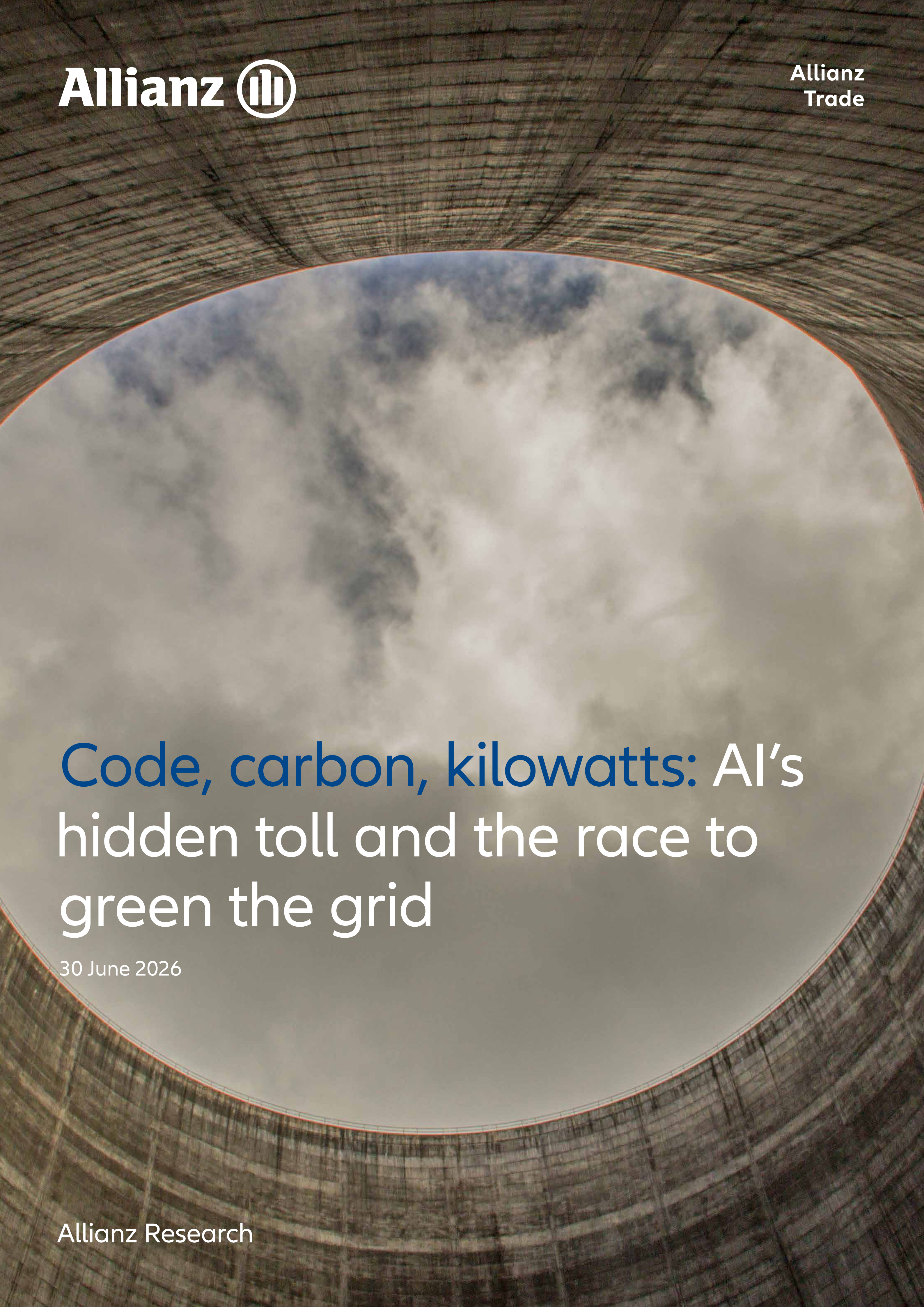

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Allianz Trade

# Code, carbon, kilowatts: AI's hidden toll and the race to green the grid

30 June 2026

Allianz Research

# Content

# Executive Summary


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- **Data-center investment reached USD580bn in 2025, putting AI on track to become one of the world's fastest-growing sources of electricity demand.** Installed capacity is expected to double by 2030, with AI workloads already accounting for 15–20% of data-center electricity use and potentially approaching 40% by the end of the decade. Yet the sector's environmental footprint remains underestimated as most analyses focus only on operational electricity use. This analysis takes a broader systems view across 26 countries (+93% of global capacity), adding lifecycle emissions, water use and AI's growing resource demand.

- **Identical workloads can generate up to 24 times more emissions depending on the emission intensity of the grid, making location as decisive as demand growth.** Fossil-dependent grids in Indonesia, India and Malaysia exceed 600 $gCO_2$/kWh, compared with under 30 $gCO_2$/kWh in Norway and Sweden. The US and China, which host the largest data-center clusters, sit in between at 384 $gCO_2$/kWh and 526 $gCO_2$/kWh, respectively, giving Europe's cleaner power mix a structural advantage for low-carbon AI growth. These disparities are amplified by transmission and distribution losses of 10–15% in some markets, while less reliable grids raise electricity needs and dependence on backup generation.

- **At 286 $MtCO_2$ in 2025, the true carbon footprint of data centers is 57% larger than IEA estimates suggest.** Electricity consumption (Scope 2) accounted for 76% of this footprint, at 218 $MtCO_2$, with hardware manufacturing and construction (Scope 3) contributing a further 66 $MtCO_2$, or 23%, and direct Scope 1 emissions remaining negligible (<1%). Emissions are also heavily concentrated geographically, with the US and China alone accounting for roughly 70% of the global total. AI accounts for an estimated 43-60 $MtCO_2$ of today's emissions, and this is set to climb steeply as deployment widens and computing demand grows.

- **Without grid decarbonization, global data-center emissions would more than double to 643 $MtCO_2$ by 2030, leading to an estimated USD154bn in annual climate damages (up from USD68bn today).** AI workloads already account for an estimated USD13bn in climate damages annually and could exceed USD50bn by 2030. By contrast, an ambitious decarbonization pathway would hold emissions to around 329 $MtCO_2$ despite continued growth in computing demand, and keep climate damages at USD79bn. This makes the pace of power-sector decarbonization the primary determinant of whether AI growth can be decoupled from emissions in the near term. Even under ambitious decarbonization, however, the footprint does not vanish but moves up the supply chain: as Scope 2 falls from more than 70% of the footprint today to around half by 2030, embodied emissions from servers, semiconductors and infrastructure become the binding constraint, approaching 50% of the total. Achieving genuinely low-carbon AI will therefore require not only cleaner power, but also closer attention to emissions embedded in digital infrastructure supply chains.

- **Deployed across the economy, AI could cut global $CO_2$ emissions by around 1.4 Gt a year by 2035, more than offsetting the emissions generated by its own infrastructure and creating net savings of roughly 750 $MtCO_2$.** According to the IEA, these reductions would result from efficiency gains, optimization and improved resource management across sectors such as energy, industry, buildings and transport, and are equivalent to around 2.6% of current global emissions. However, this outcome is not guaranteed. With most AI applications still at an early stage of deployment, its ultimate climate impact will depend on whether these economy-wide benefits can scale faster than the infrastructure required to support them.

- **Data centers consumed 814bn liters of water in 2025 and could require 1.3–1.8trn liters by 2030, comparable to Switzerland's annual consumption, making water the overlooked resource constraint of AI.** Most of this footprint is indirect, with roughly three-quarters originating from electricity generation and the remainder from on-site cooling and semiconductor manufacturing. This ties water use closely to the energy transition, since fossil and nuclear plants require substantial cooling water while wind and solar use little or none in operation, lowering both the carbon and water footprints of a cleaner grid. Although power-sector decarbonization can help moderate future water demand, water-related risks are becoming increasingly concentrated in water-stressed regions such as South Korea, India, Mexico and parts of China, where rapid data-center growth is colliding with existing pressure on local water resources, raising the risk of access constraints and community or regulatory opposition to new capacity.

- **Realizing „green AI" will depend less on making data centers marginally more efficient than on transforming the energy systems that power them.** Unlocking AI's environmental potential will require a broader policy framework, combining clean-power expansion, greater transparency on resource use, stronger incentives to price environmental costs, and faster deployment of AI applications that reduce emissions across the wider economy.

# Setting the scene: Power demand growth and impact on energy investments

**Data center investment reached USD580bn in 2025 and installed capacity is set to double again by 2030, but the sector's environmental costs and geographic scope remains poorly understood.**[1] In 2024, the IEA estimated that global data center emissions from electricity use stood at around 180 MtCO2 (0.3% of global emissions), comparable to the total emissions of Kuwait and sufficient to place the sector among the top quarter of global emitters if it were a country. The carbon intensity of individual AI models illustrates how rapidly this trajectory is accelerating: Training AlexNet in 2012 produced an estimated 0.01 tCO2 equivalent, whereas training Grok 4 in 2025 generated approximately 72,816 tons, exceeding the lifetime carbon output of more than 1,000 average cars.[2] Looking ahead, the IEA projects that emissions from data-center electricity use could rise from 180 MtCO2 today to 320 MtCO2 by 2030 in its baseline scenario, and to as much as 500 MtCO2 under a high-growth scenario (0.6-0.9% of global emissions).[3] Importantly, these projections account only for operational emissions associated with electricity consumption, leaving a substantial gap in our understanding of the sector's broader environmental footprint.

**To address these gaps, this analysis adopts a broader systems perspective on the environmental implications of data-center growth.** It focuses on 26 countries that together account for more than 93% of global data-center capacity and represent the principal geographies for both digital infrastructure and AI deployment. In addition to operational emissions from electricity use, the analysis considers lifecycle emissions across the different emission scopes, assesses the sector's water footprint and evaluates the increasingly important contribution of AI workloads to future resource demand. Together, these dimensions provide a more comprehensive assessment of the environmental consequences of rapid data-center expansion.

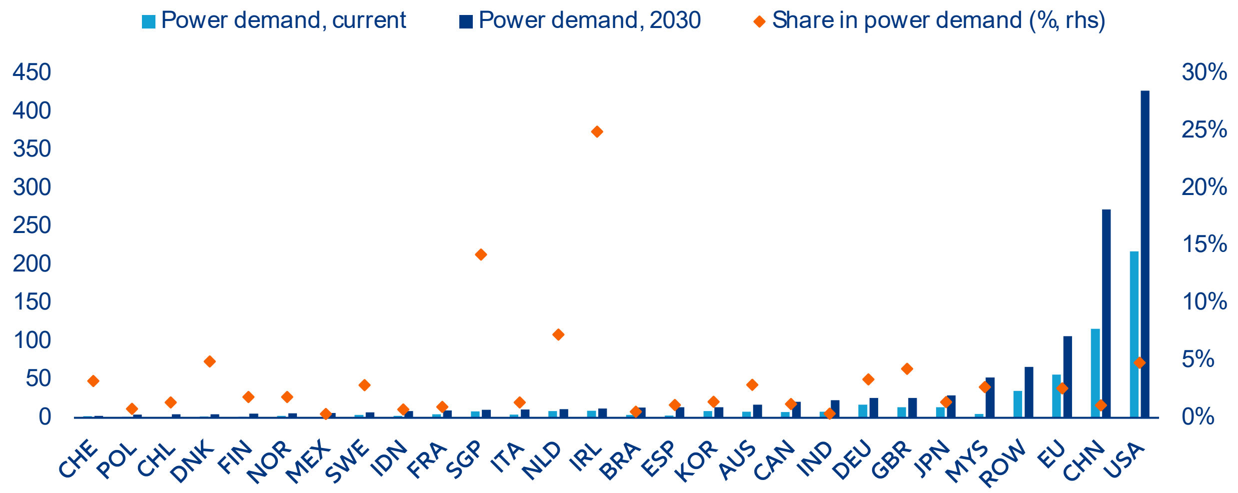
**A first step in understanding these impacts is to examine how data-center capacity and electricity demand are evolving across major markets.** Estimates of electricity demand are derived from installed computing infrastructure, adjusted for regional power usage effectiveness (PUE) and utilization rates averaging around 49%, with country-specific variations in line with IEA region estimates. Future demand is projected to 2030 using announced capacity pipelines and official forecasts where available, providing a baseline assessment of likely sectoral growth should currently planned developments materialize.

[1] 2026 Data Center Marketplace Report | Colliers
[2] 2026 AI Index Report (Stanford HAI)
[3] AI and Energy 2025 (IEA)

**Based on this approach, data-center electricity demand globally is estimated to have reached approximately 515 TWh in 2025 and could more than double to around 1,110 TWh by 2030 (Figure 1).** Such growth would make data centers one of the fastest-growing sources of electricity consumption and an increasingly important driver of power-demand growth in several major economies. While expansion is occurring across most regions, growth remains heavily concentrated in the sector's two largest markets. The US is projected to account for the largest absolute increase in demand, adding approximately 49 GW of data center load, equivalent to around 210 TWh of annual electricity consumption by 2030. China follows with an additional 38 GW, or roughly 155 TWh. Together, the two countries are expected to retain approximately 63% of global data center demand by the end of the decade, only marginally below their current share of 64%, highlighting the continued concentration of digital infrastructure despite the emergence of new regional hubs.

**Beyond the two largest markets, some of the fastest relative growth is expected in emerging data-center hubs.** Electricity demand could increase by a factor of three to eight in Malaysia, Mexico and Spain, reflecting strong investment pipelines and their growing role as alternative locations for digital infrastructure, driven by competitive energy costs, supportive policy frameworks and strategic connectivity to adjacent markets. However, these estimates remain subject to considerable uncertainty as a substantial share of announced capacity has yet to reach final investment decisions, secure grid connections or obtain long-term power supply agreements.

**Figure 1:** Data-center power demand in 2025 by country (TWh, left) and share in total demand (%, right)[4]




Sources: Allianz Research based on EMBER, IEA, LBNL

[4] For specific country level power capacity and demand estimates, see Table A1 in the Appendix

**The system-level implications of this expansion are already visible in several smaller and highly digitalized economies.** Ireland stands out as the most exposed, with data centers accounting for approximately 25% of total electricity demand. Significant impacts are also evident in Singapore at around 14%, while the Netherlands has reached approximately 7% and both Denmark and the US around 5%. At these levels, data-center growth is increasingly shaping national demand trajectories and raising constraints around grid capacity, permitting and decarbonization planning.

**A key uncertainty is the extent to which artificial intelligence is driving this demand growth.** While attribution remains complex, current estimates suggests AI workloads are becoming increasingly material: The IEA reports that AI-accelerated servers accounted for around 15% of total data-center electricity demand in 2024, while Gartner projects the share of AI-optimized servers could rise from 21% of power demand in 2025 to 44% by 2030. Similarly, Goldman Sachs estimates that AI workloads currently account for around 13% of demand and could rise to 27% by 2027.[5] Taken together, these estimates suggest AI-related electricity consumption of roughly 67–77 TWh today, rising to approximately 300–489 TWh by 2027–2030, although some of these figures likely understate total AI-related demand, as a share of inference also runs on conventional infrastructure.

**The rapid expansion in data-center electricity demand is already having a measurable impact on power-sector investment.** This is occurring against a broader structural shift in global energy capital allocation, with electricity increasingly becoming the dominant destination for energy investment. Its share of total energy investment has risen from around 25% in 2015 to roughly 50% in 2026, with annual electricity supply and infrastructure investment reaching approximately USD1.6trn.[6] Within this shift, technology-related demand is playing an increasingly important role, with the tech sector accounting for around 40% of corporate power-purchase agreements globally.

**Against this backdrop, data-center-driven electricity demand is emerging as a material force shaping investment decisions across generation, grids and flexibility assets.** According to the IEA World Energy Investment 2026 analysis, total spending on data center-related IT equipment and energy reached approximately USD565bn in 2025, with investment in associated energy infrastructure, including grid upgrades, power equipment and onsite generation, estimated at around USD105bn. This alone exceeds total annual energy investment across the entire African continent, highlighting the scale of capital mobilized directly or indirectly by digital infrastructure expansion.

**These pressures are increasingly translating into concrete investment decisions in electricity systems.** Grid expansion and storage investment are rising across most major regions, including China, Europe, the US and parts of Asia, as utilities respond to the need to connect and serve large, concentrated data-center loads alongside broader electrification trends. While renewable investments are projected to decline slightly in 2026, driven by falling technology costs, policy shifts in the US and China and a smaller construction pipeline, their shorter build times and lower lifetime costs make them a critical supply component for meeting data-center demand growth. At the same time, gas-fired generation has also seen renewed investment, although this trend is largely concentrated in the US, where approximately USD24bn of gas turbine final investment decisions over the past five quarters have been directly associated with data-center demand, with onsite generation increasingly preferred for large-scale facilities requiring high reliability and fast deployment.

**Overall, these developments suggest that data centers are becoming a structural driver of power-sector investment.** While they are accelerating investment in grids, renewables and network reinforcement, they are also contributing to renewed demand for dispatchable fossil generation, particularly natural gas, with important implications for the pace and credibility of long-term decarbonization pathways.

[5] IEA, Gartner and Goldman Sachs
[6] World Energy Investment 2026 (IEA)

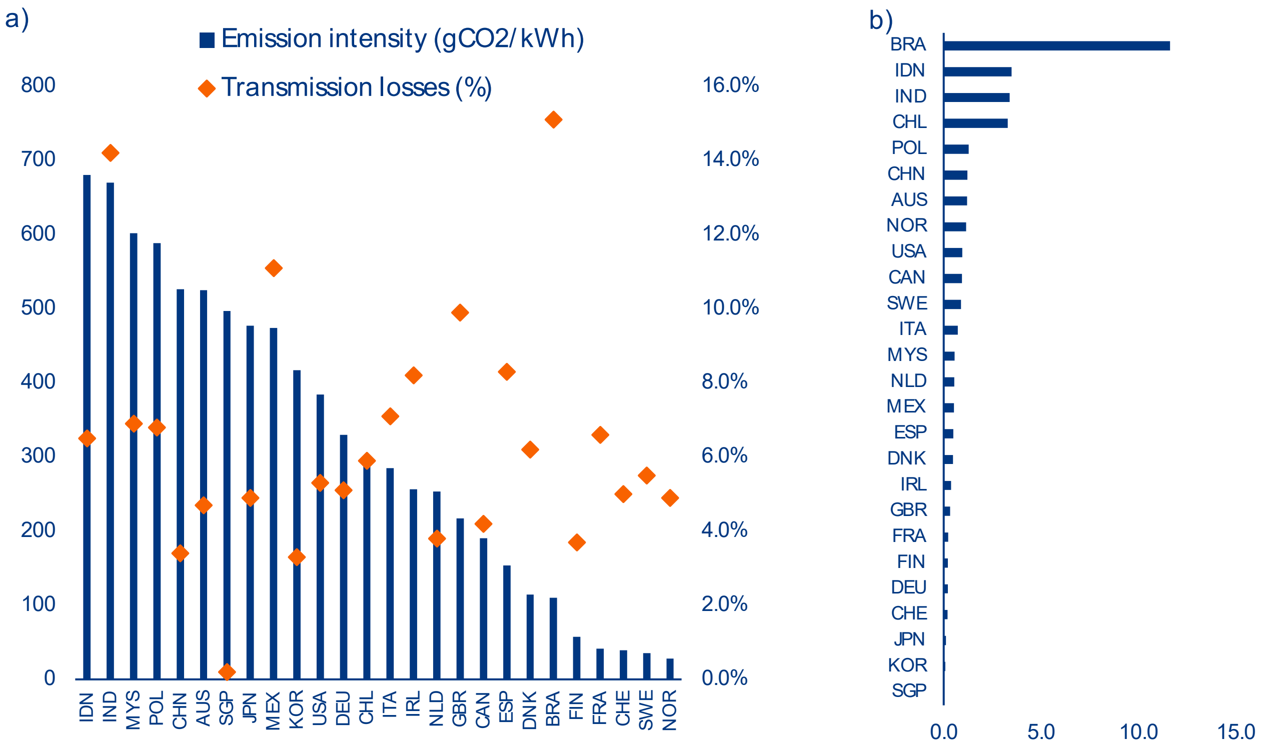

# How well are countries prepared for green AI?

**The environmental footprint of AI-driven data-center expansion is not determined solely by electricity demand growth, but also by the characteristics of the power systems supplying that demand.** Three dimensions are particularly important in assessing how well countries are prepared for "green AI": the carbon intensity of electricity generation, the efficiency of transmission and distribution networks and the operational reliability of the grid. Together, these factors determine the extent to which incremental data-center demand translates into emissions, system losses and reliance on backup generation. In addition, technology-specific factors such as power usage effectiveness (PUE) and utilization rates influence the efficiency of data centers themselves, although these are likely to evolve more gradually over the short-term horizon considered in this analysis.

**There is substantial heterogeneity across countries in the carbon intensity of electricity supply.** Eight of the ten best-performing countries in the sample are located in Europe, led by Norway, Sweden and Switzerland, where hydropower- and nuclear-dominated generation mixes result in the lowest emissions per unit of electricity consumed (Figure 2 a). In contrast, several emerging data-center markets exhibit significantly higher grid emission intensities. Indonesia, India and Malaysia all exceed 600 $gCO_2/kWh$, implying lifecycle emissions per unit of electricity that are around 20 to 24 times higher than in Norway. These differences imply that identical increments of data-center demand can have vastly different climate impacts depending on location.

**System efficiency further amplifies some of these disparities.** Transmission and distribution losses are highest in Brazil, India, Mexico and the UK, where they increase effective electricity supply requirements by approximately 10–15% (Figure 2 a). By contrast, losses remain below 3% in Singapore, South Korea and China, reflecting more efficient and tightly managed grid infrastructures. These differences are particularly relevant for data centers, which are highly electricity-intensive and sensitive to marginal changes in delivered power requirements.

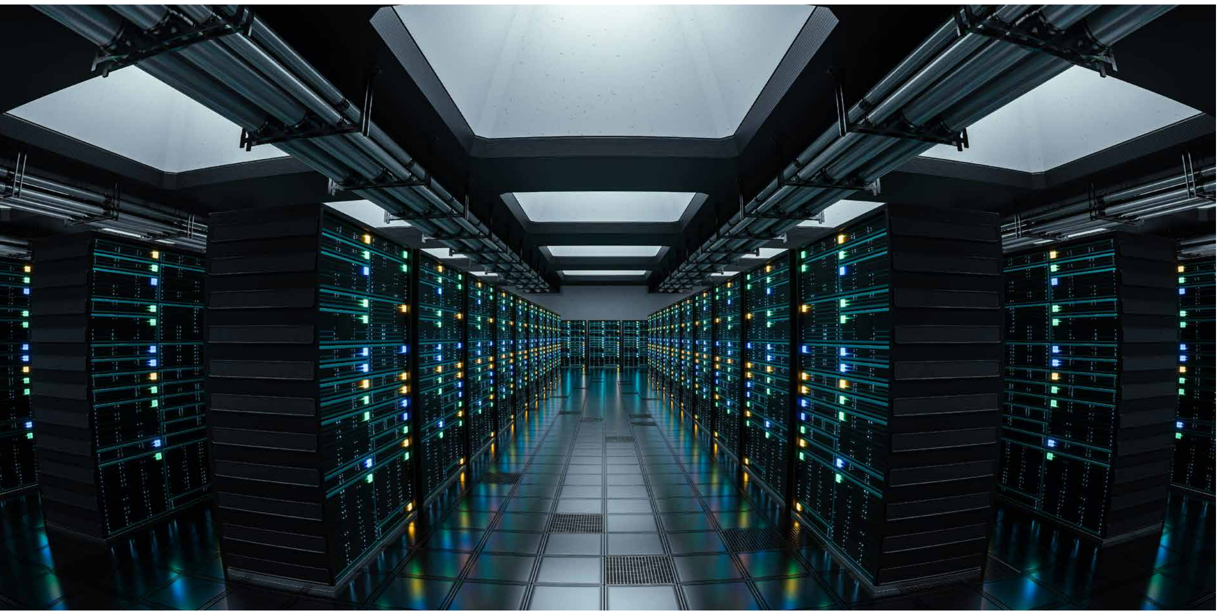
**Figure 2:** AI preparedness of the power system: a) emission intensity vs transmission losses and b) average annual grid outage duration (hours)




Sources: Allianz Research, EMBER, World Bank

**Grid reliability adds a further layer of variation.** Among the most data-center–exposed regions, reliability is generally high: the US, China and most European economies experience annual outage durations of less than two hours per customer (Figure 2 b). However, several emerging markets, including India, Indonesia and Brazil, exhibit higher outage levels, with Brazil reaching approximately 11 hours per year. While this remains lower than the roughly 19 hours or more observed in many other developing economies, it nonetheless increases the likelihood that data centers rely on on-site backup generation or behind-the-meter capacity to ensure operational continuity, which in turn can contribute to higher direct on-site emissions during grid disruption events.[7] In addition, increasing exposure to extreme weather events may place upward pressure on outage durations in several regions, reinforcing the importance of backup generation and distributed reliability solutions. This is already evident in the US, where major natural catastrophe events have increased outage durations to around 6.5 hours per year on average, peaking at approximately 11 hours in 2024, highlighting the extent to which extreme weather can materially alter reliability outcomes in advanced grid systems.

[7] IEA and World Bank



# Sizing the footprint: data center emissions today

**To assess the carbon footprint of data centers comprehensively, three emission levels are of interest.** First, there are direct on-site emissions from fuel combustion and fugitive gases (Scope 1). Second, indirect emissions from purchased electricity, which represent the dominant term in most facility assessments (Scope 2). Third, upstream value chain emissions embedded in the manufacture of hardware and construction of infrastructure (Scope 3). While the relative contribution of each varies with grid conditions and facility design, a complete assessment requires all three, particularly as grids decarbonize and the balance between operational and embodied emission shifts.

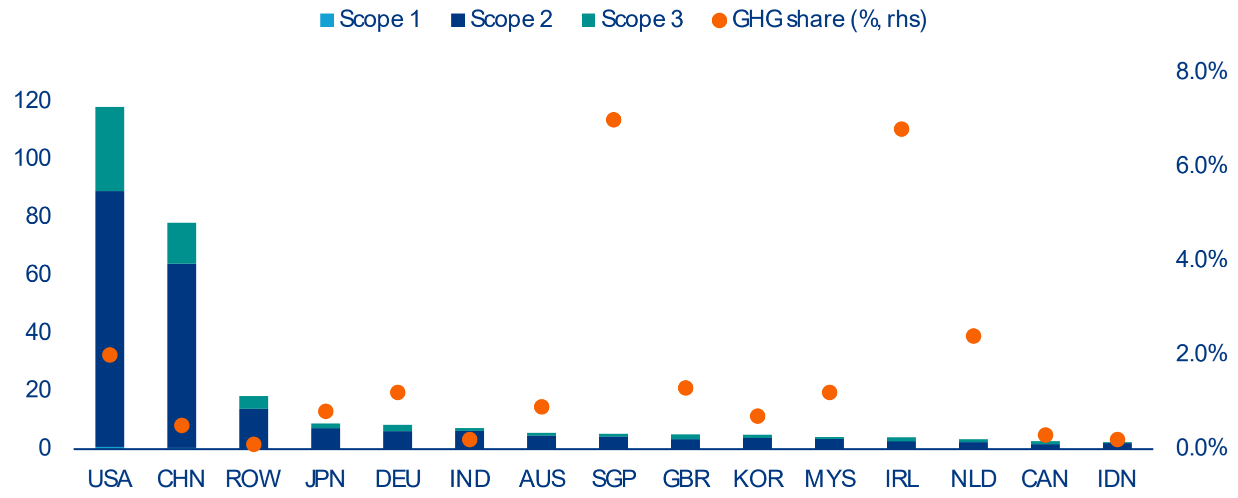
**Direct on-site (Scope 1) emissions are negligible relative to the total carbon footprint of a data center.** They primarily consist of emissions from three main factors: diesel combustion in backup generators during routine testing and grid outages, fugitive refrigerant leakage from cooling systems and increasingly on-site (behind-the-meter) natural gas generation used to bypass slow grid connections. For simplicity, behind-the-meter (BTM) generation is abstracted from this analysis, resulting in all electricity-related emissions being attributed to Scope 2.[8] The remaining two components are largely independent of operational load and grid conditions as their magnitude is primarily determined by system design parameters and local grid reliability. To quantify their emissions, we follow the methodology of Schneider Electric (2023)[9], who estimate Scope 1 at 0.2–0.5% of total lifecycle emissions for a representative 1 MW enterprise data center. Applied to approximately 89 GW of current global installed capacity, this yields an estimate of 1.8 MtCO2/year, equivalent to only 0.6% of total data center emissions in 2025 (Figure 3).

**More than 70% of global data-center emissions can be attributed to indirect emissions from purchased electricity (Scope 2), making the power sector the single most important lever for decarbonizing digital infrastructure in the near term.** To quantify these emissions, country-level electricity demand is combined with grid-specific carbon intensity factors, capturing the emissions associated with each kilowatt-hour consumed. As a result, the carbon footprint of an otherwise identical data center can differ substantially across locations depending on the electricity sources supplying the grid. Facilities operating in coal- and gas-intensive power systems therefore face significantly higher emissions than those located in regions with extensive renewable, hydro or nuclear generation.

[8] This implicitly assumes that BTM generation carries a similar carbon intensity as the local grid average. While this may lead to over- or underestimation of emission results in theory, the practical error is likely limited given that BTM capacity of approximately 2 GW currently represents roughly 2% of total global data centre capacity (Cleanview)
[9] Schneider Electric (2023)

**Globally, Scope 2 emissions are estimated at approximately 218 $MtCO_2$ in 2025.** These emissions are highly concentrated geographically, with the US and China accounting for around 88 $MtCO_2$ and 64 $MtCO_2$ respectively, together representing roughly 70% of the global total. The European countries covered in this analysis host around 15% of global data center capacity but generate only 8% of Scope 2 emissions, reflecting the comparatively low carbon intensity of their electricity systems. Conversely, Asia-Pacific countries account for roughly one-third of global capacity but around 44% of emissions, indicating a significantly more carbon-intensive power supply. These differences highlight that the future climate impact of data centers will depend not only on the growth of computing demand, but equally on the pace of power sector decarbonization in the regions where new capacity is deployed.

**Figure 3:** Data-center emissions for top 15 global hubs by emission scope (MtCO2, left) and share in regions total CO2 emissions (%, right)[10]




Sources: Allianz Research based on IEA, Schneider Electric, EMBER and LBNL

**Scope 3 emissions capture the upstream carbon footprint embedded in the construction and operation of data centers.** Unlike Scope 1 and Scope 2 emissions, which are linked directly to on-site fuel use and electricity consumption, Scope 3 spans a broad value chain that includes building construction, servers and networking equipment, cooling systems, electrical infrastructure, transport, waste and other supporting activities. Among these categories, embodied emissions from capital goods are by far the most material, reflecting the carbon-intensive production of semiconductors, servers and facility infrastructure.

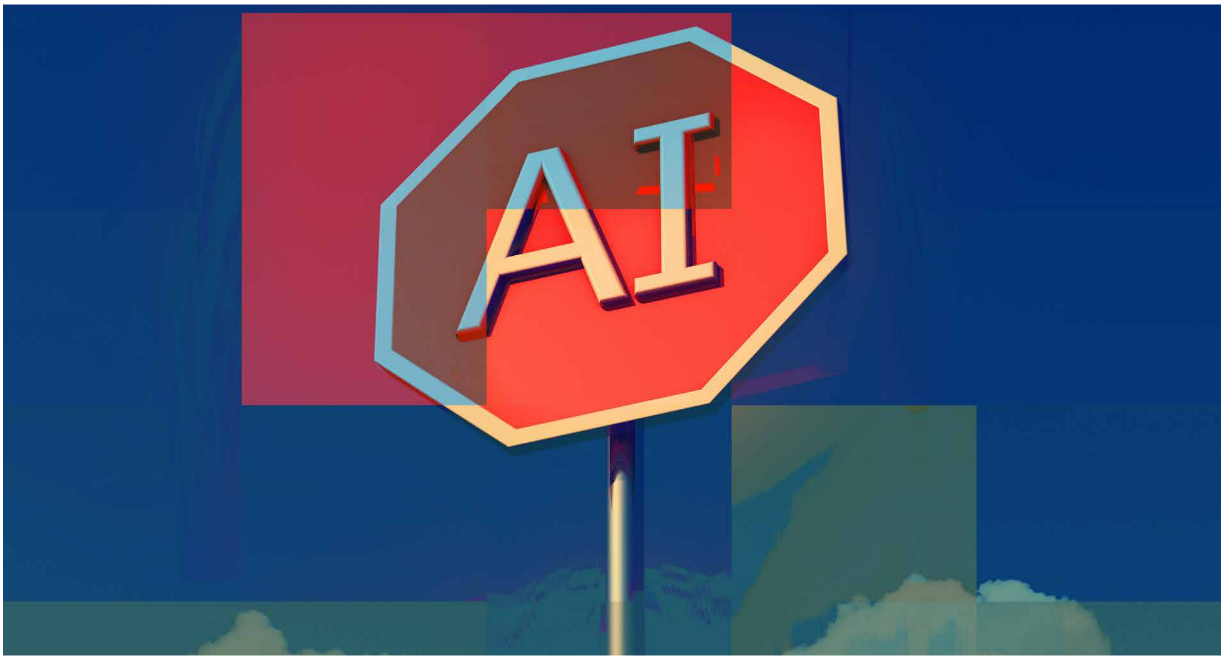
**Applying the Schneider Electric (2023) lifecycle framework to estimated country-level data center capacity yields Scope 3 emissions of approximately 66 $MtCO_2$ in 2025, equivalent to around 23% of the sector's total carbon footprint.** The estimate combines embodied emissions from IT equipment, building construction („core and shell"), transformers, backup generators, chillers and other supporting infrastructure, scaled to the installed capacity of each market. Capital goods and upstream fuel-cycle emissions together account for more than 84% of total Scope 3 emissions. While these emissions remain smaller than those associated with electricity consumption today, their relative importance is likely to increase as power systems decarbonize and the deployment of AI infrastructure drives demand for increasingly hardware-intensive computing systems.

**Global data-center emissions are estimated at approximately 286 MtCO2 (0.5% of total global emissions) in 2025.** This is around 57% higher than the latest IEA assessments, reflecting the inclusion of Scope 3 emissions, updated capacity estimates and the explicit accounting of system components such as transmission losses. Despite this upward revision, data centers

[10] For current country level emission estimates, see Table A2 in the Appendix

account for only around 0.5% of global greenhouse gas emissions in 2025. At the national level, their contribution generally remains below 2%, although significantly higher shares are observed in concentrated hubs such as Singapore (around 7%) and Ireland, where data-center electricity demand represents a materially larger share of domestic power consumption.

**Artificial intelligence is emerging as a rapidly growing driver of electricity demand and associated emissions.** Based on an estimated 15–20% share of global data center electricity consumption attributable to AI workloads, AI-related emissions are estimated at approximately 43–60 $MtCO_2$ in 2025, broadly consistent with recent literature (De Vries & Gao, 2025). Within AI-related emissions, inference accounts for around 80%, reflecting the rapid scaling of deployed AI applications and the increasing integration of model use into search, productivity tools, and enterprise systems. These estimates highlight an important structural dynamic: future emissions trajectories will depend less on incremental efficiency improvements within data centers and more on the pace of electricity system decarbonization and the geographic location of new capacity. In the absence of sufficiently rapid clean power expansion, continued growth could reinforce fossil-based generation in certain regions, creating potential lock-in effects that delay broader decarbonization trajectories.




# Can AI growth be decoupled from emissions?

**The future emissions trajectory of data centers will depend critically on whether power-system decarbonization can keep pace with rapidly rising electricity demand.** To assess this, we model four scenarios that differ in their assumptions about future grid carbon intensity. A no-improvement scenario assumes emissions factors remain at 2025 levels, while a linear trend scenario extrapolates historical decarbonization rates observed over the past decade. These are complemented by two NGFS-based pathways: a below-2°C transition scenario and a scenario aligned with current Nationally Determined Contributions (NDCs). Across all scenarios, electricity demand growth from data centers is held constant, isolating the effect of power-sector decarbonization on emissions outcomes.

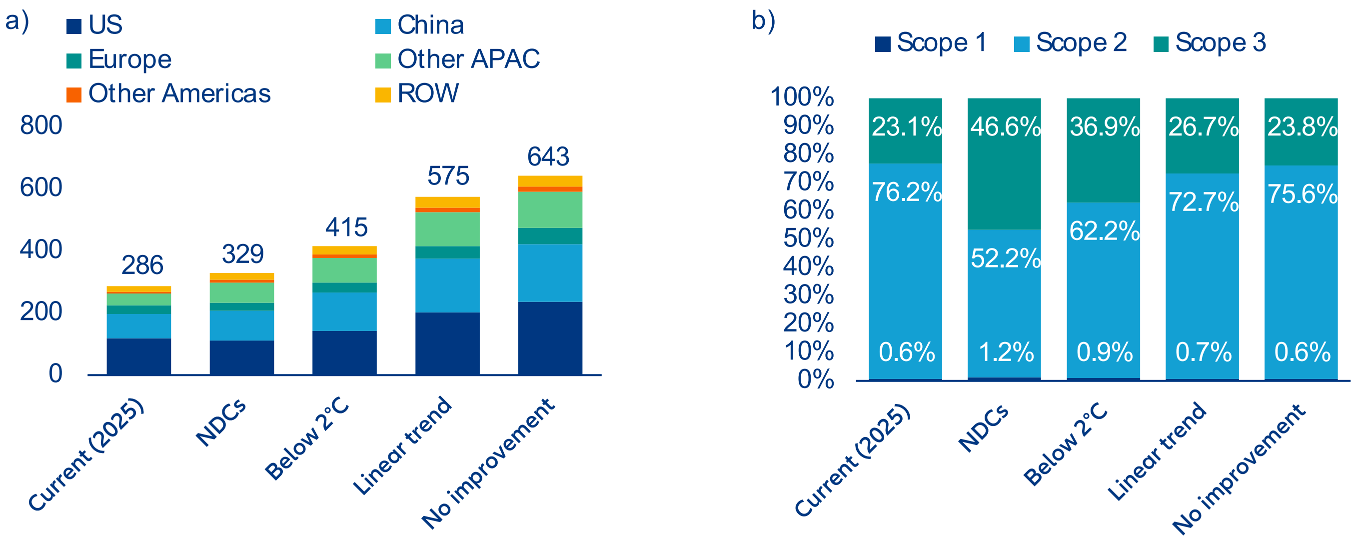
**In addition to grid decarbonization, assumptions on power usage effectiveness (PUE) and utilization rates are allowed to evolve over time but are kept constant across scenarios.** While improvements in cooling efficiency, workload optimization and next-generation chip design are expected to reduce energy intensity at the margin, these effects are highly heterogeneous across facility types and vendors and are relatively small compared to changes in Scope 2 emissions over the 2025–2030 horizon. For this reason, they are not varied across scenarios.

**Under these assumptions, global data-center emissions are projected to diverge significantly across scenarios.** They range from approximately 643 $MtCO_2$ in the no-improvement case to around 329 $MtCO_2$ under the most ambitious decarbonization pathway by 2030 (the NGFS NDC scenario) (Figure 4 a). This wide range highlights that the emissions trajectory of digital infrastructure is driven less by uncertainty in demand growth than by differences in the pace of power sector decarbonization. Achieving the lower bound of this range requires a rapid reduction in grid carbon intensity, equivalent to an average decline of around 54% over the next five years. This would imply particularly steep reductions of 70–80% in major data-center markets such as the US and parts of Europe. Given current trends in electricity demand growth, continued expansion of gas-fired generation capacity, and grid integration constraints in several regions, such a trajectory appears highly challenging under present policy and investment conditions.

**More moderate decarbonization pathways yield more incremental but still material improvements.** Under a continuation of historical trends in power sector emissions intensity, global data-center emissions would still rise substantially, but by around 70 $MtCO_2$ less than in the no-improvement case. This reflects an average reduction in grid carbon intensity of approximately -26% over the same period, underscoring that even partial decarbonization of electricity systems can significantly moderate the emissions impact of rapid data-center expansion.

**A more ambitious 2°C-aligned power sector transition would further reduce global data-center emissions by approximately 160 $MtCO_2$ relative to the no-improvement case.** Under this pathway, several economies with more moderate data center expansion profiles, including Germany, the Netherlands and Ireland, could even experience absolute declines in emissions compared to current levels, reflecting the combined effect of cleaner electricity systems and relatively contained demand growth.

**Figure 4:** Data-center emissions to 2030: a) absolute emissions by region ($MtCO_2$) and b) composition by emission scope (%), across decarbonization scenarios[13]




Sources: Allianz Research based on IEA, NGFS, Schneider Electric, EMBER and LBNL

**The implications for national decarbonization targets are therefore highly uneven.** In countries such as Brazil, China, Poland and Italy, data center emissions remain below 2% of total national emissions across all scenarios, suggesting limited implications for overall economy-wide mitigation pathways. By contrast, in high-growth and high-exposure markets such as the US, Ireland, Singapore and Malaysia, the choice of decarbonization pathway becomes materially relevant, with scenario outcomes diverging by around 2–5pps of national emissions. For example, in Malaysia, the data-center emission share in total national emissions ranges from roughly 7% to 12% depending on the decarbonization pathway, up from 1.2% today. This highlights that data center emissions are becoming more material in national emissions profiles in a subset of countries, and that the choice of decarbonization pathway can have a meaningful impact on their overall emissions outcomes.

**Beyond differences in aggregate emissions levels, decarbonization pathways also fundamentally reshape the structure of the data-center carbon footprint.** In

[13] For more detailed country level emission projections, see Table A3 in the Appendix

today's system, emissions are dominated by electricity consumption, with Scope 2 accounting for approximately three-quarters of total emissions (Figure 4 b). However, as power systems decarbonize, this dominance gradually weakens even in scenarios where total emissions remain broadly stable or only moderately decline. Under an ambitious NDC-aligned pathway, the share of Scope 2 emissions declines to around 52% by 2030, reflecting the decarbonization of electricity supply across major data center markets. At the same time, Scope 3 emissions, which are largely driven by embodied carbon in servers, semiconductors and construction materials, increase in relative importance from around 23% today to almost half of total emissions.

**The effect is not uniform across countries.** In already low-carbon electricity systems such as Scandinavia, Scope 2 emissions account for only 16–28% of the total footprint today, limiting the potential for further reductions through further grid decarbonization. In these systems, mitigation increasingly shifts toward supply-chain and hardware-related emissions, with Scope 3 becoming the main remaining lever. By contrast, in higher-carbon systems such as Germany or Italy, electricity decarbonization still delivers substantial absolute reductions in operational emissions and remains the dominant near-term mitigation priority. However, even in these countries, progress in grid decarbonization alone is insufficient to offset the rising importance of Scope 3 emissions as capacity expands. Overall, this implies that the balance of mitigation priorities differs systematically by stage of power system decarbonization: electricity supply dominates in less advanced systems, while embodied emissions become increasingly binding in mature low-carbon systems.

**The environmental implications of data center expansion can also be expressed in monetary terms through the social cost of carbon, which estimates the economic damages associated with an additional ton of CO2 emissions.** Applying a range of carbon-cost estimates from the literature to current emissions levels suggests that the annual climate-related cost of global data-center emissions amounts to between USD23bn and USD141bn in 2025 (Table 1). Using the mid-range estimate proposed by Renner (2022), this corresponds to an annual climate externality of approximately USD68bn.

**Looking ahead, these external costs are expected to increase further as data-center demand expands, although the magnitude of the increase depends heavily on the pace of power sector decarbonization.** Across the scenarios considered, annual climate costs rise by between 15% and 125% by 2030. In the absence of further improvements in grid carbon intensity, annual climate damages would increase to approximately USD154bn. By contrast, under the NGFS NDC pathway, costs rise only modestly to around USD79bn despite continued growth in electricity demand. While achieving this trajectory globally appears challenging, the comparison illustrates the extent to which power sector decarbonization influences the environmental cost of digital infrastructure.

[14] Understanding climate damages: Consumption versus investment - ScienceDirect

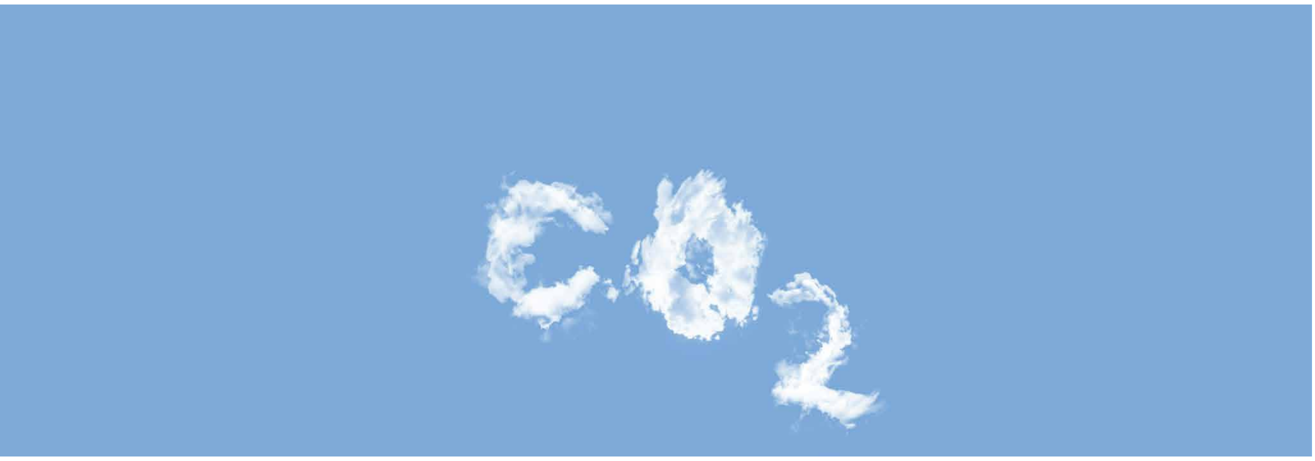
**Table 1:** Estimated social cost of data center emissions globally (in USD bn; 2026)[14]

| Scenario | Nordhaus (2023) SCC: ~USD81/tCO2 | EU ETS (2026) SCC: USD92/tCo2 | Renner (2022) SCC: USD239/tCO2 | EPA high (2023) SCC: USD492/tCO2 |
|---|---|---|---|---|
| Current | 23.2 | 26.3 | 68.4 | 140.8 |
| No improvement | 52.1 | 59.1 | 153.6 | 316.2 |
| Linear trends | 46.6 | 52.9 | 137.3 | 282.7 |
| Below 2°C | 33.6 | 38.2 | 99.2 | 204.2 |
| NDCs | 26.6 | 30.2 | 78.6 | 161.7 |

Sources: Allianz Research, Nordhaus (2023), Renner (2022), EBA (2023), LSEG Workspace; Note: Carbon prices from the respective primary data sources have been adjusted to current 2026 values

**Artificial intelligence represents an increasingly important share of these externalities.** Assuming AI-related workloads account for around 20% of data-center electricity demand today and increase to approximately 40% by 2030, the climate cost attributable to AI rises from an estimated USD13bn currently to roughly USD54bn by 2030 under the linear trend scenario, assuming a carbon cost of USD239/tCO2. While still a minority of total data-center emissions today, AI-related workloads are likely to become one of the fastest-growing sources of climate externalities within the digital economy. As AI deployment scales, the environmental challenge therefore shifts from managing a niche source of emissions to ensuring that rapidly growing digital demand remains aligned with broader climate objectives. Achieving this will require continued decarbonization of electricity systems, stronger incentives to improve the energy and material efficiency of AI infrastructure and a more systematic internalization of the environmental costs associated with digital growth.

[14] For country level social cost of carbon estimates of current emissions, see Table A4 in the Appendix



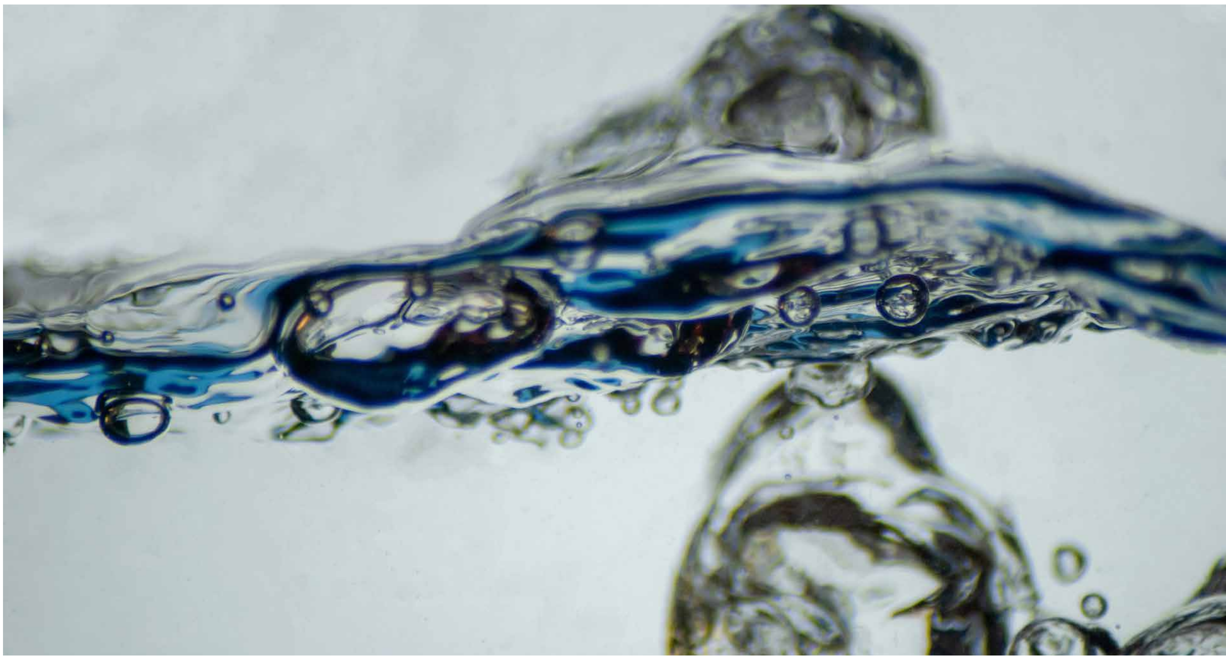
# Beyond the data center: AI as a decarbonization tool

**The environmental impact of AI hinges not only on its own footprint but also on its potential to accelerate decarbonization across the wider economy.** While growing attention has focused on the energy, emissions and water requirements of AI infrastructure, the technology could also contribute to reducing resource consumption and emissions in sectors such as industry, buildings, transport and energy. The International Energy Agency (IEA) identifies a broad range of applications through which AI could support decarbonization, including methane leak detection, optimization of industrial processes and energy consumption, predictive maintenance, more efficient operation of power plants and electricity grids and improvements in transport and logistics.[15] Under a scenario of widespread deployment, the IEA estimates that AI-enabled applications could reduce global final energy consumption by up to 13 EJ by 2035 and lower annual $CO_2$ emissions by around 1.4 Gt. This would more than offset even our high-end estimate of AI-related emissions growth of 643 $MtCO_2$, implying a net reduction of approximately 750 $MtCO_2$. Put differently, AI-enabled emissions savings could exceed the technology's own emissions footprint by a factor of more than two.

**Emerging evidence from the corporate sector suggests that some of these benefits may already be materializing.** According to recent Bearingpoint research, around two-thirds of technology leaders expect AI and digital technologies to reduce business emissions by between 6% and 30% through operational optimization, improved resource efficiency and lower waste generation.[16] At the same time, however, most organizations remain in the early stages of adoption, with AI deployment often confined to isolated use cases rather than enterprise-wide transformation programs.

**As a result, the gap between technical potential and realized environmental benefits remains considerable.** The IEA notes that there is currently insufficient momentum to ensure widespread adoption of many AI-enabled decarbonization applications. Consequently, the environmental case for AI depends not only on improvements in data-center efficiency but also on the successful diffusion of productivity-enhancing and emissions-reducing applications throughout the real economy. While AI's direct footprint is becoming increasingly visible, its ultimate environmental impact will be determined by the balance between these costs and the potentially much larger, but still uncertain, efficiency gains it can unlock elsewhere in the economy.

[15] IEA
[16] WEF



# The blue cost: water consumption in data centers

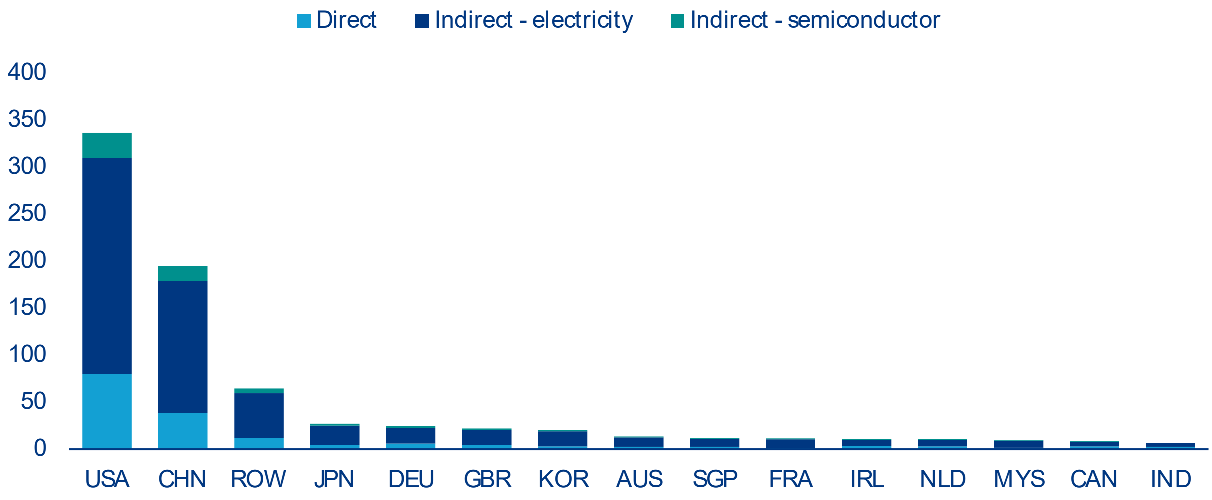
**Beyond emissions, the primary environmental footprint of data centers stems from water consumption.** This footprint can be decomposed into three components: direct on-site consumption for cooling and humidification, indirect consumption associated with electricity generation and upstream consumption embedded in semiconductor manufacturing. The total water footprint is therefore shaped both by the efficiency of on-site systems and by the water intensity of the electricity system supplying the facility.

**Direct on-site cooling is the most visible component of data-center water consumption.** Data centers generate substantial heat through continuous server operation and must remove it to avoid hardware failure, with water-based cooling systems being the dominant solution at scale. Water use depends on cooling system efficiency, measured by Water Usage Effectiveness (WUE), defined as liters of water consumed per kilowatt-hour of IT energy use. WUE varies across facility types, averaging around 0.32 l/kWh in smaller facilities and 0.62 l/kWh in mid-sized and colocation data centers. Given the absence of consistent country-level reporting, a uniform value of 0.48 l/kWh is applied, based on European Commission and LBNL estimates.[17]

**Applying these parameters to country-level IT load data, global data centers consumed approximately 180bn liters of water on-site in the past year (Figure 5).** The US accounts for around 44% of this total and China for a further 21%, reflecting the concentration of global capacity in these markets. This figure could more than triple by 2030 under projected capacity expansion, unless substantial improvements in WUE are achieved. While direct cooling accounts for around 22% of total water consumption on average, its share varies significantly across countries, from 12% in France to 87% in Norway, highlighting the dominant role of indirect water use in many electricity systems.

[17] European Commission and LBNL.

**Figure 5:** Data-center water consumption by country (current, bn liters)[18]



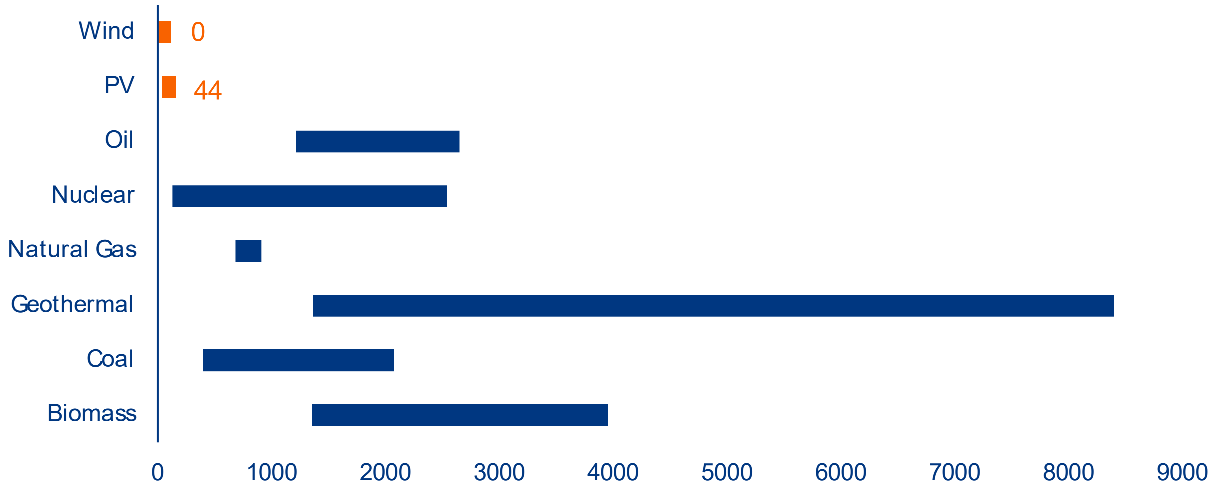

Source: Allianz Research, Jin et al (2019), IEA

**Indirect water consumption from electricity constitutes the lion's share of total data-center water use, yet remains the least visible part of the footprint.** Much like Scope 2 carbon emissions, this consumption occurs off-site at power plants but is nonetheless attributable to the data center through its electricity demand, as most forms of generation require water for cooling during the production process. To quantify this, we apply grid water intensity factors expressed in liters per kilowatt-hour, capturing the weighted average water consumption of each country's electricity mix.

**As with carbon emissions, grid water intensity varies substantially across generation technologies.** Renewable sources generally have the lowest operational water requirements, with wind power exhibiting effectively no on-site water use, making renewable penetration a key determinant of indirect water intensity (Figure 6).[19] However, the relationship between carbon and water intensity is not one-to-one. Nuclear power, while carbon-free in operation, is relatively water-intensive due to cooling requirements in reactor systems. As a result, countries with nuclear-heavy grids such as France may exhibit low carbon intensity but comparatively high grid water intensity, helping to explain part of the gap between France and Norway in indirect water consumption (around 80% versus 5% of total data-center water use, respectively). The other main driver of this difference is methodological: reservoir evaporation losses from hydropower are excluded due to substantial uncertainty in their estimation. This is particularly relevant for Norway, where hydropower accounts for around 89% of the electricity mix, implying that indirect water consumption in highly hydro-dependent systems such as Norway, Brazil and Canada may be understated.

[18] Country level estimates of the current water consumption in data centers can also be found in Table A5 in the Appenix.
[19] In Life-cycle assessments wind power has a median water footprint of 43l/MWh, associated with turbine production, but this is abstracted from in this analysis

**Figure 6:** Operational water consumption by power generation technology (l/MWh)




Source: Jin et al (2019)

**Despite this caveat, indirect water consumption from electricity supply is estimated at more than 560bn liters per year, making it roughly three times larger than direct water consumption associated with on-site cooling.** However, this component is expected to grow more slowly than electricity demand, increasing by around 35–61% to 2030 as power systems continue to decarbonize and shift towards lower water-intensity renewable generation, thereby reducing the average grid water intensity over time.

**The second component stems from semiconductor and microchip manufacturing, which following the IEA's sectoral breakdown is assumed to account for roughly 8% of total data center water consumption.** In our assessment this translates into around 65bn liters annually, reflecting water use across chip fabrication processes, particularly ultra-pure water required for wafer cleaning and rinsing, which represents the dominant share of manufacturing-related water demand. This component is expected to grow in importance as demand for high-performance and AI-accelerated chips increases.

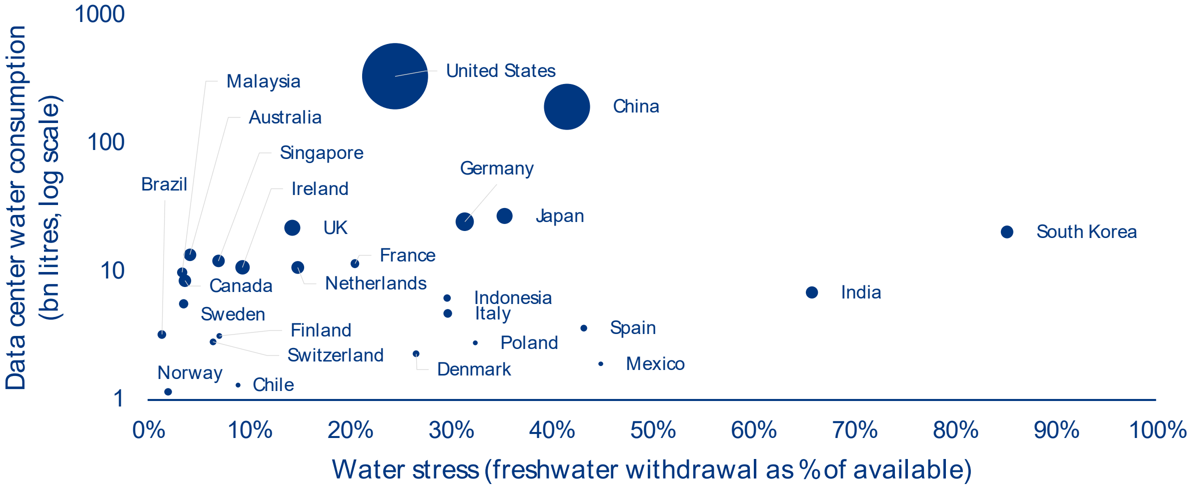
**In total, our estimate puts data-center water consumption today at around 814bn liters per year, equivalent to the annual domestic drinking-water use of approximately 17mn people in Germany.**[20] This is around 45% higher than the IEA estimate of 560bn liters for 2023, reflecting updated capacity figures and differences in underlying assumptions across direct and indirect components. Looking ahead, total water consumption is projected to increase to between 1,286bn liters under a decarbonization pathway aligned with national targets (NDC scenario) and 1,791bn liters under a scenario in which today's electricity mix is held constant. This range highlights the extent to which power sector decarbonization can simultaneously reduce both carbon emissions and the water intensity of data center operations. At the upper end of this range, global data-center water consumption would exceed that of more than 80 countries and be comparable to the annual water use of Switzerland, underscoring the growing importance of water as a constraint in digital infrastructure expansion.[21]

**Besides the sheer amount of water consumed, the location of withdrawals is also critical.** In water-scarce regions, additional demand can intensify competition between households, agriculture and industry, while also placing pressure on local ecosystems and biodiversity. These trade-offs can be illustrated by comparing data-center water consumption with national water stress levels (Figure 7). Most countries in our sample exhibit low to moderate water stress, with freshwater withdrawals accounting for less than 30% of available resources. However, South Korea, India, Mexico, Spain and China experience considerably higher stress levels, exceeding 40%, with South Korea reaching as high as 85%. While this country-level view does not capture local conditions

[20] This estimate is based on UBA assuming a daily water consumption of 126l/person
[21] World Population Review

at individual data-center sites, it underscores the importance of accounting for water consumption impacts in already water-stressed regions when planning data-center deployment.

**Figure 7:** Data-center water consumption (bn liters) vs water stress level (%; 2023)




Sources : Allianz Research, FAO Aquastat

# What do we need to realize green AI?

**The environmental footprint of AI is shaped less by improvements in model or data-center efficiency alone than by the broader energy and infrastructure systems in which it is embedded.** Across emissions and water use, renewables-led power system decarbonization emerges as the dominant determinant of future outcomes, while embodied emissions and supply-chain impacts gain importance as electricity systems become cleaner.

**At the same time, a gap remains between private investment decisions and the full societal costs of digital infrastructure.** While operators face direct costs for electricity, hardware and construction, a significant share of climate and water impacts is not fully reflected in market signals. Closing this gap will require cleaner electricity systems, better information on resource use and stronger alignment between private incentives and environmental costs.

**Key policy priorities are as follows:**

- **Greening the grid remains the central priority.** Expanding renewable generation is the most effective lever for reducing both the carbon and water footprint of AI-driven data center growth. Grid expansion, faster permitting and investment in storage and flexibility are essential to ensure that rising electricity demand can be met with low-emission supply.

- **Improve transparency and environmental reporting.** Standardized disclosure of electricity consumption, emissions, water use, utilization rates and AI-specific workload intensity is needed to improve comparability across operators and geographies. This would enable more consistent benchmarking and better policy targeting of high-impact segments.

- **Internalize climate and water externalities.** Current investment decisions do not fully reflect the social costs of emissions and water consumption. Strengthening carbon pricing, integrating environmental costs into electricity market design, and developing pricing mechanisms for water use in stressed regions would help align private incentives with societal costs. For AI-related applications, usage-based environmental charges (for example per token or compute use) could in principle help reflect their environmental footprint more directly, but would require better transparency and reliable measurement of energy use and emissions.

- **Address embodied emissions across the AI supply chain.** As electricity systems decarbonize, upstream emissions from semiconductors, servers and construction materials will become increasingly important. Lifecycle disclosure requirements, low-carbon procurement standards and supply-chain decarbonization policies will be key to managing this shift.

- **Maximize AI-enabled decarbonization opportunities.** AI applications in energy systems, industry, transport and buildings offer substantial potential for emissions reductions. Policy support should focus on accelerating deployment in high-impact areas such as grid optimization, industrial efficiency and logistics.

# Appendix

Table A1: Data-center capacity and power demand by country (current & 2030)

| Region | Country | IT capacity (GW) Current | IT capacity (GW) 2030 | PUE Current | PUE 2030 | Capacity Factor Current | Capacity Factor 2030 | Power Demand (TWh) Current | Power Demand (TWh) 2030 |
|---|---|---|---|---|---|---|---|---|---|
| North America | United States | 39.0 | 81.0 | 1.30 | 1.23 | 0.49 | 0.49 | 217.6 | 427.7 |
| | Canada | 1.4 | 4.0 | 1.30 | 1.24 | 0.49 | 0.49 | 7.9 | 21.0 |
| | Mexico | 0.2 | 1.2 | 1.30 | 1.24 | 0.49 | 0.49 | 1.2 | 6.5 |
| Europe | Germany | 3.0 | 4.8 | 1.39 | 1.29 | 0.48 | 0.48 | 17.5 | 26.0 |
| | France | 0.7 | 1.8 | 1.55 | 1.29 | 0.48 | 0.48 | 4.6 | 9.7 |
| | Spain | 0.4 | 2.5 | 1.66 | 1.29 | 0.48 | 0.48 | 3.1 | 13.8 |
| | UK | 2.3 | 4.8 | 1.42 | 1.29 | 0.48 | 0.48 | 13.8 | 26.0 |
| | Italy | 0.7 | 2.0 | 1.46 | 1.29 | 0.48 | 0.48 | 4.2 | 11.0 |
| | Netherlands | 1.5 | 2.2 | 1.39 | 1.29 | 0.48 | 0.48 | 8.8 | 11.7 |
| | Poland | 0.2 | 0.8 | 1.55 | 1.29 | 0.48 | 0.48 | 1.4 | 4.4 |
| | Denmark | 0.4 | 1.0 | 1.21 | 1.21 | 0.48 | 0.48 | 2.0 | 5.0 |
| | Finland | 0.3 | 1.2 | 1.17 | 1.17 | 0.48 | 0.48 | 1.6 | 5.7 |
| | Sweden | 0.8 | 1.5 | 1.17 | 1.17 | 0.48 | 0.48 | 3.9 | 7.4 |
| | Norway | 0.5 | 1.2 | 1.18 | 1.18 | 0.48 | 0.48 | 2.5 | 6.0 |
| | Ireland | 1.9 | 2.5 | 1.18 | 1.18 | 0.48 | 0.48 | 9.4 | 12.3 |
| | Switzerland | 0.4 | 0.5 | 1.37 | 1.29 | 0.48 | 0.48 | 2.1 | 2.9 |
| APAC | China | 19.0 | 49.0 | 1.46 | 1.35 | 0.48 | 0.47 | 116.6 | 272.4 |
| | India | 1.3 | 4.2 | 1.46 | 1.35 | 0.48 | 0.47 | 8.0 | 23.3 |
| | Japan | 2.3 | 5.3 | 1.46 | 1.35 | 0.48 | 0.47 | 14.1 | 29.4 |
| | South Korea | 1.4 | 2.5 | 1.46 | 1.35 | 0.48 | 0.47 | 8.8 | 13.8 |
| | Australia | 1.4 | 3.1 | 1.46 | 1.35 | 0.48 | 0.47 | 8.3 | 17.2 |
| | Malaysia | 0.9 | 9.6 | 1.46 | 1.35 | 0.48 | 0.47 | 5.4 | 53.1 |
| | Indonesia | 0.5 | 1.6 | 1.46 | 1.35 | 0.48 | 0.47 | 2.8 | 9.1 |
| | Singapore | 1.4 | 1.9 | 1.46 | 1.35 | 0.48 | 0.47 | 8.6 | 10.6 |
| South America | Brazil | 0.7 | 2.4 | 1.67 | 1.50 | 0.43 | 0.44 | 4.1 | 13.6 |
| | Chile | 0.2 | 0.8 | 1.67 | 1.50 | 0.43 | 0.44 | 1.2 | 4.7 |
| **ROW** | **ROW** | **6.0** | **12.3** | **1.38** | **1.29** | **0.49** | **0.48** | **35.5** | **66.7** |
| **World** | | **88.8** | **205.6** | **1.38** | **1.29** | **0.49** | **0.48** | **515.2** | **1,110.9** |

Sources: Allianz Research based on EMBER, IEA and LBNL

Table A2: Estimated data center emissions by country (current)

| Region | Country | Emission intensity (GCO2/kWh) | Scope 1 (MtCO2) | Scope 2 (MtCO2) | Scope 3 (MtCO2) | Total Emissions |
|---|---|---|---|---|---|---|
| **North America** | United States | 384.40 | 0.75 | 88.35 | 29.07 | 118.17 |
| | Canada | 190.61 | 0.03 | 1.57 | 1.05 | 2.65 |
| | Mexico | 474.02 | 0.00 | 0.64 | 0.16 | 0.80 |
| **Europe** | Germany | 329.65 | 0.06 | 6.09 | 2.24 | 8.39 |
| | France | 41.44 | 0.02 | 0.21 | 0.53 | 0.75 |
| | Spain | 153.60 | 0.01 | 0.51 | 0.33 | 0.85 |
| | UK | 217.41 | 0.05 | 3.34 | 1.73 | 5.11 |
| | Italy | 284.78 | 0.01 | 1.29 | 0.51 | 1.81 |
| | Netherlands | 253.56 | 0.03 | 2.32 | 1.12 | 3.47 |
| | Poland | 588.60 | 0.00 | 0.91 | 0.16 | 1.07 |
| | Denmark | 114.41 | 0.01 | 0.25 | 0.30 | 0.55 |
| | Finland | 57.47 | 0.01 | 0.10 | 0.24 | 0.34 |
| | Sweden | 35.26 | 0.01 | 0.15 | 0.60 | 0.76 |
| | Norway | 28.11 | 0.01 | 0.07 | 0.37 | 0.46 |
| | Ireland | 256.38 | 0.03 | 2.63 | 1.41 | 4.07 |
| | Switzerland | 39.22 | 0.01 | 0.09 | 0.27 | 0.37 |
| **APAC** | China | 526.49 | 0.40 | 63.59 | 14.16 | 78.15 |
| | India | 670.13 | 0.03 | 6.23 | 0.97 | 7.23 |
| | Japan | 477.26 | 0.05 | 7.09 | 1.71 | 8.85 |
| | South Korea | 417.06 | 0.03 | 3.81 | 1.07 | 4.92 |
| | Australia | 525.18 | 0.03 | 4.57 | 1.01 | 5.60 |
| | Malaysia | 601.97 | 0.02 | 3.47 | 0.65 | 4.14 |
| | Indonesia | 680.25 | 0.01 | 2.04 | 0.34 | 2.39 |
| | Singapore | 497.09 | 0.03 | 4.28 | 1.04 | 5.36 |
| **South America** | Brazil | 109.95 | 0.01 | 0.53 | 0.55 | 1.10 |
| | Chile | 289.49 | 0.00 | 0.38 | 0.15 | 0.53 |
| **ROW** | **ROW** | **363.86** | **0.12** | **13.77** | **4.46** | **18.36** |
| **World** | | **363.86** | **1.78** | **218.24** | **66.21** | **286.23** |

Sources: Allianz Research based on IEA, Schneider Electric, EMBER and LBNL

Table A3: Estimated data center emissions by country by 2030 scenario (MtCO2)

| Region | Country | No improvement | Linear Trends | Below 2°C | NDCs |
|---|---|---|---|---|---|
| North America | United States | 235.47 | 202.15 | 142.33 | 111.24 |
| | Canada | 7.20 | 6.90 | 4.46 | 3.79 |
| | Mexico | 4.40 | 4.04 | 2.49 | 1.85 |
| Europe | Germany | 12.71 | 10.18 | 6.24 | 4.90 |
| | France | 1.79 | 1.76 | 1.79 | 1.62 |
| | Spain | 4.24 | 2.56 | 2.82 | 2.36 |
| | UK | 9.95 | 7.32 | 5.52 | 4.55 |
| | Italy | 4.92 | 4.39 | 2.54 | 2.03 |
| | Netherlands | 4.73 | 2.36 | 2.84 | 2.22 |
| | Poland | 3.38 | 2.94 | 1.48 | 1.03 |
| | Denmark | 1.37 | 0.86 | 1.04 | 0.89 |
| | Finland | 1.23 | 0.96 | 1.20 | 1.04 |
| | Sweden | 1.42 | 1.40 | 1.42 | 1.34 |
| | Norway | 1.10 | 1.08 | 1.10 | 1.10 |
| | Ireland | 5.31 | 4.02 | 2.88 | 2.36 |
| | Switzerland | 0.52 | 0.51 | 0.52 | 0.52 |
| APAC | China | 185.94 | 172.85 | 123.83 | 95.63 |
| | India | 21.44 | 20.95 | 13.57 | 10.49 |
| | Japan | 18.83 | 17.27 | 13.90 | 11.33 |
| | South Korea | 7.85 | 7.11 | 5.91 | 4.98 |
| | Australia | 11.87 | 9.85 | 9.23 | 7.64 |
| | Malaysia | 41.65 | 39.55 | 27.52 | 22.85 |
| | Indonesia | 7.84 | 7.72 | 5.05 | 4.17 |
| | Singapore | 6.71 | 6.69 | 4.48 | 3.78 |
| South America | Brazil | 3.56 | 2.83 | 2.91 | 2.46 |
| | Chile | 2.05 | 1.41 | 1.53 | 1.16 |
| ROW | **ROW** | **35.26** | **34.96** | **26.44** | **21.38** |
| **World** | | **642.70** | **574.60** | **415.00** | **328.70** |

Sources: Allianz Research based on IEA, NGFS, Schneider Electric, EMBER and LBNL

Table A4: Estimated current social cost of data center emissions by country (in USD bn; 2026)

| Region | Country | Nordhaus (2023) SCC: ~USD81/tCO2 | EU ETS (2026) SCC: USD92/tCo2 | Renner (2022) SCC: USD239/tCO2 | EPA high (2023) SCC: USD492/tCO2 |
|---|---|---|---|---|---|
| North America | United States | 9.57 | 10.87 | 28.24 | 58.14 |
| | Canada | 0.21 | 0.24 | 0.63 | 1.30 |
| | Mexico | 0.07 | 0.07 | 0.19 | 0.39 |
| Europe | Germany | 0.68 | 0.77 | 2.00 | 4.13 |
| | France | 0.06 | 0.07 | 0.18 | 0.37 |
| | Spain | 0.07 | 0.08 | 0.20 | 0.42 |
| | UK | 0.41 | 0.47 | 1.22 | 2.52 |
| | Italy | 0.15 | 0.17 | 0.43 | 0.89 |
| | Netherlands | 0.28 | 0.32 | 0.83 | 1.71 |
| | Poland | 0.09 | 0.10 | 0.26 | 0.53 |
| | Denmark | 0.04 | 0.05 | 0.13 | 0.27 |
| | Finland | 0.03 | 0.03 | 0.08 | 0.17 |
| | Sweden | 0.06 | 0.07 | 0.18 | 0.37 |
| | Norway | 0.04 | 0.04 | 0.11 | 0.22 |
| | Ireland | 0.33 | 0.37 | 0.97 | 2.00 |
| | Switzerland | 0.03 | 0.03 | 0.09 | 0.18 |
| APAC | China | 6.33 | 7.19 | 18.68 | 38.45 |
| | India | 0.59 | 0.66 | 1.73 | 3.56 |
| | Japan | 0.72 | 0.81 | 2.12 | 4.35 |
| | South Korea | 0.40 | 0.45 | 1.17 | 2.42 |
| | Australia | 0.45 | 0.52 | 1.34 | 2.76 |
| | Malaysia | 0.34 | 0.38 | 0.99 | 2.04 |
| | Indonesia | 0.19 | 0.22 | 0.57 | 1.17 |
| | Singapore | 0.43 | 0.49 | 1.28 | 2.63 |
| South America | Brazil | 0.09 | 0.10 | 0.26 | 0.54 |
| | Chile | 0.04 | 0.05 | 0.13 | 0.26 |
| ROW | ROW | 1.49 | 1.69 | 4.39 | 9.03 |
| **World** | | **23.18** | **26.33** | **68.41** | **140.82** |

Sources: Allianz Research based on Nordhaus (2023), LSEG Workspace, Renner (2022) and EPA (2023)

Table A5: Data center water consumption by country (current, bn liters)

| Region | Country | Direct | Indirect - electricity | Indirect - semiconductor |
|---|---|---|---|---|
| North America | United States | 80.4 | 229.4 | 27.06 |
| | Canada | 2.9 | 5.0 | 0.7 |
| | Mexico | 0.4 | 1.3 | 0.2 |
| Europe | Germany | 6.1 | 16.7 | 2.0 |
| | France | 1.4 | 9.3 | 0.9 |
| | Spain | 0.9 | 2.5 | 0.3 |
| | UK | 4.7 | 15.7 | 1.8 |
| | Italy | 1.4 | 3.0 | 0.4 |
| | Netherlands | 3.0 | 6.9 | 0.9 |
| | Poland | 0.4 | 2.1 | 0.2 |
| | Denmark | 0.8 | 1.3 | 0.2 |
| | Finland | 0.7 | 2.3 | 0.3 |
| | Sweden | 1.6 | 3.6 | 0.5 |
| | Norway | 1.0 | 0.1 | 0.1 |
| | Ireland | 3.8 | 6.2 | 0.9 |
| | Switzerland | 0.7 | 1.9 | 0.2 |
| APAC | China | 38.3 | 140.8 | 15.7 |
| | India | 2.6 | 3.7 | 0.6 |
| | Japan | 4.6 | 20.5 | 2.2 |
| | South Korea | 2.9 | 16.0 | 1.7 |
| | Australia | 2.7 | 9.8 | 1.1 |
| | Malaysia | 1.8 | 7.4 | 0.8 |
| | Indonesia | 0.9 | 4.8 | 0.5 |
| | Singapore | 2.8 | 8.4 | 1.0 |
| South America | Brazil | 1.2 | 1.8 | 0.3 |
| | Chile | 0.4 | 0.9 | 0.1 |
| ROW | ROW | 12.3 | 47.2 | 5.2 |
| **World** | | **180.9** | **568.2** | **65.5** |

Sources:: Allianz Research based on Jin et al (2019) and IEA

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