Data centres and energy – from global headlines to local headaches?

George Kamiya, Digital/Energy Analyst
Oskar Kvarnström, Energy Analyst
Commentary — 20 December 2019

Cite Share

Global energy demand for data centres is flat... but how are they impacting local grids?

As the world becomes increasingly digitalised, demand for data centre services is rising rapidly. But huge strides in energy efficiency including a shift to efficient "hyperscale" data centres have helped to limit data centre electricity demand growth globally. At the local level, however, these large hyperscale data centres represent huge electricity demand loads, adding pressure to electricity grids and increasing the challenge of energy transitions, especially in smaller countries.

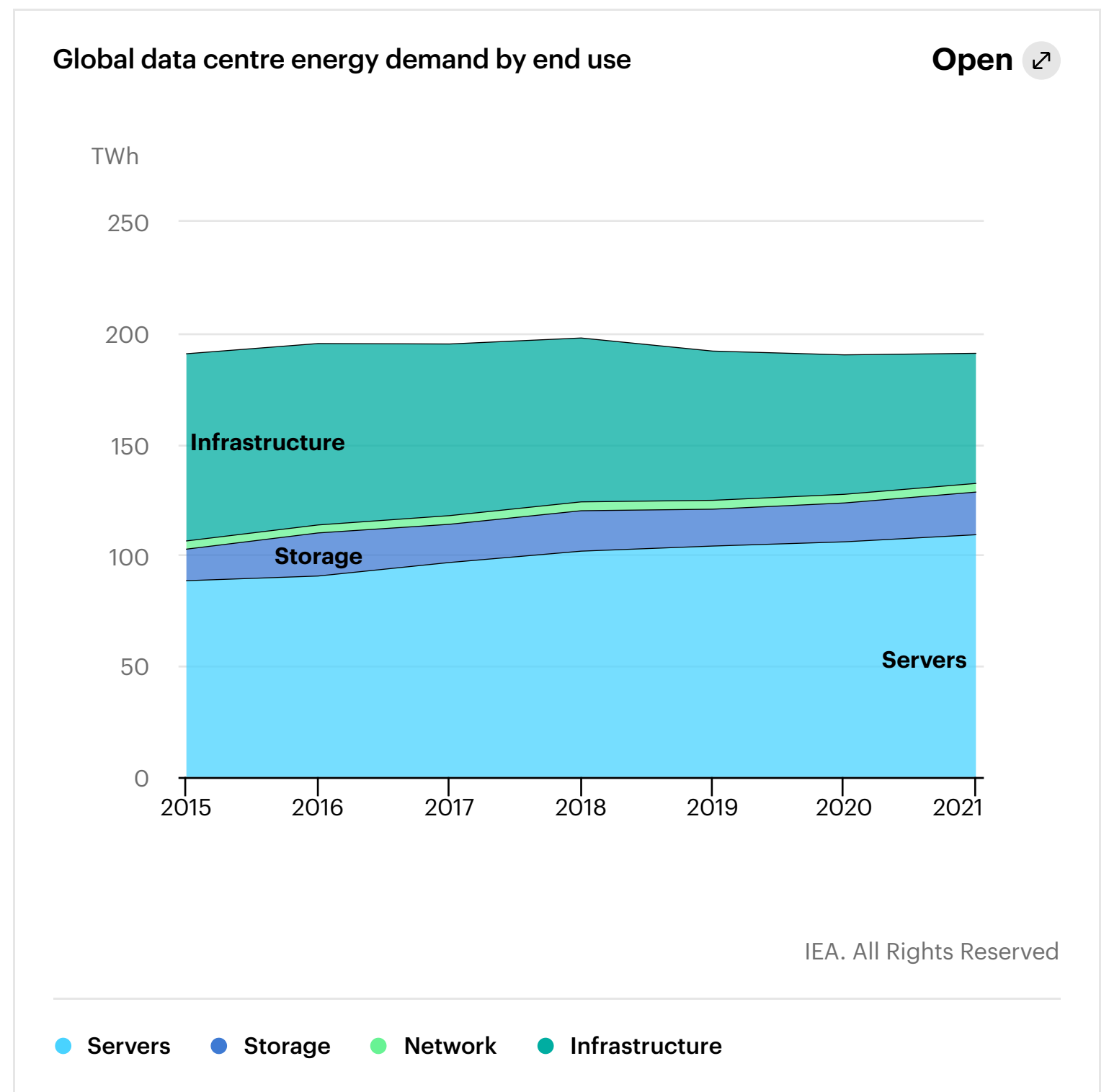
In this commentary, we explore the global and local energy implications of data centres, and discuss how energy policy makers can help ensure that data centre developments contribute to broader energy policy goals.

Does growth in data equal growth in electricity consumption?

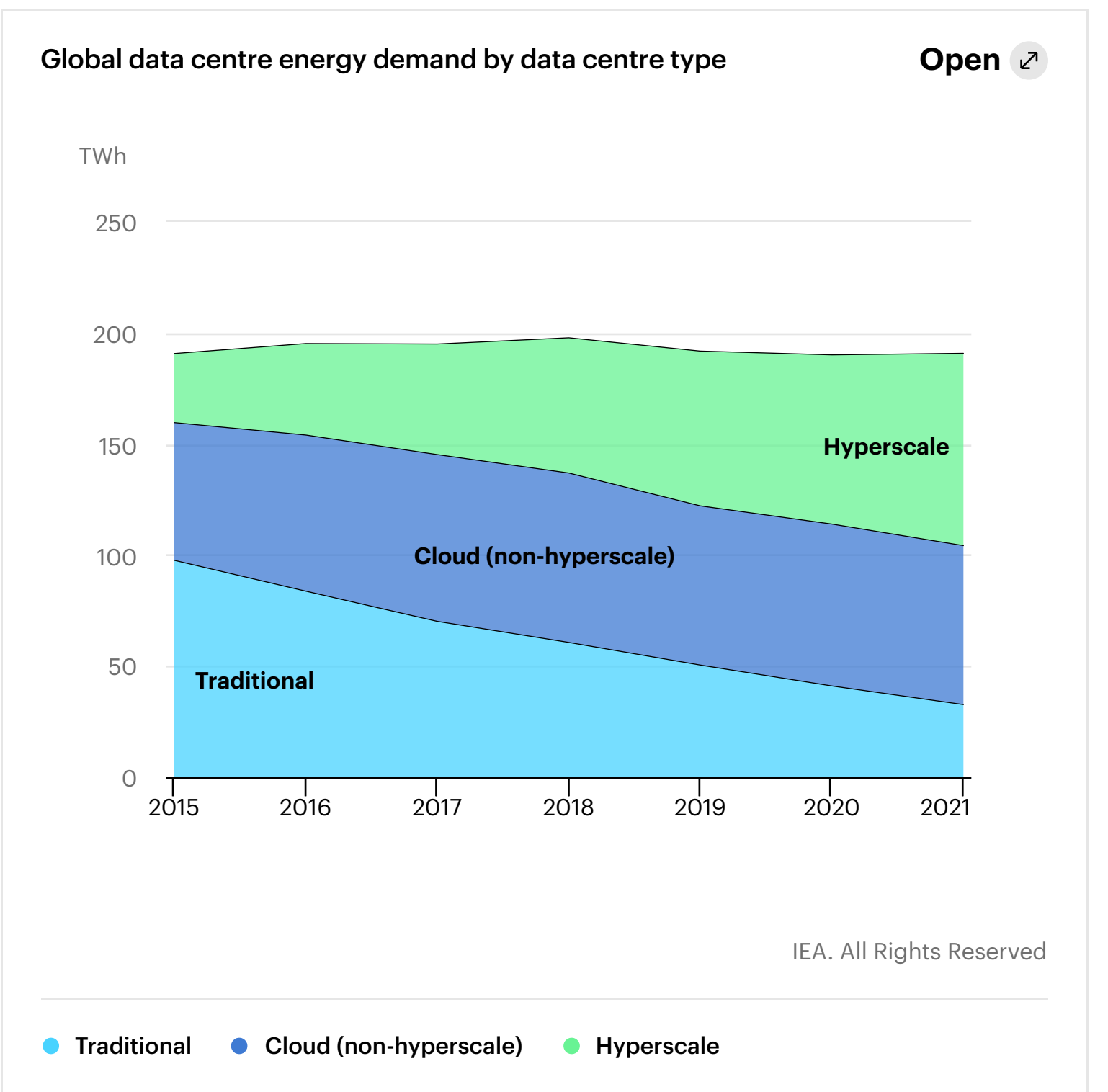
The rapid growth in internet traffic has raised concerns about the energy and climate impacts of data centres, with some media headlines warning that a "'Tsunami of data' could consume one fifth of global electricity by 2025".

Contrary to these alarming headlines, data centres worldwide only consumed around 200 TWh in 2018, or about 1% of global electricity use. Their energy use has been flat since 2015, while global internet traffic tripled and data centre "workloads" (a measure of service demand) more than doubled (Cisco, 2018). Electricity demand from data centres globally is expected to remain flat to 2021, despite a projected 50% increase in data centre workloads.

Increasingly efficient IT hardware and a major shift to hyperscale data centres have helped to keep electricity demand flat, despite exponential growth in demand for data centre services.



Global data centre energy demand by end use



Global data centre energy demand by data centre type

Rapid improvements in the efficiency of servers, storage devices and data centre infrastructure, as well as a shift away from small, inefficient data centres to larger and more efficient cloud and hyperscale data centres have helped to limit electricity demand growth.

Hyperscale data centres in particular are extremely energy efficient, consuming proportionally much less energy for cooling compared to smaller data centres. The number of hyperscale data centres globally is expected to more than double between 2015 (259) and 2021 (628), while their share of all data centre traffic will rise from 34% to 55% (Cisco, 2018).

Where are data centres located?

There are data centres in almost every country around the world, but nearly all hyperscale data centres are located in three regions: North America (46%), Asia Pacific (30%), and Western Europe (19%) (Cisco, 2018). Asia Pacific is the fastest growing region, and is expected to surpass North America as the largest hyperscale data centre market by 2021. Cloud and hyperscale data centre operators have recently announced major expansions in north-western Europe, notably in Ireland and the Nordics.

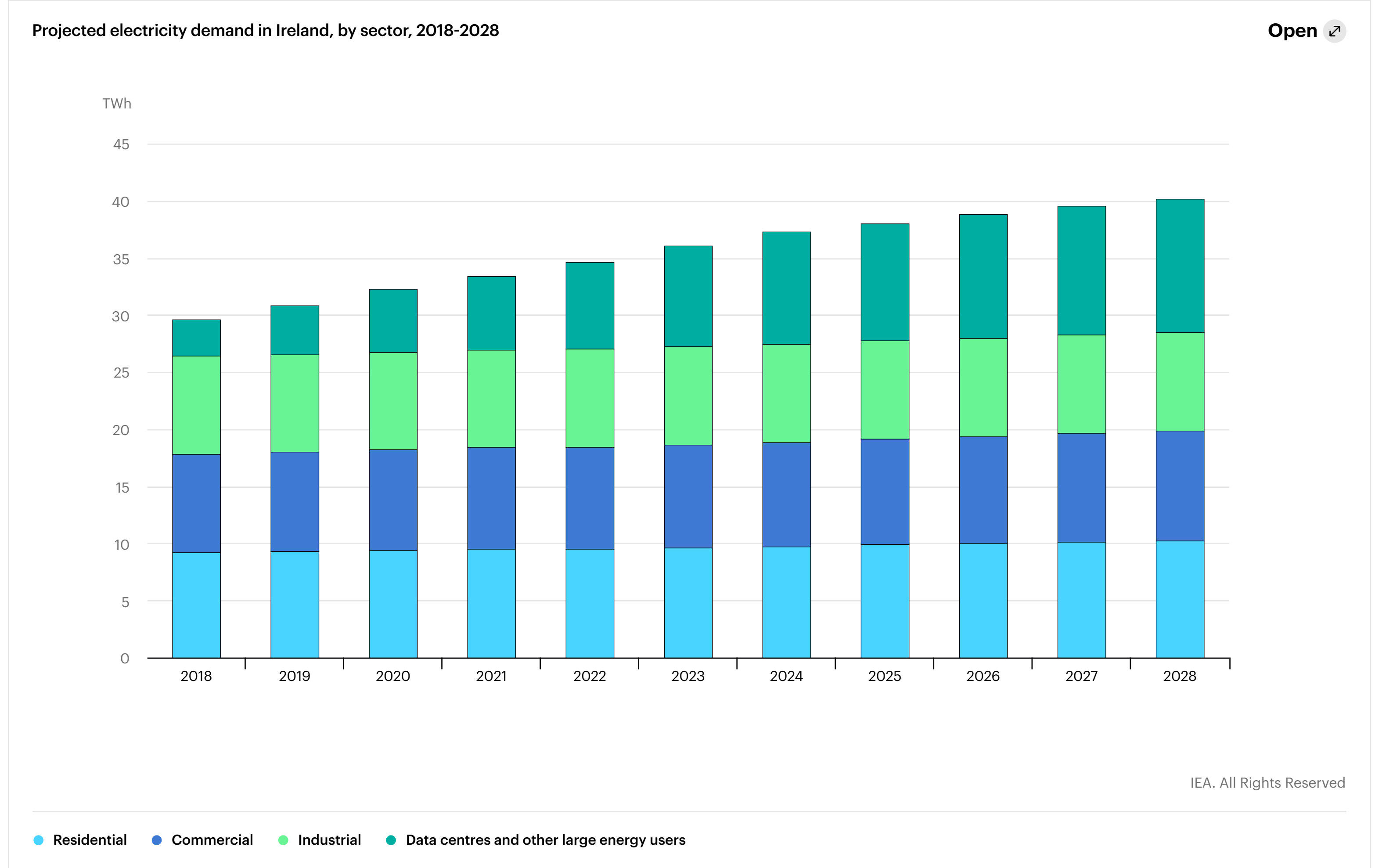
Site selection for large data centres depends on a balance of factors, including:

- Access to a stable supply of cost competitive electricity, preferably from renewable sources.
- Favourable environmental conditions: low risk of natural hazards (e.g. extreme weather, flooding, seismic activity) and cooler climates requiring less energy for cooling.
- Strong connections to data infrastructure and networks.
- Favourable regulatory and market conditions, including proximity to major markets, political stability, and low taxation.

Can local grids cope with the rapid growth in data centres?

Although data centre electricity consumption globally has been flat, new hyperscale data centres can have major impacts on local power grids. A hyperscale data centre can require 100-150 MW of grid capacity and consume hundreds of GWh of electricity annually.

In smaller countries with expanding data centre markets like Denmark and Ireland, data centres are quickly becoming a major source of electricity demand. In Ireland, projections by transmission system operator EirGrid show that electricity demand from data centres and other large energy users could more than double in a decade to account for almost 30% of the country's electricity demand in 2028 (Eirgrid, 2019). In Denmark, data centre electricity consumption is projected to grow from less than 1% today to 15% of total electricity consumption in 2030 (Danish Energy Agency, 2019). However, these projections still have considerable uncertainty, given the potential for new project announcements as well as cancellations.



Projected electricity demand in Ireland, by sector, 2018-2028

For countries in the midst of major energy transitions, adding large volumes of new electricity demand within a decade could add to existing challenges. The sheer size and power demand of hyperscale data centres can also have significant impacts on the local power grid (and potentially other rate payers' electricity bills). Although data centres typically have a flat demand profile, "busy hour" internet traffic (i.e. early evening) is growing more rapidly than at other times of day, raising potential concerns that they could add to peak demand. In addition, large data centres typically expand over time, requiring greater power capacity than what is initially required.

Could data centres become an asset for energy systems?

In some electricity systems, data centres may be able to help balance the system or provide other services. In Ireland, for example, wind accounts for a significant and growing share of electricity generation (28% in 2018). However, much of this wind power is generated at night time when electricity demand is low in the residential and commercial sectors. With steady overnight demand, data centres can absorb excess supply and increase the utilisation of electricity from wind power.

Furthermore, data centres could play an increasingly important role in demand side response. Although they typically have a stable energy demand profile, large data centres are highly automated and monitored, making them potentially more flexible and responsive compared to conventional industrial facilities. Regulation and price signals can help tap into this potential.

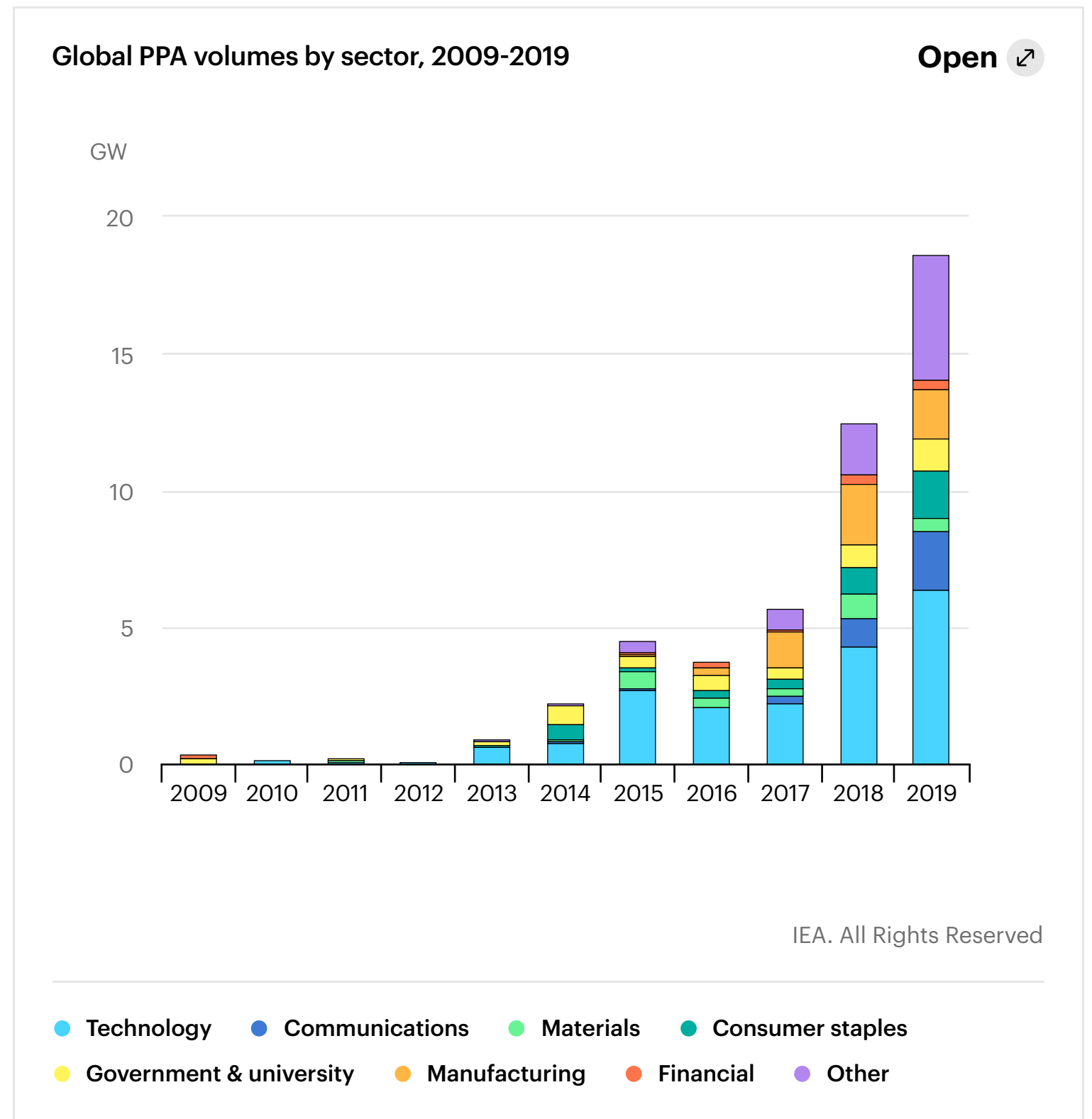
Finally, waste heat from data centres could help to heat nearby commercial and residential buildings, reducing energy use from other sources. Countries with large district heating systems, e.g. Denmark, typically have existing infrastructure that can accommodate this service. Given the high costs of new infrastructure, proximity to users of waste heat is needed to ensure that waste heat is actually used. There are several potential barriers to waste heat utilisation, including taxation on its use, technical challenges of getting sufficiently high temperatures, as well as contractual and legal challenges. For example, data centre operators and district heating suppliers need to work together on how to guarantee the delivery of heat to customers even if a data centre is shut down.

Strong efforts on energy efficiency and initiatives on demand response and waste heat utilisation can help minimise the impacts of large data centres on the grid as well as the environment. Ensuring that data centres are powered with zero-carbon energy sources can help to reduce these impacts further.

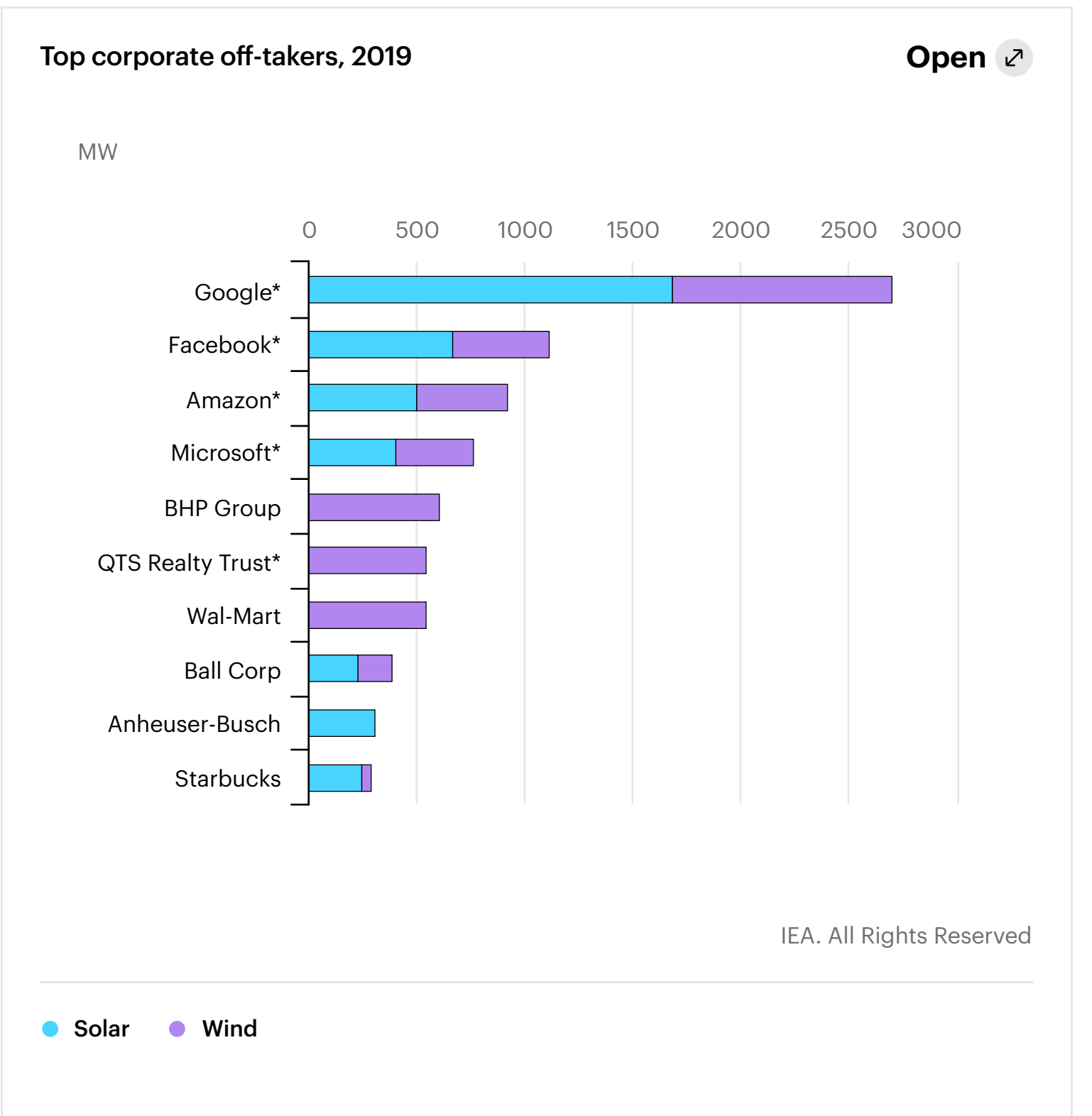
How green is the cloud?

Information and communications technology (ICT) companies are major investors in renewable energy, protecting themselves from volatile power prices, reducing their environmental impact and improving brand reputation. Hyperscale data centre operators in particular are leaders in corporate renewables procurement, particularly through power purchase agreements (PPAs). The top six corporate off-takers of renewables in 2019 (through November) were all ICT companies, led by Google (BloombergNEF, 2019).

ICT companies operating large data centres are leaders in corporate procurement of renewables, accounting for about half of global procurement of renewables in recent years.



Global PPA volumes by sector, 2009-2019



Top corporate off-takers, 2019

In 2018, Google (10 TWh) and Apple (1.3 TWh) purchased or generated enough renewable electricity to match 100% of their data centre energy consumption. Facebook data centres consumed 3.2 TWh in 2018, of which 75% came from renewables. Amazon and Microsoft sourced about half of the data centre electricity from renewables.

While these achievements are impressive, matching 100% of annual demand with renewable energy purchases or certificates does not guarantee that data centres are actually 100% powered by renewable sources *all the time*. Wind and solar are variable sources that may not match the demand profile of a data centre, and renewable energy purchases might be occurring in a different grid or region.

More ambitious approaches to carbon-free procurement and generation can have an even bigger environmental benefit, specifically by accounting for both location and time. Google, for instance, has set a long-term goal to source carbon-free energy on a "truly 24x7 basis". Data centres operators investing in renewable energy, working with electric utilities, regulators, and project developers, should seek to identify projects that maximise benefits for the local grid as well as reducing overall GHG emissions.

How can energy policy help to maximise the benefits of data centres?

Policy makers in key data centre markets should take a proactive approach to the data centre development. Without proper planning and coordination, large data centres risk stressing the local grid. If properly managed, however, data centres can accelerate renewable energy deployment and improve grid integration and flexibility. To maximise the benefits of data centres, policymakers and data centre operators can work together to:

- **Ensure sufficient grid capacity and planning when attracting new data centres.** Initially, this requires improved data collection and understanding around the energy use characteristics of ICT systems including data centres. Governments and grid operators can then work together with data centre operators to encourage siting data centres at optimal locations for the grid and plan for effective grid integration.
- **Encourage energy efficiency and flexibility.** Data centres can be a more efficient and flexible resource on the grid than they are today. Governments can encourage further energy efficiency through guidance, incentives, and standards, while regulations and price signals could help incentivise demand side flexibility.
- **Use data centres as a driver for renewable energy.** Governments and grid operators can work with data centre operators to determine how renewable energy investments can most optimally benefit the whole system as well as contribute towards national energy and climate targets. Investment in energy storage and other demand side response capacity can also be encouraged as a complement to more renewable capacity.
- **Share best practices and lessons learned.** As other jurisdictions may face similar challenges, there is an opportunity to learn from each other and assess best practises in terms of policy and strategy.
- **Invest in RD&D for efficient next-generation computing and communications technologies.** Demand for data centre services will continue to grow strongly, driven by streaming media and emerging technologies like AI, virtual reality, 5G, and blockchain. As efficiency trends of current technologies slow (or even stall) in the coming years, we will need new efficient technologies to keep pace with growing data demand.