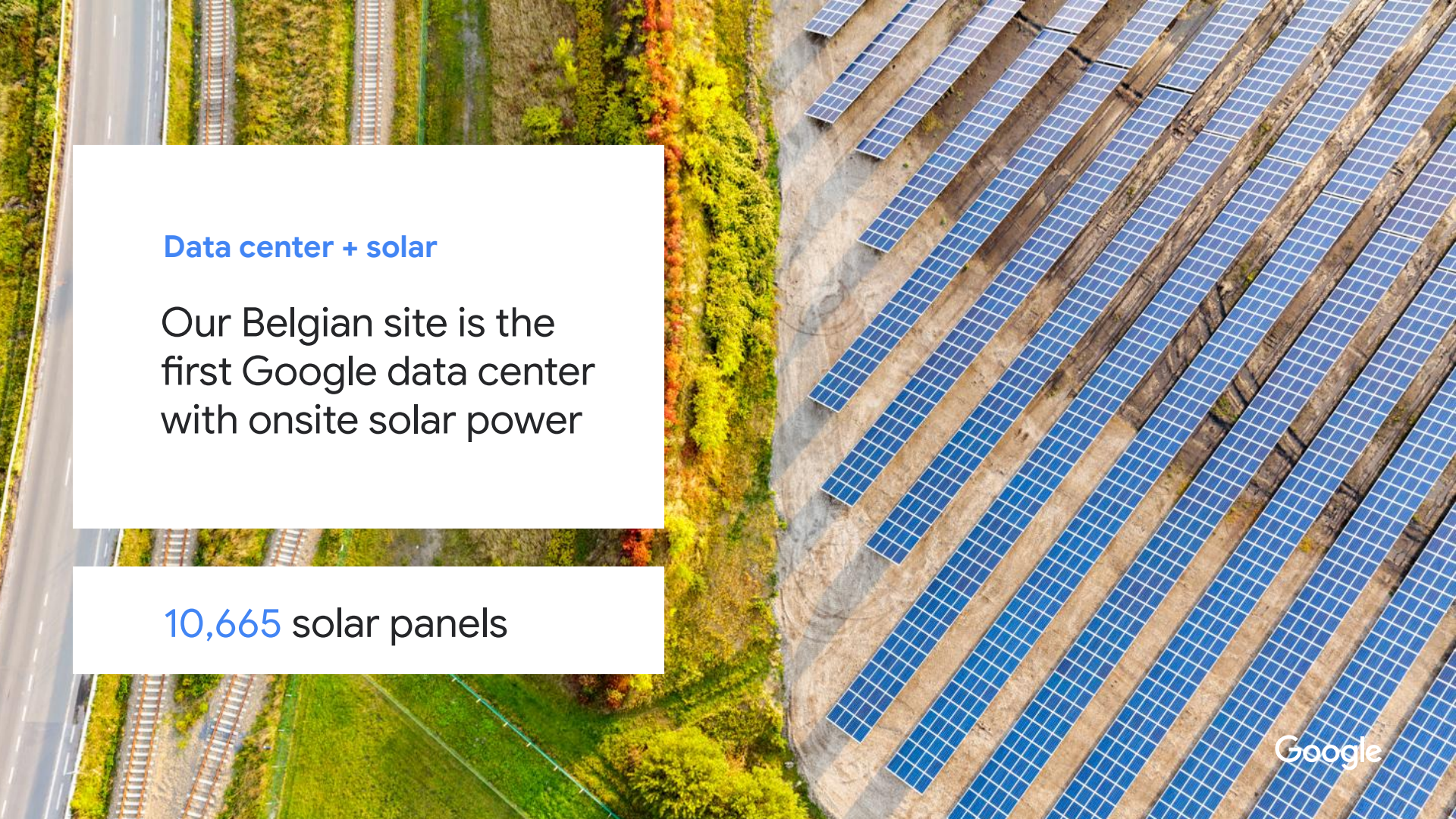
Purchase multiple types of renewables in more regions

Employ technologies to improve the economics and performance of existing renewables

Explore next-generation carbon-free energy technologies

Remove policy barriers





Data center + solar

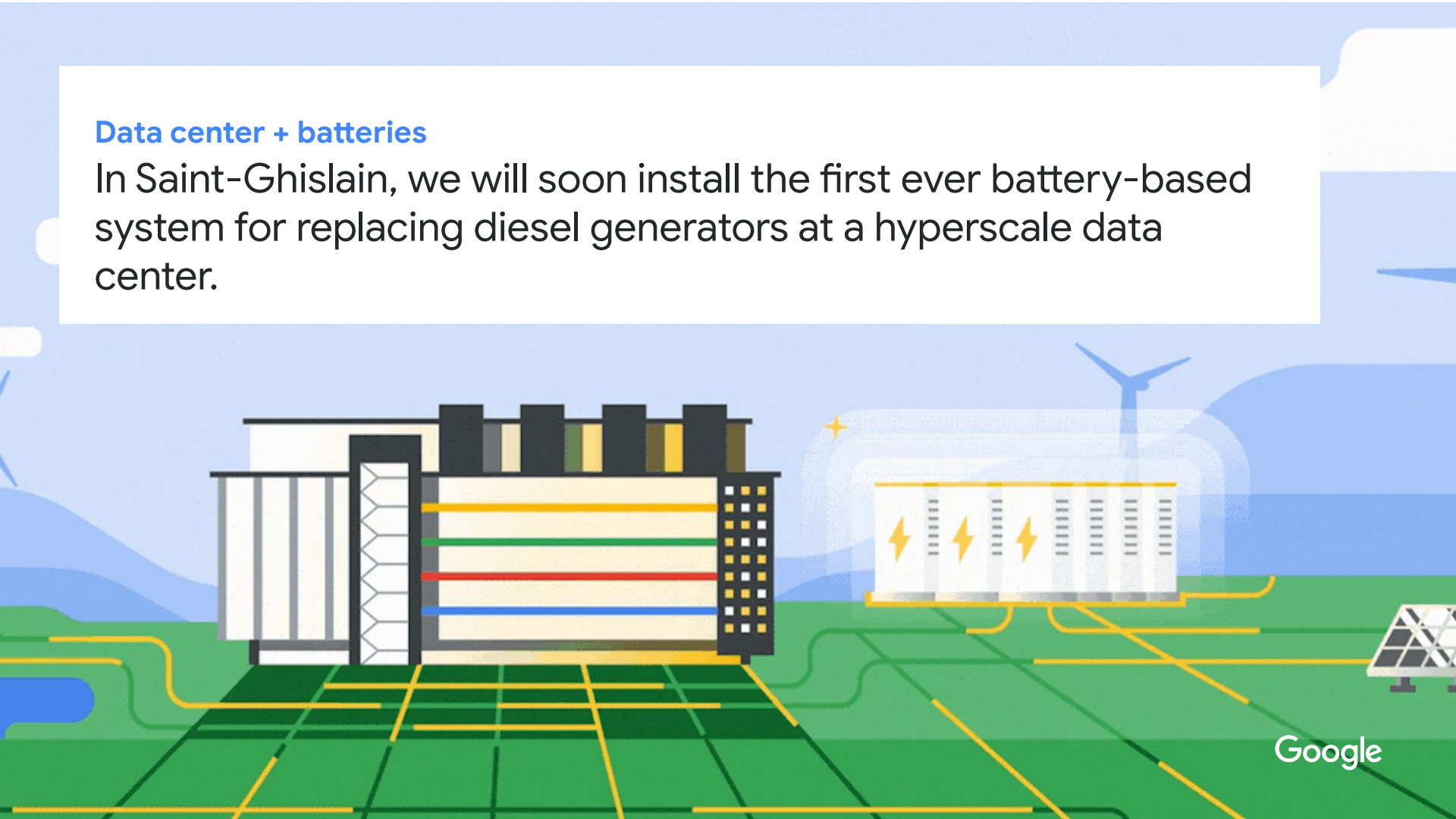
Our Belgian site is the first Google data center with onsite solar power

10,665 solar panels

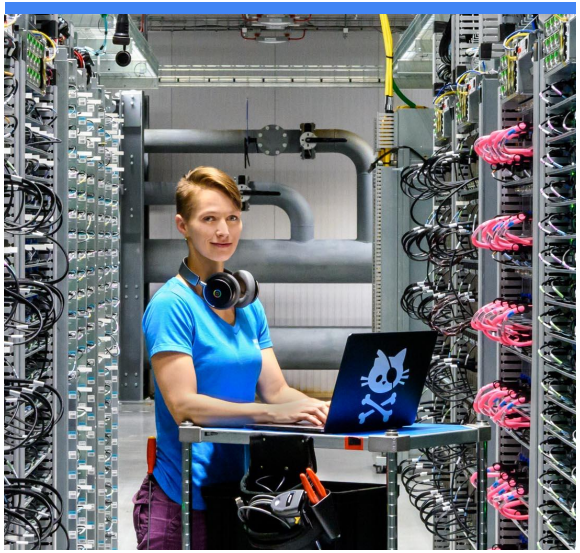
Google

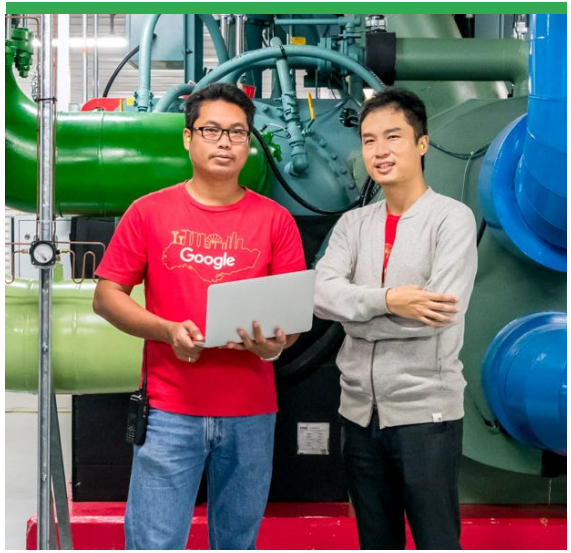
Data center + batteries

In Saint-Ghislain, we will soon install the first ever battery-based system for replacing diesel generators at a hyperscale data center.



Our sustainable future





Google Cloud