The data centre surge, energy efficiency and the ICT boom

Strong growth of the technology sectors has boosted economic growth. And data centres are a crucial enabler of this growth. In this bundle, we analyse ICT sector growth and corresponding energy demand, enhanced data centre efficiency, water usage and incentives coming from sustainable finance

In this bundle

TMT

Data centre growth proves crucial in the shift towards a digital economy

The rapid growth of the technology sector, increasing computer power and what it could all mean for data centre development

By Diederik Stadig, Jan Frederik Slijkerman and Coco Zhang

Energy | Sustainability | TMT

Data centres provide a boost to companies' energy efficiency efforts

In the global shift towards a more sustainable economy, data centres could offer key solutions for boosting efficiency in fast-growing sectors

By Jan Frederik Slijkerman, Diederik Stadig and Coco Zhang

Energy | Sustainability | TMT

Growth in water consumption of data centres needs more attention

The water use and management of data centres needs more attention

By Coco Zhang, Jan Frederik Slijkerman and Diederik Stadig

Energy | Sustainability | TMT

Sustainable finance helps data centres reduce their environmental impact

Pressure to accelerate data centre decarbonisation is mounting as a result of new regulations and ESG

By Coco Zhang, Diederik Stadig and Jan Frederik Slijkerman

Article | 24 October 2023 TMT

Data centre growth proves crucial in the shift towards a digital economy

Smartphones, streaming services and applications such as video calls have now become part of our everyday lives. And as demand for these services grows, so too does the need for data centres to store and distribute the data

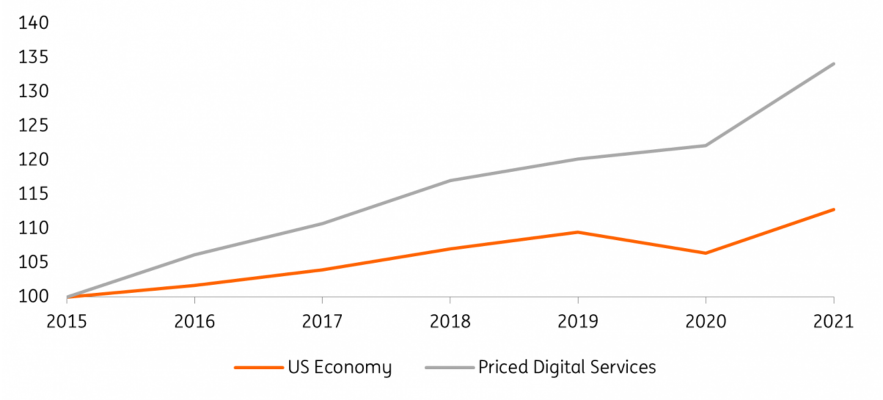
Surging growth in the ICT sector has been bolstered by rising demand for digital infrastructure and data centre capacity

Fast ICT growth means more data centres

The Information and Communications Technology (ICT) sector in the EU and the US has shown above-average growth rates, in line with policies such as the European Commission's action plan, Europe’s Digital Decade. This has been enabled by the strong growth of the data centre sector. As we expect the ICT sector to continue to show above-average growth rates, the data centre sector is expected to grow as well.

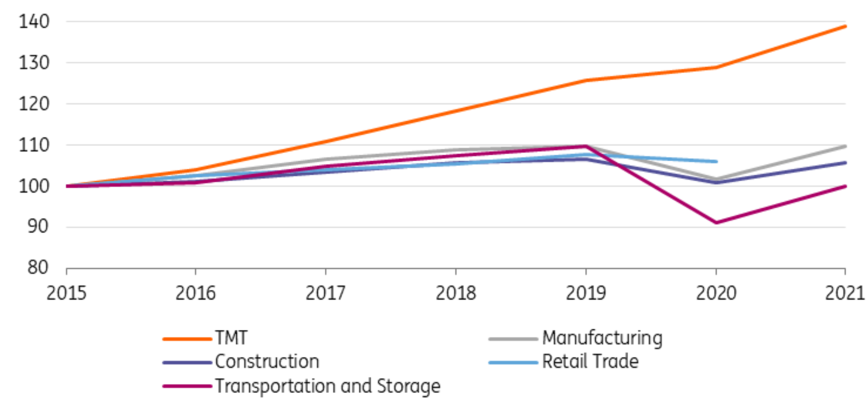
In related articles, we write about the opportunities to manage the increasing energy and water use that accompany this growth.

Strong GDP growth of ICT sector compared to broader US economy



Source: Bureau of Economic Analysis

Strong GDP growth of ICT sector compared to other sectors of the economy in the EU



Source: Eurostat

Strong historical and future growth of data centres

The ICT sector's strong growth in recent years can be seen in the charts above. Data from Eurostat and a special Bureau of Economic Analysis investigation into the ICT sector (more specifically, segment-priced digital services) shows above-average growth rates in both the EU and US. In both regions, the sector makes up an increasingly large portion of total GDP. This holds true even without accounting for the fact that the sector also enables growth in other segments of the broader economy.

What's driving growth?

Growth of the ICT sector is facilitated by investment in (digital) infrastructure, such as data centres. The increasing contribution of digital services to the broader economy has been fuelled by the growth in computing power, which is provided through data centres. It is, therefore, no surprise that the data centre sector has shown strong growth over the years. The International Data Corporation (IDC) forecasts that worldwide spending on public cloud services will reach $1.35 trillion in 2027, reflecting a five-year compound annual growth rate of around 20%. IDC also estimates that the spending on cloud infrastructure will reach over $150 billion in 2027 and is expected to grow with a compound annual growth rate of around 11% until then. Therefore, the investments in the compute and storage hardware markets enable the accelerated revenue growth in services. According to Masanet et al (2020), the number of servers globally has increased from 35.8 million in 2010 to 45.1 million in 2018. The growing number of servers, efficiency improvements and the resulting energy use are discussed in a related article in this series.

One explanation for the growing demand for data centre capacity is the services and benefits the sector offers. Companies often decide to move their servers to data centres because these operate at a lower cost, and therefore help with decreasing their total cost of IT ownership. These cost-reduction opportunities arise from significant economies of scale in the data centre sector. Other benefits from outsourcing are improved interconnectedness and better speeds. Decisions are sometimes also made to upgrade the legacy IT stack to a modern, cloud-based IT infrastructure. Engaging with a hyperscaler allows enterprises to benefit from their cloud-based communications networks as well as their buying power with third-party suppliers and DC engineering skills, including the application of modular DC designs. Hyperscalers are able to offer an array of services and cybersecurity that would be prohibitively expensive for enterprises to replicate in an on-premise environment

These factors explain why the demand for data centres has been growing at a similar rate as ICT services. The fact that the ICT sector is growing faster than other sectors is particularly relevant for ageing societies and policymakers. If we want to improve our GDP per capita (labour productivity), it becomes particularly relevant to focus on sectors that show above-average growth rates. This is also what the EU is aiming for with its Digital Economy action plan.

Additional benefits

Besides general factors such as the contribution to GDP growth and employment, positive effects include the creation of communication hubs, as well as possible spin-off effects like the emergence of new companies that are located in the proximity of data centres. For other companies, the close proximity to data centre services can be beneficial. The presence of data centres also gives governments control over regulations impacting data centres and their services, such as environmental standards and internet and communication networks.

Rising concerns and new resistance

While the data centre sector contributes to economic growth, there is sometimes resistance to the construction of new facilities. The Netherlands and Singapore, for instance, had a moratorium in place on new hyperscalers. Singapore now has strict demands for the construction of new hyperscalers and in the Netherlands this legislative process is still ongoing.This resistance is because the strong sector growth raises questions about the negative externalities, such as high energy use, heat, water usage and a changing landscape.

However, the sustainability of data centres has been improving. The management of these externalities is often part of sustainable finance objectives, which can be part of sustainable finance frameworks. As with many economic activities, data centres can be beneficial for society overall (with said benefits being larger than direct and indirect costs), but this does not imply that every location is suited to building a data centre. This could be the case given a scarce local green energy supply, for instance.

Data centres explained

Data centres are physical locations that house a network of computer servers which can be used to store, process or distribute data. In general, three types of data centres can be distinguished:

1. **Enterprise data centres** are used by one single organisation but are often relatively small data centres.
2. **Colocation data centres** are often larger. These data centres can be used by multiple organisations. The organisations have their own servers; the data centre provides the location and additional services, such as cooling, power, communication lines, and security services.
3. **Hyperscale data centres** are the largest type of data centres. These facilities are generally built by and for single occupants such as Microsoft, Amazon, Alphabet or Meta. These large companies need a lot of computing and storage capacity. The combination of similar computing tasks and scale makes it possible to achieve efficiencies through data centre design, the efficient use of hardware, optimal procurement policies and tailor-made hardware and software designs. Services that can be performed through these data centres are managed services, cloud computing or communication services.

Locational factors

Some places are better suited to locate data centres than others. Data centre operators prefer to choose a safe place that has large amounts of (green) energy available. This safety is determined by whether locations are safe – i.e., are tectonically stable, and have a low risk of flooding. Since the cooling of data centre servers costs a lot of energy, locations in mild climates are preferable. Locations with network effects are also desirable. This means that there is an established IT sector, good availability of knowledge, and fast connections through up-to-date infrastructure. A favourable regulatory and tax regime is also important.

Different types of data centres

Type	User	Size	Use
Hyperscalers	Single/multiple user	Biggest	Efficient
Colocation data centres	Multiple users	Big	Infrastructure as a service
Enterprise data centres	Single user	Relatively small	

This article is part of a series which also evaluates the energy use of the data centre sector, as well as measures that the financial industry can take to reduce its environmental impact. Through green bonds and other sustainability frameworks, the financial industry can help promote the increasing efficiency of data centres and support the decarbonisation efforts of the sector.

Author

Diederik Stadig
Sector Economist, TMT & Healthcare
diederik.stadig@ing.com

Jan Frederik Slijkerman
Senior Sector Strategist, TMT
jan.frederik.slijkerman@ing.com

Coco Zhang
ESG Research
coco.zhang@ing.com

Article | 24 October 2023 **Energy | Sustainability | TMT**

Data centres provide a boost to companies’ energy efficiency efforts

Amid the ongoing energy transition, the infrastructure for green electricity supply is under pressure to meet growing demand. This poses a challenge for fast-growing sectors, such as Information and Communications Technology. Fortunately, the data centre sector has avenues to improve efficiency

As the focus on companies' environmental footprint increases alongside the digitisation of our economy, the most sustainable data centres will be able to gain a competitive edge

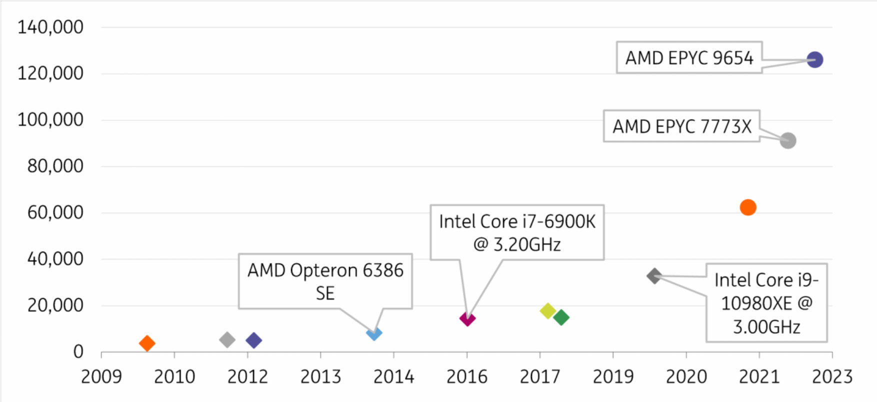
Computing power grows at an exponential rate

In the past decade, the data centre industry has witnessed a decoupling between the growth in compute instances (explained below) and the energy use of data centres. In this article, we want to highlight three main developments:

1. The spectacular increase in computing capacity;
2. The role played by data centres in increasing the proportion of energy use for computing functions. That is to say, a relatively larger share of energy use is consumed by the primary activity of a data centre;
3. An increase in the use of energy by data centres, which is far smaller than one would expect

based on the computational output.

Indicative processor speed developments (CPU Mark)



Source: cpubenchmark.net, ING

A compute instance can be seen as a virtual machine, a server resource provided by a third-party cloud service. Until 2020, the number of compute instances increased roughly eightfold, from 100mn to 800mn, according to Masanet et al. This is an impressive increase and can be explained by the rise in the number of servers and the continued evolution in hypervisor-based applications, as well as by the increase in computing power over time, which allows for more virtual machines to be run on servers. An indication of the development in server capacity is shown in the graph above. Server sales have also gone up considerably, according to IDC data. In 2022, 13.8m servers (x86 architecture) were sold, which is up from 11.8mn in 2018.

The servers themselves, which are installed in data centres, have also become more efficient over time. Microchips have become more energy efficient due to innovations in microchip design and manufacturing capabilities. As a result, data centres have been able to perform many more calculations, while keeping the relative power consumption in the DC in check. Also, microchips and software can be designed for specific applications, which can enhance efficiency.

In their 2010 research paper, Koomey et al evaluate computational power efficiency. According to Koomey's Law, the number of computations per joule of dissipated energy doubled every 1.57 years from 1945 to 2000 (100x per decade). After 2000, the efficiency advance rate slowed down but still doubled approximately every 2.6 years. In addition to technological advances in the domain of semiconductors, there is also scope for other efficiencies, such as more efficient software, compression applications, Hadoop and the optimal use of servers.

Masanet et al (2020)

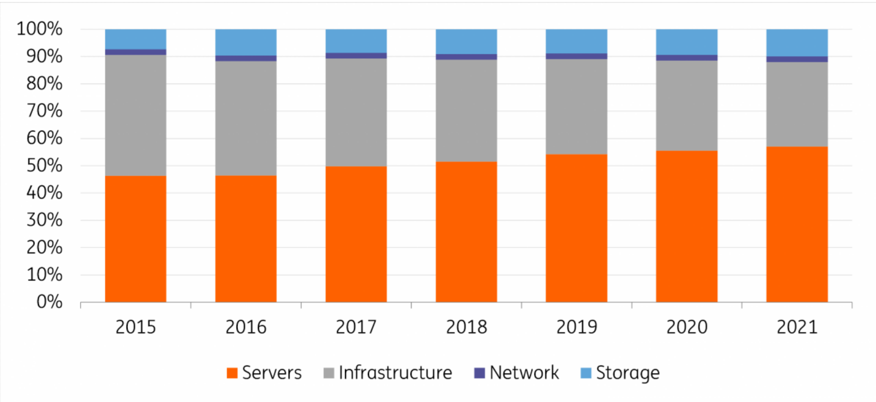
Koomey et al (2010)

More energy allocated for use by servers (computing)

While the computational efficiency has gone up over time, so too has the efficiency of data centres. We believe it is important to look not just at the total energy consumption of data centres, but also at the way this energy is used. Today, servers, performing the compute function, take a proportionally larger share of the total electricity consumption of data centres, while the share of other components (non-computing) has gone down. We will elaborate on this below, but the main takeaway is that this change makes data centres more efficient. This gain comes on top of the potential efficiency gains of the servers themselves (as described above).

The three main functions of data centres (storage, distribution, and processing) all require electricity. Yet not all three functions do so in equal parts. **Storage** (saving information on a storage device) is not the most energy-intensive function and has become more efficient over time. Also, the **network function** (or communication function) has seen significant efficiency gains over time so this is not the most energy-intensive in a data centre. Despite the intuitive expectation that an increase in traffic implies more energy use, existing fibre networks often have substantial spare capacity and can often be upgraded to faster standards with a disproportionate increase in energy use. Today, the most energy-intensive data centre function is **processing or computation**. The servers that perform calculations require energy, and energy use increases with the server's capacity. It is on the servers that the actual software runs (from office and banking to social media and AI applications). Finally, the (physical) **infrastructure** of a data centre has to be powered. This function includes the energy costs of cooling the data centre. Notably, the energy demand of the servers as a percentage of total data centre energy demand has increased from 46% in 2015 to 57% in 2021.

Larger proportion energy take-off used directly for servers

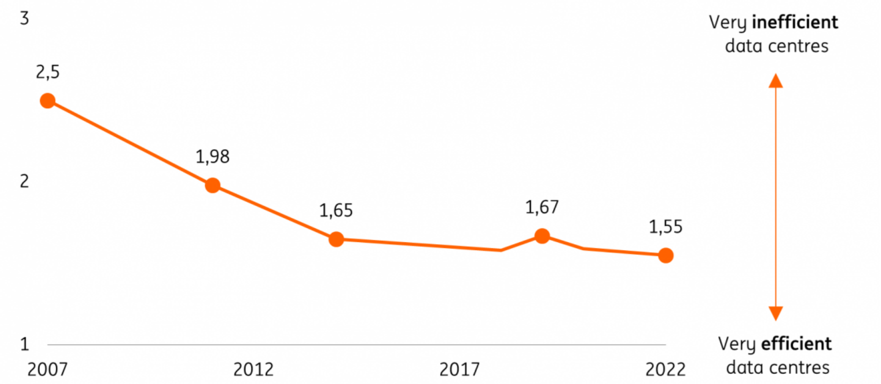


Source: IEA & Masanet et al. (2020)

Efficiency of data centres has improved substantially over the past decade

A frequently used measure to gauge the enhanced energy efficiency of data centres is power usage effectiveness (PUE). PUE compares the amount allocated to non-computing uses (such as cooling) to the amount of energy used to power IT equipment (such as compute and storage functions). As a result of technological progress PUE has gone down, from an average of 2.5 in 2007 to 1.55 in 2022. Large data centre builders (such as Equinix, NTT and Digital Realty) have reported that the PUE of new data centres hovers between 1.2 and 1.1 whereas average PUEs are between 1.6 and 1.4. Google's newest data centres are reported to have PUEs below 1.1.

Average annual power usage effectiveness (PUE) at the largest data centre of operators worldwide



Source: Uptime Institute; A PUE of 2 means that for every watt of IT power, another watt is consumed for cooling and other non-IT equipment. A PUE of 1.0 means that all energy is used for computing.

While PUE has become a standardised metric in measuring data centre energy efficiency, there has been some debate over whether it is effective. Now that PUEs are approaching 1.0 among some companies, the extent to which this metric can measure future efficiency gains becomes questionable.

Moreover, PUE does not measure energy consumption at the rack level, which indicates that the ratio is not as comprehensive. PUE can be impacted by (i) region, (ii) utilisation levels of the DC, (iii) the primary function of a DC – storage, communications, how companies are using their IT infrastructure and (iv) type of DC, as retail colo or hyperscalers differ in terms of infrastructure control and standardisation potential. That said, PUE is still a widely accepted and implementable benchmark that allows companies and investors to make comparisons.

Energy use statistics do not include the switch-off of enterprise data centres

Across the economy, there is also scope for further efficiency gains. The implementation of IT services is moving away from on-premise servers to off-premise data centres, as well as from smaller enterprise data centres to large and (or) efficient data centres, such as hyperscalers.

The proportion of servers housed in efficient hyperscalers went up from 7.7% in 2010 to 38% in 2018 (Masanet et al, 2020). A study commissioned by Microsoft (updated in 2020) finds that companies could potentially save 22-93% of energy when they run applications in the cloud. An earlier, 2013 study, commissioned by Google, found a potential efficiency gain of 87%. However, often, only the energy use of the data centres is measured, not its offsetting impact of obsolete corporate data centres or the energy requirements associated with the actual data transmission. This is shown in the example below.

Example of increased efficiency

An example of the impact on energy use from server migration can be found in the Netherlands. The percentage of the national electricity use of data centres has grown from 1.5% in 2017

(1,65TWh) to 3.3% in 2021 (3,73TWh). However, this increase in electricity is measured because the off-premise data centres now consume more energy, while the declining use of the legacy (on-premise) is not reflected in the figures on data centre energy use. Hence, when institutions move their servers to an off-premise facility, energy use of data centres rises on paper but there may actually be a net saving of energy. This was the case in the Netherlands when the Dutch government moved its servers from 60 on-premises locations to five large off-premise ones, and the energy use of servers by the Dutch government went from 235GWh to 128GWh.

The main challenge for researchers investigating efficiency gains in the data centre sector is that there is sometimes only data on the energy use of data centres within a country, while the decreasing use at the site of companies is not explicitly measured. There is hardly any energy consumption data measuring the uses of servers that are switched off within companies. This likely overstates the increase in electricity demand by data centres, also because data centre services in a country can replace servers in other countries. Finally, there are projects through which data centres reuse waste heat for heating residential and commercial areas, which complicates the measurement of net energy use further.

Data centres consume more energy, but by less than what could be expected

It is hard to find a precise measure of the energy use of data centres. The IEA estimates that the global use of electricity by data centres has gone up by 20%-70% from 2015-2022 to 240-340TWh (excluding the electricity use associated with crypto, roughly 110TWh in 2022) while the total electricity use by Amazon, Microsoft, Google, and Meta more than doubled to 72TWh from 2017 to 2021. According to Masanet et al (2020), the increase in electricity use has been more moderate from 2010-2018, increasing by 6% to 205TWh.

They estimate that the impact of efficiency measures has been tremendous (20% per annum, expressed as energy use per compute instance). The EU has also evaluated energy use and found that “the energy consumption of data centres in the EU28 increased from 53.9 TWh/a to 76.8 TWh/a between 2010 and 2018. This means that in 2018, data centres accounted for 2.7% of the electricity demand in the EU”.

The way we look at the figures above is that the increase in energy use matches the ICT sector GDP growth, of c.6% per annum. This number also matches the increase in annual server sales. Note that these increases are smaller than the increase in computing power, which has risen over time and reflects the substantial efficiency gains made.

How do we look at future energy demand from servers and data centres without strong AI growth?

With the arrival of new technologies such as generative AI and the Internet of Things (IoT), the demand for the computing potential of data centres will likely grow further. Therefore, society needs an increase in computing power. Part of this demand can be met through efficiency gains at the server level, but we also expect that the number of servers will increase as a result of these trends. When looking at the future electricity demand, this is largely driven by the increase in the number of servers. Let’s assume that the number of servers increases at a high single-digit annual growth rate in the medium term. This should (on average) also provide an estimation for the growing electricity demand of the ICT sector. Note that the growing availability of servers implies an even higher increase in workloads due to faster servers, which is beneficial – but it will also cost more power.

Moreover, the efficiency of the new servers is an important element in determining total electricity demand. We do not have a forecast for this, because it could go both ways. Servers could become more efficient, lowering energy consumption. Higher workloads, however, could also be responsible for increasing power consumption.

How does AI change the picture?

Recent developments in generative AI, such as the launch of GPT-4 and its uptake by the public, have caused an increase in demand for the computing power of data centres. This also means an increase in the electricity use of data centres, as 'compute' is an energy-intensive function. The extent of the increase of generative AI use remains uncertain. Yet, De Vries (2023) worked out multiple scenarios based on NVIDIA's AI servers, as INVIDIA has a 95% market share. The 100,000 servers NVIDIA delivers in 2023 will consume between 5.7 and 8.9 TWh of electricity, which is a large amount of energy but is not very significant given the overall demand of the sector. In addition, challenges in the manufacturing of advanced semiconductors may prevent fast adoption. However, NVIDIA may be able to deliver many more AI server units in the future. According to De Vries (2023), these servers could annually require as much as 134 TWh of electricity in 2027, an extreme scenario. This would of course be a large amount of electricity.

It is important to note, however, that these calculations hinge on a variety of factors that are, as of yet, uncertain, such as the ability to have profitable business models at that scale, and also the absence of further efficiency enhancements (in both hardware and software). Moreover, in our base case, we already assume a mid- to high-single-digit increase in annual server growth. Accelerated growth in generative AI would increase server growth further, but our base case can already account for regular growth in AI.

In short, the expected growth of the data centre sector is a consequence of the increasing digitisation of our economy. However, since many companies must report the environmental footprint from their procured services, environmental impact measures of data centres, as described in sustainable finance frameworks, will become more important over time. This will give the most sustainable data centres a competitive edge. We discuss this in the article about data centres and sustainable finance.

Author

Jan Frederik Slijkerman
Senior Sector Strategist, TMT
jan.frederik.slijkerman@ing.com

Diederik Stadig
Sector Economist, TMT & Healthcare
diederik.stadig@ing.com

Coco Zhang
ESG Research
coco.zhang@ing.com

Article | 24 October 2023

Energy | Sustainability | TMT

Growth in water consumption of data centres needs more attention

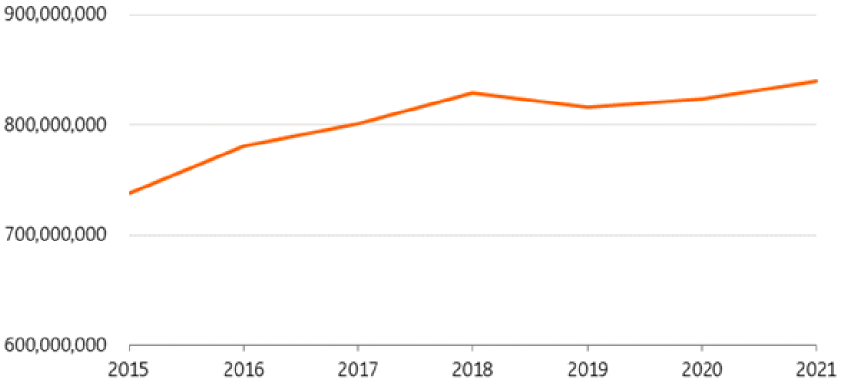
While energy efficiency and greenhouse gas emissions have become mainstream in the sustainability strategies of data centres, water management is an area that needs more attention

In order to continue using water to cool data centres, companies now need to enhance water usage efficiency, work with local communities and minimise the risk from droughts

Water consumption by big tech firms has surged

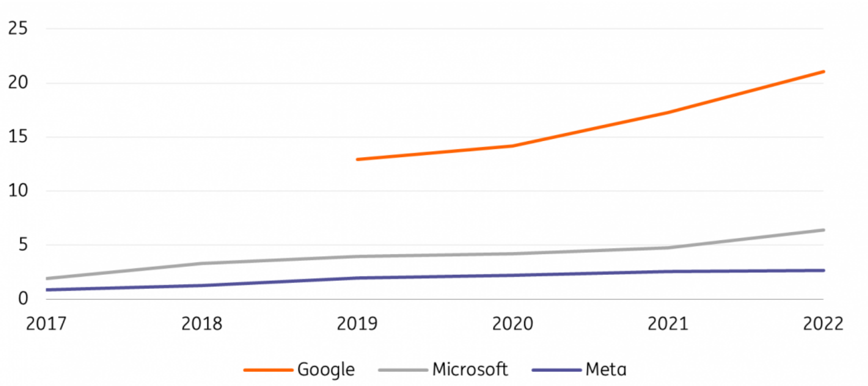
Some data centres can use water for the cooling of their suites that house the cabinets and racks. With the increase in servers, water consumption from data centres has risen significantly worldwide from 738 million litres in 2015 to more than 840 million litres in 2021, as can be seen in the graphs below. This is largely driven by the rising water usage by big technology companies. In the US, which has about 25% of the data centres globally, a mid-sized data centre uses about 300,000 gallons of water a day, equal to the water consumption of 100,000 homes.

Water consumption of data centres globally in litres per day



Source: WSJ

Water consumption by Microsoft, Google and Meta in billion litres per year



Source: ING Research based on company reporting (Note: Water consumption = water withdrawal – water discharge)

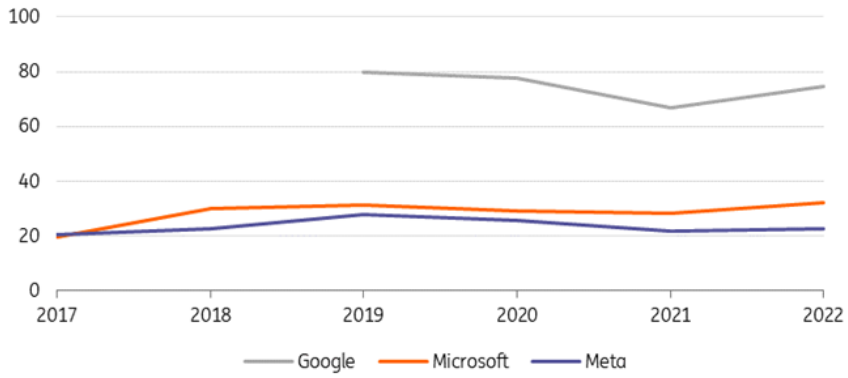
Managing water usage

The challenges data centres face around water usage are often related to their geographical location. Data centres are sometimes in areas where water sources are scarce. For instance, in 2022, 23% of Microsoft's and 18% of Google's freshwater withdrawals were from water stress areas. This means that to continue using water to cool data centres, companies need to enhance water usage efficiency and minimise the risk from droughts. They must also properly manage relationships with the local community for large amounts of water consumption.

Companies like Microsoft and Google have been working on water replenishment through projects such as water conservation to offset their consumption. Microsoft plans to be 'water positive' by 2030 by reducing water consumption, replenishing more than it uses, providing people with access to water and sanitation services, and engaging in water policy. But there is a long way to go to replenish more than one consumes. Google is one of the only companies to have reported that it replenished 6% of its freshwater consumption in 2022. There are more nuances to this. If a company consumes less water than it replenishes at the global level, it could still worsen water stress situations in a specific region while replenishing water elsewhere.

Other practices include water recycling, cooling system upgrading, and research & development to bring innovative technologies into use. Although more data centres and technology companies are actively managing water usage, reporting on water usage is not as widespread as reporting on power consumption or energy efficiency. Companies need to up their game. In addition to absolute usage, there is limited disclosure of relative water consumption metrics (some metrics can be calculated from other disclosed data). The first is Water Usage Efficiency (WUE). Similar to PUE, WUE is the ratio between annual data centre water usage and the energy use (kWh) of ICT equipment. The second metric is water consumption as a ratio of company revenue. For big technology companies, this ratio has more or less stayed stable over the past few years. This possibly indicates that there is room for improvement for more efficient water management.

Water consumption intensity by Microsoft, Google and Meta in cubic meters per $million of revenue



Source: ING Research based on company reporting

More work needed

These metrics would allow for better comparisons among peers. Some investors are becoming interested in looking at water and water intensity-related metrics when considering sustainable finance products. In a nutshell, water usage is attracting attention from the data centre industry, but a lot more effort is needed to bring net water usage down and report on progress.

Author

Coco Zhang
ESG Research
coco.zhang@ing.com

Jan Frederik Slijkerman
Senior Sector Strategist, TMT
jan.frederik.slijkerman@ing.com

Diederik Stadig
Sector Economist, TMT & Healthcare
diederik.stadig@ing.com

Article | 24 October 2023 Energy | Sustainability | TMT

Sustainable finance helps data centres reduce their environmental impact

Pressure to accelerate data centre decarbonisation is mounting as a result of new regulations and ESG, and companies are increasingly using sustainable finance products to help reach their environmental goals

Sustainable finance products now provide an effective tool for data centres to fund their decarbonisation efforts and reach key environmental goals

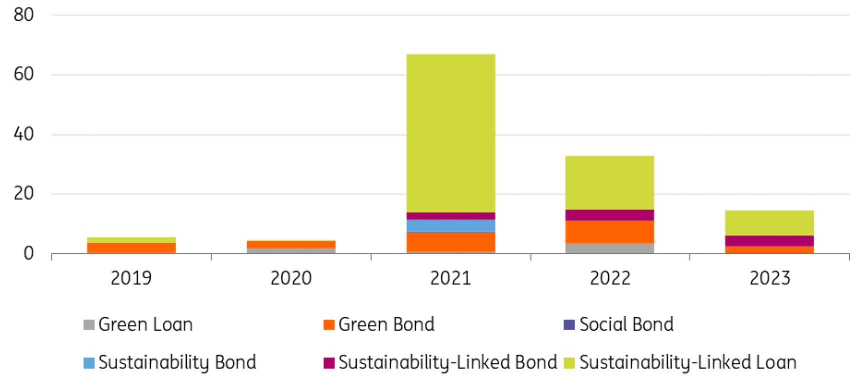
Pressure for data centre decarbonisation is mounting

The pressure for data centres to accelerate decarbonisation has never been stronger. Environmental, Social, and Governance (ESG)-conscious investors and corporate clients of data centres are demanding lower emissions. Moreover, mandatory sustainability data disclosure is forcing data centre providers to manage their sustainability efforts more actively.

In the EU, with the Energy Efficiency Directive (EED) and Corporate Sustainability Reporting Directive (CSRD) coming into force (the latter requires c.50,000 companies to report their direct and indirect emissions from 2024 onwards), data centres (with an installed IT power demand of at least 100 kilowatts) will need to provide detailed public reports of their energy usage and performance. The EU Taxonomy also includes a reference to the European Code of Conduct on Data Centre Energy Efficiency. In the US, the signing of California's Climate Corporate Data Accountability Act (SB 253) and Climate-Related Financial Risk Act (SB 261) together require thousands of companies to report quality climate data. These acts will likely impact the Securities and Exchange Commission's highly anticipated climate disclosure rules, likely this year. Moreover, states such as Virginia and Oregon have proposed bills to strengthen data centre sustainability reporting and slash emissions by 60% by 2027.

Sustainable finance products remain an effective tool for data centres to fund their decarbonisation efforts. This is the case despite uncertain economic conditions and government sustainability policies contributing partly to a decline in issuances among a wide range of corporates – including those in the technology sector – from January to September this year compared to the same period in 2022. Sustainability-Linked Loans (SLLs) is still the dominating ESG financing mechanism in the techology space (58% of the sector's total issuance in Jan-Sept 2023, up from 55% in 2022). This contrasts with a sharp decline in the share of SLLs in the general sustainable finance market this year.

Global issuance of sustainable finance products in the technology sector (US$bn)



Source: Bloomberg New Energy Finance, ING Research
Note: 2023 data is from January to September

Indeed, companies with substantial data centre operations have been using sustainable finance products to help reach their sustainability goals. Through an examination of company green bond frameworks, we found that common eligible projects for financing include (1) energy efficiency improvement, measured in power usage effectiveness (PUE); (2) renewable energy solutions; and (3) the greening of buildings, benchmarked by building efficiency certifications. These cover a good range of material climate issues for data centres.

What is not as common in these frameworks but requires increasing attention is water management, as our analysis shows a need for data centres to tackle risks around water stress and local community relationships. That said, when establishing its sustainable finance framework, a company needs to have a good breadth and depth of eligible project areas that address environmental concerns and not ignore any issues that can introduce more risks in the long term.

Green bond framework and impact metrics of companies with data centre operations

Equinix

Highlights of eligible projects related to data centres in green bond frameworks	Example impact reporting metrics
• **Green buildings:** design, construction, and maintenance of buildings (including data centres) that achieve a certain certificate or have a design of average annual PUE at or below 1.45	• Data center that is certified (type of scheme, certification level, sqm/sqft certified) • Design average annual PUE (no.) (site-level) • Emissions avoided (mtCO2e) over a building's lifetime or annually • Embodied carbon quantified (kg CO2e/square foot by project)
• **Renewable energy:** generation, procurement, and conversion to clean fuel	• Electricity from clean and renewable energy (MWh) • Percent renewable energy for global portfolio (MWh renewable / MWh electricity consumption) • Annual emissions reduced/avoided (mtCO2e)
• **Energy efficiency**: improvements of efficiency (a 2% per annum improvement in a site's power usage, or a top 15% score based on the US ENERGY STAR Industry benchmark; innovative cooling systems, technology optimizations)	• Energy savings (MWh/year or over project lifetime) • GHG emissions avoided (mtCO2e) • Operational average annual PUE (no.) (site-level)
• **Sustainable water and wastewater management**: water-efficient cooling solutions, infrastructure upgrades, etc.	• Water use savings (gallons) • Reclaimed (greywater or rainwater) water used (gallons)

Source: Company data

NTT

Highlights of eligible projects related to data centres in green bond frameworks	Example impact reporting metrics
• **Energy efficiency:** Highly efficient and power-saving data centres: PUE under 1.5	• Volume of CO2 emissions (tCO2)
• **Green buildings:** design, construction, and maintenance of buildings (including data centres) that achieve a certain certificate, or buildings with a power-saving evaluation of AAA based on the Tokyo Building Environment Plan	• Name of green property, certification level, etc. • Volume of CO2 emissions (tCO2)
• **Renewable energy**: renewable power generation	• Power generation capacity/actual volume (GWh) • Volume of CO2 emissions reduced (tCO2)

Source: Company data

Digital Realty

Highlights of eligible projects related to data centres in green bond frameworks	Example impact reporting metrics
• **Green buildings:** projects that contribute to the receiving of green building certificates	• Name and information of projects that have achieved certification
• **Energy and resource efficiency:** improvement of the energy or water efficiency of a building, a building subsystem, or land by at least 15% from a determined baseline	• MWh of energy efficiency savings
• **Renewable energy:** Renewable energy and low carbon energy supply solutions including generation, procurement, and storage	• MWh of renewable energy produced

Source: Company data

Alphabet

Highlights of eligible projects related to data centres in green bond frameworks	Example impact reporting metrics
• **Energy efficiency:** design, construction, operation, and maintenance of facilities (data centres of a PUE of less than 1.5; server, storage, or networking efficiency and utilization)	• Trailing 12-month (TTM) PUE
• **Clean energy:** Renewable energy generation, storage, and procurement; equity investments in renewable energy projects	• Annual GHG emissions reduced/avoided (tCO2e) • Renewable energy capacity commitments (MW)
• **Green buildings:** design, construction, and maintenance of buildings (including data centres) that achieve a certain certificate	• office space that is Gold or Platinum LEED-certified (sqm)

Source: Company data

Apple

Highlights of eligible projects related to data centres in green bond frameworks	Example impact reporting metrics
• **Energy efficiency:** energy efficiency projects intended to reduce emissions in new or existing infrastructure	• Lifetime carbon benefit (tCO2e)
• **Renewable energy** projects	• Renewable energy capacity (MW)

Source: Company data

Amazon

Highlights of eligible projects related to data centres in green bond frameworks	Example impact reporting metrics
• **Renewable energy:** generation, procurement, renewable energy storage installation	• Renewable energy capacity commitments (MW)
• **Sustainable buildings:** design, construction, and maintenance of buildings (including data centres) that achieve a certain certificate	• Square footage built that is Gold or Platinum LEED-certified

Source: Company data

Impact reporting—the disclosure of both use-of-proceeds allocation and the improvement of environmental impact—is a crucial practice to boost issuer sustainability credibility. For instance, Equinix allocated $3.66bn of green bond use of proceeds as of June 2022, with almost 98% dedicated to lowering the design average annual power usage effectiveness to 1.45 or below. Equinix's annual average PUE decreased from 1.54 in 2019 to 1.46 in 2022. Comparatively, Alphabet's cumulative $5.69bn of ESG bond allocation has been mainly toward green buildings (48%), clean energy (31%), and energy efficiency (18%). On the back of their green bonds, Alphabet has reported that 25mn tonnes of CO2 equivalent has been avoided through renewable energy power purchase agreements (PPAs), and 807,000 square metres of LEED Platinum-certified office space.

While the reported data already shows a fair level of company commitment to sustainability reporting, there is still great room for improvement. This includes:

- Disclosing more detailed data across metric categories. According to a survey by Uptime

Institute covering more than 700 companies in the data centre industry, 88% of the respondents report IT or data centre power consumption, 71% report on PUE whereas only 41% report on water usage and 34% disclose renewable energy consumption.

- Choosing a good combination of absolute data (e.g. water usage amount) and ratios (e.g. water usage energy intensity), as well as further breakdowns of data by product, operation, project, or geography.
- Reporting separately on data centre decarbonisation results, but also contextualising data centre numbers in the bigger picture of a company's entire operations.

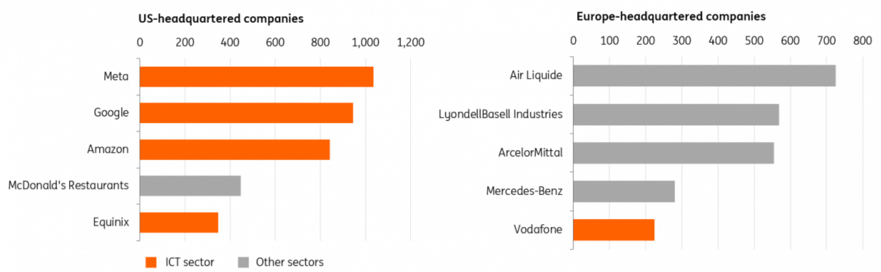
Finally, reporting metrics need to be updated as needed. For instance, if a company has been consistently achieving a low PUE number, then it might need to add further metrics to reflect ongoing sustainability efforts more precisely.

Most companies also acquire and publish third-party assurances of green bond allocations, and this will enhance investor confidence that the use of proceeds is indeed going into eligible green projects indicated in companies' sustainable finance frameworks. In an environment where greenwashing is increasingly criticised and less tolerated, it is important for issuers to provide assurances to investors that the proceeds of loans and bonds have been allocated to high-quality projects, with the desired associated impact.

Ramping up investments in renewable energy

In addition to the increased energy efficiency, data centres substantially rely on renewable energy—through the buying of power purchase agreements (PPAs) and direct investment—to achieve carbon neutrality targets. Google, Amazon, Meta and Microsoft have all committed to this goal and are among the largest corporate purchasers of renewable energy along with other data centre operators such as Equinix.

Top Corporate Power Purchase Agreement (PPA) buyers in 2023 (January to Mid-September, in MW)



Source: ING Research based on Bloomberg New Energy Finance

As a result, large technology companies have mostly achieved 100% use of renewable electricity, while Equinix and Digital Realty powered 96% and 62% of their operations with renewable energy in 2022, respectively. It is also no surprise then that 21% of data centre executives say that the opportunity to buy more renewable energy is the biggest driver of data centre sustainability in the next five years.

The purchase of renewable energy and robust sustainable finance frameworks will further develop the sustainable finance market. First, data centre companies can choose to use sustainable finance to support the investment aimed at becoming more environmentally friendly. Second, the large demand for renewables (through power purchase agreements) can also spur clean electricity developers to finance capacity expansion.

One could perceive the procurement of green energy by data centres as a problem because it is a scarce commodity. Nevertheless, one reason the sector procures green energy is that margins allow it to do so. Moreover, the companies have the scale and willingness to sign large PPA contracts. It shows that the sector is relatively profitable and growing fast, which enables the transition to a green and digital economy.

Author

Coco Zhang
ESG Research
coco.zhang@ing.com

Diederik Stadig
Sector Economist, TMT & Healthcare
diederik.stadig@ing.com

Jan Frederik Slijkerman
Senior Sector Strategist, TMT
jan.frederik.slijkerman@ing.com