Daily sea surface temperature

SST World (60S–60N)

Proportion of solar and wind generation needs to rise dramatically

The “Duck Curve”

Net load - March 31

Source: California ISO
The “Duck Curve”

Average energy prices by region – Q1 2023

Average NEM energy prices by time of day – Q1 2023 vs Q1 2022

Source: AEMO, 2023. Quarterly Energy Dynamics Q1 2023
Growth in solar PV generation is driving wholesale prices negative

Occurrence of Victorian negative or zero prices by time of day – Q1 2023 and Q1 2022

Source: AEMO, 2023. Quarterly Energy Dynamics Q1 2023
Emerging correlation between carbon intensity and price (South Australia)

Period: 1 May 2021 to 12 Dec 2022; $r = 0.523$

Source: Buildings Alive
Most reporting of emissions from electricity use is misleading – South Australia
Most reporting of emissions from electricity use is misleading - Victoria
Carbon intensity varies depending on renewable generation sources

Poland (some wind)

California (solar)

South Australia (wind & solar)

Ireland (wind)

Source: Buildings Alive
Commercial building consumption profile vs emissions profile

Source: Buildings Alive
EE + DR = “Active efficiency” and GHG reductions

Forecast GHG emissions: 6,370 kg CO₂-eq (grid)
Demand reduction: 175 kVA
Measured GHG emissions: 5,350 kg CO₂-eq (grid)
GHG saving: 16%

Demand response, 17th Jan 2022: At 8:00am, the global setpoint was changed to 22.0°C. This was increased to 24.5°C at 1:45pm. The setpoint was reset to the normal summer setpoint (23.0°C) at the end of the day.

The plot on the left shows the carbon intensity of electricity supplied to Sydney on 17th January, the plot on the right juxtaposes the building onto the South Australian electricity grid, highlighting the emerging emission reduction opportunity.

Measured GHG emissions: 2,022 kg CO₂-eq (grid)
GHG saving: 68%
Renewables only cover part load for this day.

Lots of renewables for 2 days, then several short gaps ~2hrs each.

Excess renewables in the morning, then drop off.

Source: Buildings Alive

Sydney Opera House: Time-sleeved Power Purchase Agreement

Map showing energy consumption with labels:
- May 7 2023
- May 9
- May 11

Graph: Grid import and Ext electricity sources
2. To here

1. Load shifted from here
Monash University – Clayton Microgrid – Wind Supply

Source: Buildings Alive
Monash University – Clayton Microgrid – Wind Supply

Source: Buildings Alive
Monash University – Clayton Microgrid – Victoria Energy Energy Mix

Source: OpenNEM [https://opennem.org.au/energy/vic1/?range=7d&interval=5m](https://opennem.org.au/energy/vic1/?range=7d&interval=5m) captured 16 August 2023

Source: OpenNEM [https://opennem.org.au/energy/vic1/?range=7d&interval=5m](https://opennem.org.au/energy/vic1/?range=7d&interval=5m) captured 16 August 2023
What is the conventional net zero carbon strategy / roadmap?

2025 Net Zero Emissions Contributions (2022 Baseline)

Source: Buildings Alive
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.

Although we matched 100% of our global, annual electricity consumption with renewable energy in 2019, on an hourly basis 61% of all the electricity we used was matched with regional, carbon-free sources.

Source: Google, 2020. 24/7 by 2030: Realizing a carbon-free future
The industry is shifting – more and more corporates want carbon innovation

- Leading tenants are looking for innovation in sustainability – Net Zero emissions
- Carbon management - changing from static, annual calculations to dynamic, hourly accounting
What does a “zero” carbon strategy look like?

Change from static to fine-grained emissions calculation

Emissions trajectory with grid decarbonisation

Wedges show emissions reduction contribution by each strategy

Target is 24/7 carbon free in 2030
What does a “zero” carbon strategy look like?

Winter’s Day – Scope 2 GHG emissions profile

This portfolio’s decarbonization pathway considers: grid real-time GHG intensity; energy efficiency initiatives; DR / flex initiatives; electrification; on-site renewables; off-site renewables; and, on-site storage.

Source: Buildings Alive
Impact of electrification

Electricity Profile - Before / After Electrification - Summer Day

Electricity Profile - Before / After Electrification - Winter Day

Source: Buildings Alive
From net zero to zero
A discussion paper on grid-interactive efficient buildings
1) **Understanding** – Buildings have a huge role to play – 50% electricity, 75% demand
2) **Peak Demand Management** – Save $$ now, prepare for grid-interactive future
3) **Electrification** – combined with flexibility creates $$ and carbon savings
4) **Building Controls** – Prepare for grid-interactivity
5) **Energy-procurement** – understand the market dynamics, emerging opportunities
6) **Thermal Storage** – emerging opportunities
7) **Energy Efficiency is evolving into Carbon Efficiency** – Net-Zero
Thank you!

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