Bundle | 25 November 2025 ENERGY TMT

How data centres are powering growth and the energy transformation

Fast-growing AI-driven data centres are key to expanding digital infrastructure and boosting economic growth. But they consume huge amounts of energy and face grid bottlenecks. These articles explore regional trends in AI and energy strategies, highlighting how data centres can remain a positive force in both sectors

In this bundle

Article | 25 November 2025 ENERGY MANUFACTURING, CONSTRUCTION AND RETAIL SUSTAINABILITY

Watch: Europe is losing out big time on the AI and data centre battle

ING's Diederik Stadig on the race for AI and data centre supremacy - it's a race that Europe appears to be losing

Europe is losing out big time on the AI and data centre battle

The US is spending more than 5 times as much as Europe on data centre construction. China is spending more than 3 times as much. And that means Europe risks losing out in the battle for AI supremacy. And ING's Diederik Stadig says there's more: spending on artificial intelligence is boosting GDP growth, growth European leaders desperately need.

Watch video

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The data centre divide: Why Europe's shortfall threatens future economic growth

Europe's data centre capacity lags behind China and the US – and the gap is widening. Without decisive action, Europe risks missing out on AI-driven growth and innovation

A data centre in the Netherlands

Why data centres are so important for the economy

Data centres provide the computing power needed for the storage, transport, and processing of our data. That may sound abstract, but data centres are the engine of our digital world, as they offer the computing power that our digital lives require. In doing so, they not only allow us to endlessly watch cat videos, but they also keep hospitals online, enable internet banking, and provide the computing power required for new digital developments, including generative AI. Data centres are thus vital for businesses across all sectors of the economy.

To make this more tangible, we break down the economic importance of the sector into first-, second-, and third-order effects. First-order effects are the direct economic contributions of the data centre sector, such as investments in the construction and maintenance of data centres, the employment the sector creates in areas like management, engineering, maintenance, and security, and the sector's energy purchases. Second-order effects are indirect effects, such as demand for goods and services from suppliers and supporting sectors like construction, civil engineering installers, and IT hardware and software companies. Third-order effects arise because other sectors benefit from the opportunities data centres provide, underscoring their critical role in the economy. These effects include digital services and innovations such as cloud computing, AI, fintech, e-commerce, and streaming services.

Overview of economic effects of data centres

First-order effects

- Investments in construction and maintenance of data centres,
- Employement created by the sector for instance in management, technical services and maintenance

Second-order effects

Suppliers and supporting sectors, for example:
- Construction
- Installers in civil engineering,
- IT hardware
- Software companies

Third-order effects

Effects that arise because other sectors benefit from the opportunities offered by data centers, for example cloud computing, AI, fintech, e-commerce.

Source: ING

Data centre capacity is key, because it unlocks gains from AI

Data centres are so essential within the digital infrastructure sector because they form the core of all digital services we use daily. Think of cloud storage, streaming, AI, online banking, and even smart devices – all these applications run on servers housed in data centres. Data centres therefore function as an economic flywheel: the more digital services emerge, the more data centre capacity is needed. The more capacity there is, the easier it becomes for new digital innovations to arise (for example, generative AI). This creates a self-reinforcing effect: more digital demand leads to more data centres, which leads to more innovation, and more innovation again leads to more demand. Because of this flywheel effect, the third-order effects of data centres are significant.

We can make this more concrete: companies that work with new technologies (e.g. in AI or fintech) tend to congregate in places with excellent digital infrastructure and fast connections (low latency). So, good digital infrastructure is vital if you want to house the companies that will shape the economy of tomorrow. But the importance of data centres is broader. We previously wrote about the economic potential of generative AI. AI is a general purpose technology: it has the potential to drive significant economic growth and affect sectors of the economy outside tech. In countries with abundant data centre capacity, startups building new AI applications and products can more easily access computing power thanks to better availability and lower marginal costs. This means that the tech successes of the future depend on strong digital infrastructure and the computing power that data centres provide. Countries with substantial data centre capacity therefore have a better chance of achieving AI breakthroughs that are still in their infancy.

Tech investment booming, but primarily driven by US firms

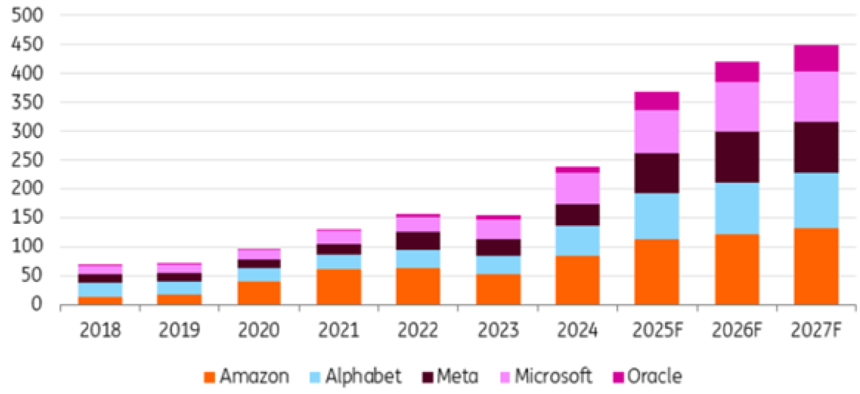
Given AI's economic potential, it's no surprise that investment in subsectors such as hardware, software, and data centres is substantial. Spending on AI by US tech companies has increased quite dramatically in recent years and is expected to continue as firms compete for AI leadership.

The expectation is that the companies that lead in AI will see their profits increase. This is already happening for companies that manufacture the software and hardware that is required to 'build' AI. NVIDIA, for instance, has seen its quarterly revenue increase fourteenfold in two years: from roughly $4 billion in the first quarter of 2023 to roughly $39 billion in the first quarter of 2025. These companies are primarily American, which means that the possible gains from AI will be unevenly distributed.

Data centres have traditionally been financed through internal profits. However, given the scale of current investments, funding increasingly comes from bond markets and other forms of lending. While this works for the buildings themselves, internal hardware such as servers has a far shorter lifespan – often much less than 30 years – creating a mismatch between assets and liabilities. As a result, concerns about credit quality and leverage risk are emerging, although these remain limited for now, thanks to the exceptional profitability of many US tech companies.

US tech investment boom to continue

Investments by selected US tech companies in billion USD



Source: Source: Refinitiv; ING

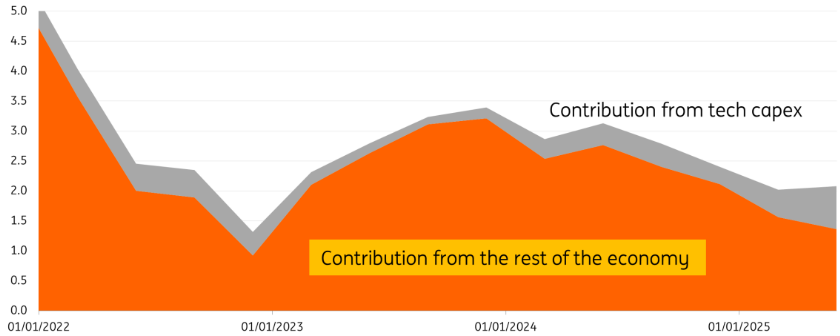
Extraordinary investments are having an effect on US GDP

The AI-driven increase in investments (also often called capital expenditure or capex) is also increasingly important for the US economy: the share of tech capex in real US GDP growth has increased, especially in the first half of this year. This clearly underlines the size of these investments and the increasing structural importance of the tech sector for the American economy.

We expect this effect to continue, particularly because the US government incentivises these investments through the CHIPS Act and the One Big Beautiful Bill. They allow companies to immediately deduct the cost of qualifying investments from their tax bill rather than use the depreciation methodology over the lifetime of the asset, which offers significant tax reductions. Moreover, there is a consensus within the US that the country needs to ‘win’ the AI race out of both economic and geopolitical necessity. Consequently, the government will likely continue or even expand its current subsidies.

Effect of tech investments on US GDP is growing

US real GDP growth contribution from computers & peripheral plus software, in %



Source: Macrobond, ING calculations

Data centre capacity will increase steeply, but Europe is lagging behind

With tech investment growing sharply, we expect global data centre power consumption to surge. This growth is primarily driven by increasing AI investment and adoption, which is boosting demand for hyperscale data centres while leaving other types relatively subdued. This means that data centres are becoming larger rather than smaller.

Moreover, growth in added data centre capacity is unevenly distributed: at the current rate of investment, Europe will lag further behind China and the US, which is a worrying development for the continent given that data centres offer the computing power that enable growth and innovation in high-tech and relatively new economic sectors.

From the energy forecast, which is based on the base case of the International Energy Agency (IEA), we extrapolate that global data centre capacity will increase by roughly 15% per year until 2030. Yet, growth will primarily be driven by China and the US. The US will more than double its current capacity and China will add roughly 2.5 times its current capacity. Europe, on the other hand, will add roughly 75% of its current capacity until 2030. Moreover, Europe already has less data centre capacity than China, which has roughly 1.5 times Europe's capacity, and the US, which has roughly three times Europe's capacity. In short, Europe is already behind the US and China and the gap will widen in the years to come.

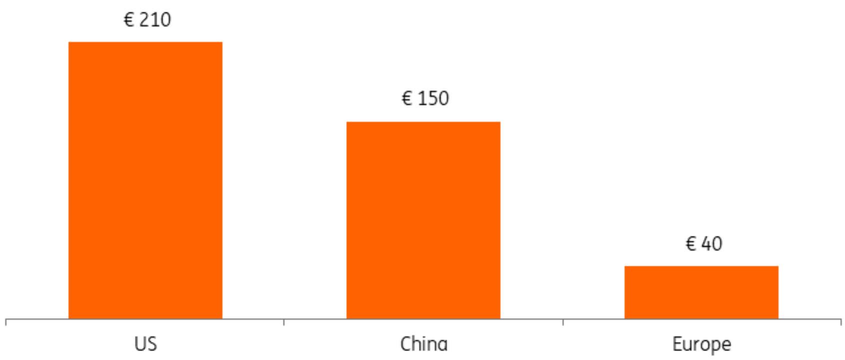
This is a concern for Europe because, as mentioned, AI is a general purpose technology, which means that it will increase economic growth and productivity and has the potential to disrupt more sectors of the economy than just tech. As data centres are the digital infrastructure that enable AI, countries with excess data centre capacity are best-positioned to profit from the economic gains of the technology.

US data centre investment could be fivefold higher than Europe's

To calculate which investments are necessary to meet our energy forecast, we take the additional TWh forecast in the US, China and Europe and from there, we convert energy to average data centre capacity. We do so by using power usage efficiency (PUE), which is a measure that shows what percentage of power used goes to IT versus other uses. We assume a PUE of 1.3, which is common for newly built hyperscalers, which gives us an estimate of additional MW in capacity. We then assume that each MW costs roughly 10 million euros to construct, which gives us the required investment to meet our energy growth forecast. In short, from the IEA base case, we extrapolate that the US will spend roughly five times as much as Europe on the construction of data centres, which excludes expenditure on IT hardware.

Required data centre construction expenditure in the US, China and Europe

Required construction (excluding IT hardware) investment to meet growth forecast until 2030 in billions of euros



Source: IEA, IDC, ING

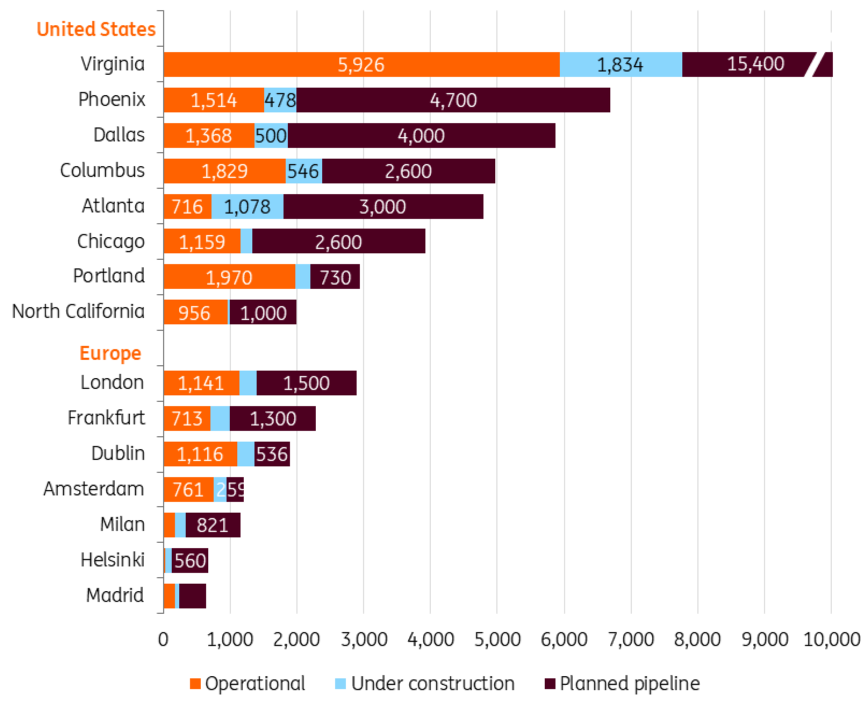
Green shoots of progress emerge in Europe

The stark contrast between American and European investment is also evidenced by the developments in Tier 1 markets. Frankfurt, London, Amsterdam, Paris and Dublin (FLAP-D) are Europe's core data centre markets. Taken together, however, America's most important market (Virginia) is bigger than Europe's five core markets combined (we estimate that Paris sits between Dublin and Amsterdam in terms of capacity). This gap will grow in the years to come: the pipeline in Virginia is three times bigger than that of the FLAP-D combined (we estimate a similar pipeline for Paris as London has). In addition, Dublin and Amsterdam have congested power grids, which limits room for expansion.

However, there are green shoots of progress emerging Europe. There are plans for significant build-outs in Frankfurt, Paris and London and important Tier 2 markets have emerged recently: Madrid, Milan and Helsinki will add roughly 2.0 GW in combined capacity in the coming years. These cities can therefore expect significant investment from consortia, rapid growth in the digital services industry, and down the line, more innovative companies making use of data centre capacity.

Core US markets accelerate data centre buildout, leaving Europe in the dust

In MW, as of end 2024



Source: Gartner, ING

The need for European ambition and a common strategy

As we have shown, data centres are expanding rapidly, driven by the AI boom. However, new data centres are mostly being built in China and the US, which means that Europe has now fallen behind.

It is therefore imperative that Europe takes decisive action, particularly as generative AI continues to grow. Of course, full-scale expansion is constrained by limited power grids and scarce resources, forcing governments to make difficult trade-offs. However, a stagnating data centre sector could have serious repercussions for the European economy, as companies with ample data centre capacity are best-positioned to profit from AI.

Greater pan-European coordination on where and how data centres can grow could help. If Europe wants to compete in the field of AI now and in the future, data centres are essential due to their computing power and the development of more autonomous European AI applications. Strategic decisions on this front should be made sooner rather than later.

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Data centres race to innovate as power demands surge

Soaring energy demand from AI-powered data centres is challenging global power grids. To sustain growth, centres must secure reliable, affordable, and green energy. This will drive innovation across the industry – although we also see regional differences in strategic planning

As the data centre industry continues its rapid expansion, the challenge of balancing sustainability, affordability, and reliable power supply is becoming more complex than ever

AI is fuelling spikes in data centre energy demand

The rapid expansion of artificial intelligence (AI) and data centres is set to reshape the global energy landscape. As an illustration, asking a question on ChatGPT consumes five times as much energy as a web search, and generating a five-second video uses the same amount of energy as running a microwave for over an hour. While these numbers may seem modest, their cumulative effect becomes significant as AI adoption accelerates. As of July, ChatGPT reportedly handled over 2.5bn prompts globally per day.

As a result, global data centre power consumption is projected to soar, but the extent of this increase remains uncertain and is currently highly debated due to several 'known unknowns'. Think of the extent to which AI will:

- Be scaled and demanded by consumers (both individuals and companies for operations optimisation).
- Stimulate GDP growth and hence energy demand (rebound effect);
- Meet current expectations (bubble or not?).
- Be limited by bottlenecks in the TMT supply chain (production capacity, chip shortages, and the availability of rare earth minerals).
- Be restricted by bottlenecks in the energy supply chain (grid congestion, land availability, permitting, incorporation of new energy sources).
- Continue advancements in energy efficiency in AI hardware and software.

Over time, big shifts can suddenly change power demand. But slow, gradual changes also add up and can have a major impact.

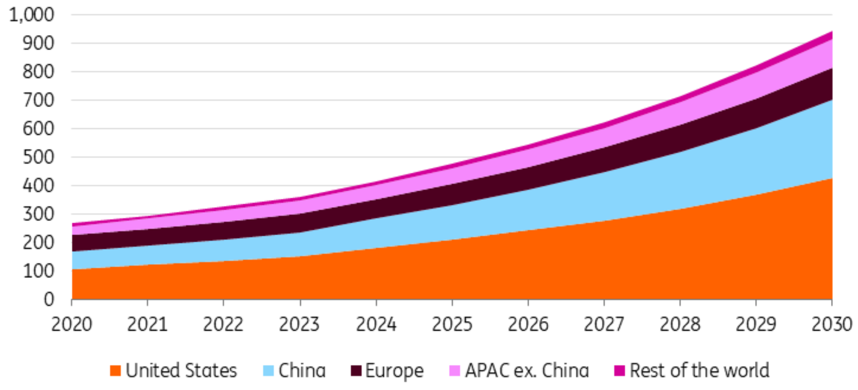
> **Global data centre power consumption is projected to soar by a staggering 130% by 2030 in the base case scenario**

The International Energy Agency therefore explores these factors for different scenarios. It predicts a staggering increase in global power consumption from data centres of 130% by 2030 in its base case scenario. Power consumption almost triples in its high growth scenario, but will only rise 60% in its low growth scenario.

The US leads the market, currently representing around 44% of total data centre electricity demand, followed by China at 25%. In the US, power demand from data centres is projected to jump to above 10% of the national total by 2030 from around 4% today. Europe, accounting for 16% of current global power demand, has the lowest growth rate by 2030, but is still projected to add a substantial 66% of power needs by 2030 in the base case.

Data centre electricity consumption set to jump this decade

Global electricity consumption from data centres in the base case, TWh



Source: ING research based on IEA

The urgent need for innovative power solutions from data centres

This surge in energy demand from data centres can put a lot of pressure on the power system and society in general. Consider the following:

- Data centres, with their need for large loads and speedy power access, could push up **electricity prices** to the detriment of users in other sectors, such as industrial companies and households.
- Demanding large loads could also destabilise the **grids**, leading to more blackouts and voltage sags or surges. If the integration of new data centres does push the grid to its limit, then they risk being forced to reduce workload or delay expansion.
- Despite continuously becoming more energy efficient, data centres are poised to raise **global emissions** and could alter the **local environments** in which they operate.

Data centres use so much energy mainly because of their computing power. They perform three tasks: storing, distributing, and processing data. Processing – also called 'computing' – is the most energy-intensive because it requires heavy server capacity. Training and running AI models demand even more computation, making them highly energy-consuming.

But despite these interconnected challenges, data centres have huge potential to be part of the solution. With booming investment into the industry, data centres are leading the way in developing and upscaling clean technologies. AI technologies can also help data centres operate more efficiently. Moreover, data centres can work with regulators and utilities to facilitate the improvement of energy systems. In addition to data centres' own energy usage, AI-enabled solutions can also enhance the energy efficiency of other consumers.

This article focuses on how data centres can make smart, sensible choices when selecting their power sources and how different regional strategies vary.

Smart power choices incorporate reliability, accessibility, affordability and sustainability

Data centres must carefully weigh four essential factors: accessibility timeline, reliability, affordability, and sustainability. Below is a summary of how each of the considerations plays out for different energy sources, and we'll later discuss these in detail.

An increasingly complex balancing act for data centres to secure power

Assessment of key considerations for data centres' power sources

	Accessibility timeline	Reliability	Affordability	Sustainability
Coal	Short to Medium	High	Medium	Low
Natural gas	Medium for CCGTs; Short for SCGTs	High	High in the US; Medium in Europe	Low
Solar & wind (without storage)	Short	Medium to Low	High	High
Solar & wind (with storage)	Medium for 4h-8h storage; Long for ultra-long storage	High to Medium	Medium for 4h-8h storage; Low for ultra-long storage	High
Traditional nuclear	Short for restarts; Long for new builds	High	Medium to Low	High
Advanced nuclear (SMRs, fusion)	Medium to Long	High	Low	High
Hydro	Medium to Long	High	Medium	High
Traditional geothermal	Short to Medium	High	Medium	High
Advanced geothermal	Medium to Long	High	Medium to Low	High

Source: ING Research. Note: SMR = small modular reactors; SCGT = simple-cycle gas turbines; CCGT = combined-cycle gas turbines.

Moreover, one region's optimal power mix can look very different to another's because of differences in local infrastructure, regulatory environments, and energy availability. Data centres should take all of these elements into consideration to meet both their immediate operational needs and long-term goals of resilience.

Accessibility timeline

Most planned data centres aim to go live within months to two years, but many energy options can't meet these timelines. In the US, combined-cycle gas turbines (CCGTs) face significant shortages, with equipment backlogged until around 2030. Advanced nuclear technologies – including small modular reactors (SMRs) and fusion – are attracting robust investment but are unlikely to be available until the next decade. Constructing a traditional nuclear plant takes even longer, often up to 15 years. Additionally, complex permitting and grid congestion in both the US and Europe can add further delays.

To address these challenges, data centre operators are seeking **short-term solutions** that can deliver power capacity more quickly. Renewable sources, with their shorter construction timelines and fewer supply-chain bottlenecks, are expected to fill much of the gap. The industry is also investing in the restart of decommissioned traditional nuclear power plants, which can be brought online relatively quickly. Given the shortage of CCGTs, alternatives like single-cycle gas turbines and gas-powered fuel cells are also gaining traction.

> **Securing immediate power capacity and investing in emerging technologies are both crucial**

While securing immediate power capacity is critical, data centres must also invest in emerging technologies that promise significant benefits in the **long term**. These include nuclear, geothermal, and expanded battery storage solutions. The application of carbon capture and storage (CCS) technologies in the power sector will also be key, especially given the US and China's projected continuing reliance on fossil fuels.

It's also important to note that upgrades to grid infrastructure and increased grid flexibility can unlock additional power capacity. Efforts to modernise grids are underway in the US and Europe; we'll explore these developments further a bit later on.

Reliability

Uninterrupted data processing – referred to as 'uptime' – is a core requirement for data centres, with the industry standard set at 99.999%. Achieving this level of reliability demands an uninterrupted power supply, making dispatchable sources like coal, natural gas, nuclear, hydropower, and geothermal especially suitable.

In contrast, solar and wind energy are inherently intermittent. Current battery solutions typically offer four hours of discharge – insufficient to guarantee full reliability. As a result, wind and solar today still need to be complemented by other generation sources to ensure continuous operation. As discussed previously, long-duration storage (LDES) technologies providing at least eight hours of discharge are essential to address the intermittency issue for wind and solar. While most LDES technologies remain in the research and development (R&D) phase, global market players are actively developing these solutions.

Affordability

The choice of energy sources for data centres often hinges on regional cost advantages. In **the US**, natural gas is the leading choice thanks to its abundance, low cost, and strong infrastructure. The IEA projects it will supply 130TWh of the 250TWh of extra electricity that data centres will need by 2030. Natural gas would then account for half of the country's power mix for data centres.

> **The choice of energy sources for data centres often hinges on regional cost advantages**

Similarly, in **China**, ample and cheap coal has been the dominant source, contributing to 70% of the country's power generation for data centres today. But China's massive build-out of renewable energy will influence its power mix for data centres in the long term, leading to coal's share being reduced to less than 50% by 2035.

In **Europe**, where cheap fossil fuel is limited, solar and wind are set to be the prevailing power sources for data centres. This, together with the stronger push for sustainability, means that the region's share of renewables and nuclear is expected to become 85% of its electricity supply for data centres by 2030.

In addition to regional differences, affordability also has a time series component. Despite heavy investment from data centres, emerging technologies like SMR, nuclear fusion, and some advanced geothermal technologies are not yet commercially available. Data centres are now partnering with energy companies to advance the R&D of these technologies. Subsequently, investment will also be needed to accelerate mass production and critical infrastructure.

Sustainability

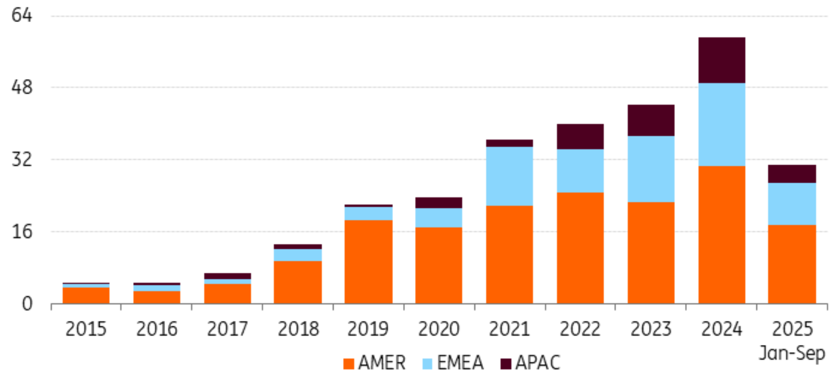
Balancing data centre growth with sustainability goals has become increasingly complex, especially as some regions are rolling back climate policies. Yet with ample financial and operational resources, data centre companies have so far maintained their ambitious sustainability targets, largely driven by the need to future-proof businesses and meet stakeholder expectations. Google, Meta, Microsoft, Equinix, and Digital Realty all have net-zero or carbon-negative targets by 2030, earlier than most companies in other industries.

> **Data centre companies have been at the forefront of driving clean power demand**

This has positioned them at the forefront of driving clean power demand. Globally, corporate power purchase agreements (PPAs) are on track to exceed 2023 volumes, albeit with weaker momentum than seen in 2024.

Steadily rising interest from corporates to buy clean power

Global power purchase agreement (PPA) purchases, GW

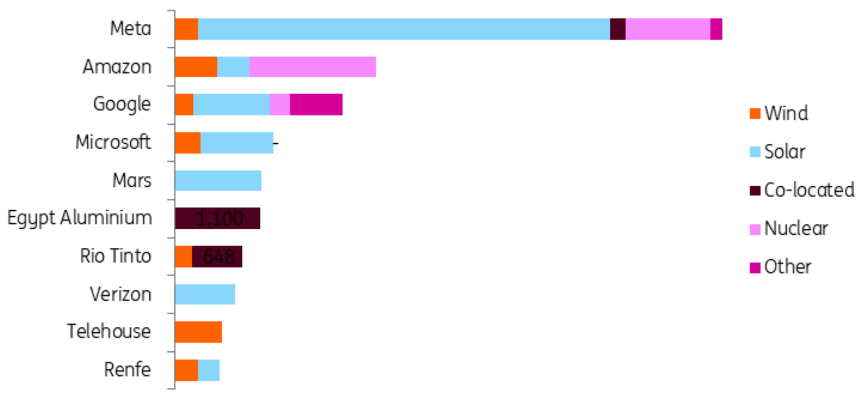


Source: Bloomberg New Energy Finance

Notably, in 2025, four of the world's five largest buyers of clean PPAs are tech companies, consistent with the historical trend. In the US alone, tech firms account for 75% of all PPA purchases this year.

Tech companies are buying huge amounts of clean electricity

Top global buyers of clean power purchase agreements (PPAs) in January-September 2025



Source: Bloomberg New Energy Finance

These PPAs are dominated by established energy sources like wind, solar, and traditional nuclear, but increasingly also include nascent clean technologies. For example, Google has entered into an agreement with Kairos Power to procure electricity from up to seven SMRs expected to come online in the next decade. Meanwhile, Meta has secured a PPA with Sage Geosystems to source advanced geothermal power as soon as it becomes available.

In addition to purchasing clean power, data centre developers are also investing directly in advancing these emerging technologies. Google is providing early-stage funding to Elementl Power to support the development of three advanced nuclear reactor sites. Amazon's Climate Pledge Fund led a $700m funding round for X-Energy to accelerate the commercialisation of its SMR technology. Data centres are now the biggest driving force of clean technology advancement, with their investments set to have a profound impact on the energy sector in the next few decades.

More innovation ahead

As the data centre industry continues its rapid expansion, the challenge of balancing sustainability, affordability, and reliable power supply is becoming more complex than ever. Yet it also triggers technological and market innovation. Case in point, data centres' desire for clean baseload power is re-energising the global nuclear industry.

> **Innovation and energy strategy vary across regions**

It is important to recognise that the concept of 'innovation' varies across regions. In **Europe**, persistent system bottlenecks imply that the data centre industry may opt to innovate within the limits of the power system and strive to make it better. In turn, Europe's AI future may see more moderate growth but with greater emphasis on sustainable energy use. **The US** also faces key power bottlenecks, but the dominant theme will remain 'growth', propelled by creative strategies to overcome limitations and unlock unprecedented opportunities. **China**, with fewer infrastructure constraints, will also focus on growth while doubling down on the R&D of emerging technologies. For **both the US and China**, the aggressive data centre growth strategies will be fuelled by substantial reliance on fossil fuels – but also the clean technologies where they hold competitive advantages.

> **Integrating advanced energy management mechanisms will be key to building long-term resilience**

Regardless of regional approaches, integrating advanced energy management mechanisms will be key to building long-term resilience. With these measures, data centres can transform from energy-intensive facilities into enablers of a smarter, more resilient power system. In the third article of this bundle, we discuss how data centres can be better integrated into the power system.

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How data centres can be better integrated into the energy ecosystem

Data centres can support grid stability and efficiency by collaborating with local grids, managing load growth, and integrating advanced energy management systems for sustainable expansion. This will increasingly define their 'license to operate'

Google uses software to alert data centres about upcoming energy supply limits and sends hourly instructions to reduce strain

Soaring energy demand from AI and data centres is putting tremendous pressure on power systems worldwide. Northern Virginia's "Data Center Alley" nearly faced a blackout when faulty grid equipment caused 60 data centres to disconnect at once. In Europe, grid constraints are expected to slow growth in traditional FLAP-D hubs (Frankfurt, London, Amsterdam, Paris and Dublin). The city of Amsterdam even banned new data centres in December 2023, with no new projects expected before 2035. Electricity prices are rising in areas with high data centre demand, limited new capacity, and long connection delays. For example, in New Jersey – part of PJM Interconnection, the regional grid operator serving much of the eastern US, and a key data centre region – retail power prices jumped 20% year over year.

> **Data centres need to manage their relationships with the grid.**

Higher power usage comes with great responsibility. Data centres need to manage their relationships with the grid to avoid stress or instability. If they don't, projects could face local opposition, delays, or even cancellations. This article explores how data centres can help build a more efficient energy system, better manage load growth, and create positive impacts for local communities.

The central role of data centres in both the TMT and energy value chains

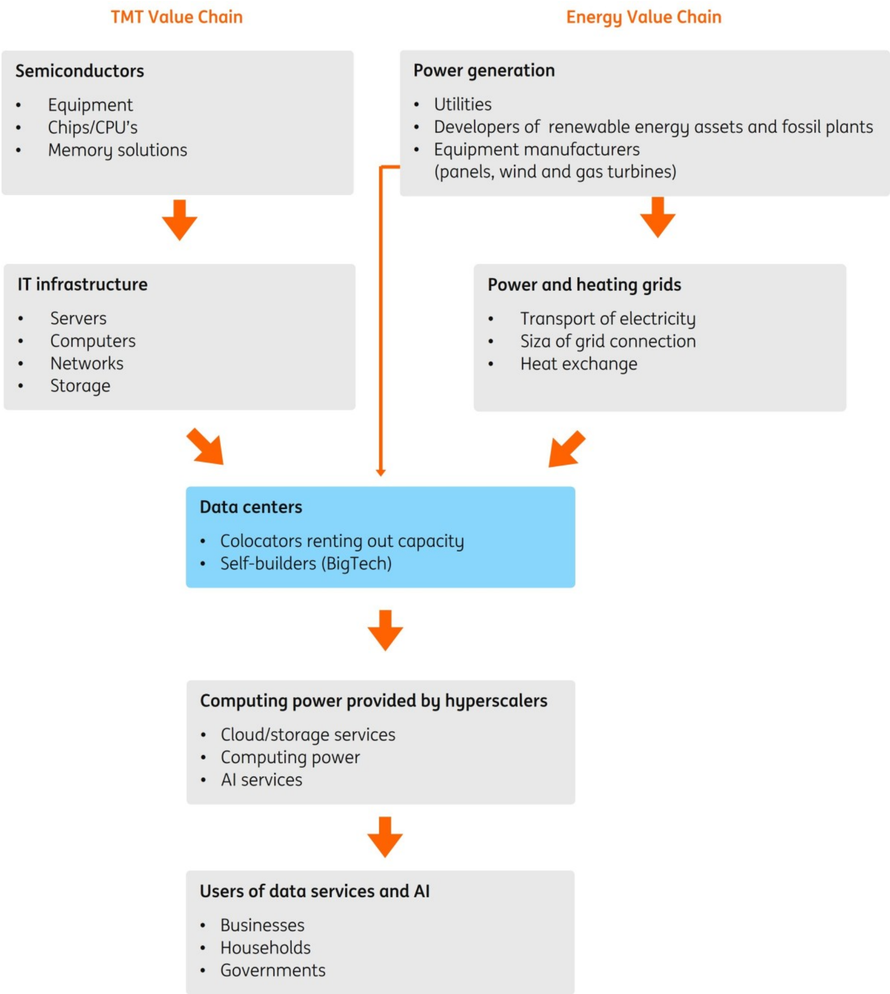
But first, let's take a step back and understand how the power system is an integral part of a data centre's broader value chain.

Data centres occupy a pivotal position at the intersection of the Technology, Media, and Telecommunications (TMT) sector and the energy system. The data centre and energy value chains are intrinsically linked, with each influencing and depending on the other.

> **Data centres are the link between the TMT and energy value chains.**

At the heart of the TMT value chain, data centres serve as the critical infrastructure that processes, stores, and transmits digital information. This chain typically begins with the IT equipment and infrastructure providers, followed by the compute layer – where data centres process the information – before finally reaching the end "user" who consumes digital services and applications.

Data centres are in the middle of the TMT and Energy value chain



Source: ING research

On the other side, the energy value chain encompasses the generation, transmission, and distribution of electricity. Power grids play a crucial role in linking energy production to consumption. Directly feeding onsite-generated power into data centres is also gaining traction. Data centres are deeply embedded in this energy chain. They depend on grids for steady, reliable power and can also give back through demand response programmes or transmit excess onsite power back to the grid.

The interaction between these two value chains is dynamic. As data centres grow to meet rising digital demand, their energy needs increase, making their connection to the power grid more complex and strategic. Choices in the energy chain directly affect the performance, sustainability, and growth of TMT. Here are the key trends we see emerging.

Onsite power gains momentum this decade, but the grid remains the dominant electricity source

As data centres choose how to integrate themselves within the power systems, three primary strategies have emerged:

1. Taking power from the grid;
2. Receiving power directly from onsite generation sources alongside data centre facilities (also called behind-the-meter, or BTM-solutions);
3. A combination of both.

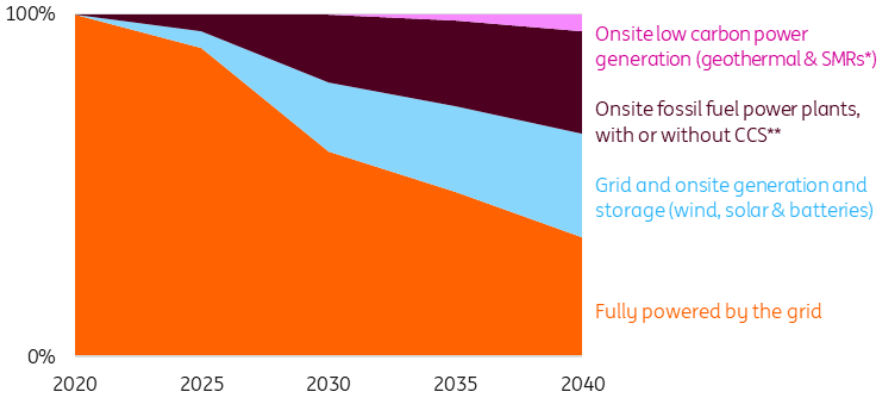
Traditionally, data centres have relied entirely on the **grid** for electricity. However, growing grid disruption risks and lengthy lead times for securing power access are set to reshape this model. The incorporation of **onsite power generation** to complement electricity from the grid will become more popular in the next few years. According to a report by Bloom Energy, 38% of data centres in the US are expected to adopt primary onsite power generation by 2030, up from 13% last year. The percentage of data centres relying solely on onsite generation, although low a year ago, at 1%, is poised to soar to 27% by the end of the decade in the US.

> **38% of data centres are expected to adopt primary onsite power generation in the US by 2030.**

In the short term, to secure power access quickly, onsite power generation is inevitably more skewed towards using fossil fuels. However, in the long term, clean onsite generation will pick up speed as large clean dispatchable power supply becomes commercially available. We can also anticipate renewed interest from data centres in sourcing electricity from the grid as it becomes cleaner and more efficient.

Data centres are mostly powered by the grid, but new models are emerging

Indicated share of power source in total power generation



Source: ING Research based on Gartner.

Note: *SMR technology development till 2035, actual generation from 2035 onwards. **CCS = emission reduction by capturing and permanently storing CO2 emissions.

Below, we discuss the specific advantages of each power receiving mechanism:

Power from the grid

Traditionally, data centres have connected to existing electrical grids. They typically provide a reliable and stable source of energy, maintaining 24/7 uptime and minimising data loss.

However, as more data centres integrate, grids risk becoming strained, raising the risk of blackouts, brownouts, and voltage sags or surges. Complicated and fragmented grid interconnection processes have also led to long wait times in Europe and the US. And a lack of effective power system improvements and transmission line upgrades can limit the contribution of renewable energy sources.

Some solutions are helping to ease these challenges. AI-powered smart grids and grid-enhancing technologies allow real-time communication with data centres, adjusting energy use automatically to manage faults and load changes. Google uses software to alert data centres about upcoming supply limits and sends hourly instructions to reduce strain. Microsoft's Pacific Northwest sites use AI to predict energy fluctuations and integrate renewables smoothly. Companies like Google are also shifting peak demand to off-peak hours to further reduce grid stress (discussed below).

Onsite power generation

Instead of relying on receiving electricity from the grid, generating electricity onsite is becoming more popular among data centres. It can offer several benefits:

- Avoiding grid strains and blackouts
- Offering faster access to power
- Reducing long term energy costs and efficiently incorporating renewable sources
- Allowing more flexible siting by reducing constraint from grid connectivity

More data centres are starting to add onsite power generation. Elon Musk's xAI site in Tennessee and OpenAI and Oracle's Stargate project in Texas use modular natural gas turbines. Meta's Ohio data centre plans to meet all its power needs with onsite gas equipment from Williams Companies. Some companies are also cutting emissions from gas-fired power plants by integrating carbon capture and storage (CCS) technology. Google is taking this approach through a power purchase agreement (PPA) with the Broadwing Energy Center in Illinois. The 400-megawatt plant, now in the design phase and expected to be operational by 2030, will capture around 90% of its CO_2 emissions for permanent underground storage. This model could eventually be applied to on-site gas plants, a development closely monitored by oil and gas majors. Exxon CEO Darren Woods recently highlighted CCS as a key advantage for building dedicated power facilities to meet the energy demands of AI data centres. In China, Tencent's Tianjin data centre uses a microgrid combining solar power, battery storage, and AI energy management to cut grid dependence and move towards green energy.

Nevertheless, challenges also exist. For instance, onsite generation may not meet a data centre's entire energy requirement. The amount of electricity a data centre can generate onsite varies, depending on its location and energy strategy. But for now, the share of data centres able to meet most of their power demand through onsite facilities remains very small.

Moreover, onsite power generation can require substantial upfront capital investment. Data centres are also directly exposed to supply chain challenges in the power sector, such as increased tariffs on clean energy equipment. Because of these challenges, some data centres opt to locate near large-capacity, clean, and reliable power generation sources. In Europe, new data centres are being planned adjacent to hydroelectric dams to secure guaranteed green power and leverage efficient water-based cooling.

Combination of onsite power and grid connectivity

While each method has individual advantages, they are increasingly incorporated together to reap the most benefits. By mixing strategies, data centres receive 24/7 power from the grid while protecting against blackouts. Moreover, reduced grid dependency can result in timelier connection. Nevertheless, challenges such as upfront technology costs and geographic flexibility can still remain concerns.

A possible reset of the clean power purchasing market

Strategically structuring power purchase agreement (PPA) contracts is also key for data centres to manage their relationship with the power system.

PPAs provide a long-term option to acquire clean energy. There are two types: physical PPAs, where a customer buys and receives power directly from a generator, and virtual PPAs (VPPAs), which are financial contracts for price hedging without physical delivery. Most PPAs match a customer's electricity use on an annual basis. And VPPAs, along with some physical PPAs, do not require the electricity generator and customer to be from the same local grid.

> **Proposed reporting rule changes could change how data centres track emissions from electricity use**

Recent proposed changes to sustainability accounting rules could change how data centres track emissions from electricity use (called Scope 2 emissions). The Greenhouse Gas (GHG) Protocol, which sets widely adopted standards, has suggested requiring companies to match their electricity consumption on a 24/7 basis – by both hour and location.

This proposal, if implemented, could create system-wide and societal benefits. It would boost a company's sustainability reputation and make PPAs better hedging tools. One study showed that a 90% hourly matched PPA could have saved a major electricity user over €14 million in Finland in 2022. Companies like Google and Microsoft are already working towards buying carbon-free electricity 24/7.

But there can also be substantial challenges. Matching electricity use 24/7 needs detailed data on a customer's electricity consumption. Large companies with more resources can manage this, but smaller ones may struggle. Hourly and geographical matching might also push purchases toward existing power in the spot market instead of supporting new clean energy projects. Companies with operations in many places that rely on VPPAs could also see their buying strategies disrupted by these changes.

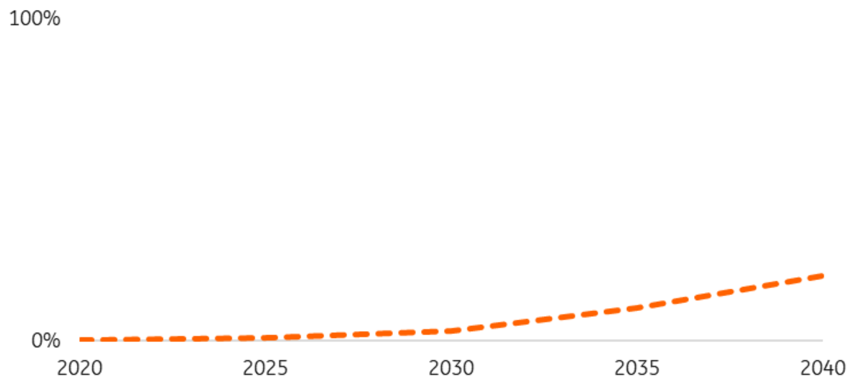
We believe big companies should aim for higher standards and try 24/7 matching. But making it mandatory under GHG reporting could shake up the clean power market. In that case, firm clean energy like nuclear and geothermal, plus more co-located renewable generation, would likely be favoured. It could also change how Scope 2 emissions are benchmarked, requiring new performance reference points.

Heat reuse can benefit local communities

In addition to improving power usage itself, reusing excess heat from data centres can benefit local communities. Normally, cooling systems release this heat outside, but heat reuse systems send it to other users for purposes like water and space heating. Locating data centres near consumers can be hard, but this approach helps both homes and industries. Regulations are still limited, though several European data centres plan to adopt this technology. For example, Google's data centre in Skein, Norway aims to run on 99% carbon-free electricity and use heat reuse systems with the local community.

Data centres produce a lot of heat and over time more heat will be utilised

Indicative share of heat utilisation in total data centre heat production



Source: ING research

Demand flexibility enhances power system efficiency

Lastly, data centres can help to ease grid stress by voluntarily shifting a small portion of their electricity demand away from peak hours. In August, Google announced plans to move less time-sensitive machine learning workloads. Similarly, Aligned Data Centers unveiled plans to fund a 31 MW battery at its upcoming Pacific Northwest facility to increase the flexibility of its power demand.

This voluntary demand shift not only helps free up grid capacity, but may also accelerate grid connections for data centres. In fact, the US Department of Energy has recommended that regulators expedite the interconnection process for large loads that can commit to being flexible.

We do acknowledge that it can be hard for some data centres to shift power demand, as their workloads may lack flexibility or control over workflows. But we do anticipate that demand flexibility will continue to gain traction as the system improves.

With more power demand comes more responsibility – and potential

> **Data centres' positive contribution to the energy system will increasingly define their 'license to operate.'**

To sustain expedited growth, data centres must adopt smart strategies that support the stability and sustainability of local energy systems. This will increasingly define their 'license to operate.' The good news: data centres have the power to deliver, with big tech companies already making efforts to enable a more resilient energy system. Over time, policymakers need to implement reforms that make power systems more efficient and encourage infrastructure investment. These changes will enable a genuine energy transformation, with data centres playing a key facilitating role.

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