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GLOBAL INSIGHT

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## Tech Diffusion and GenAI

# Powering GenAI: How Much Power, and Who Benefits?

Introducing our proprietary analysis sizing GenAI power consumption. We estimate GenAI power demand will rise rapidly, reaching 224 TWh by 2027 in our base case, equivalent to >75% of the total global data center power use in 2022 (i.e., close to Spain's total 2022 power consumption). We expect growth upside for power providers and data center infrastructure stocks, but do not expect GenAI power to move the needle for regulated utilities. We highlight 14 OW-rated stocks that could benefit.

Sustainability

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# Contents

# Powering GenAI: How Much Power, and Who Benefits?

**Leveraging the work of Morgan Stanley analyst teams around the world, we developed a proprietary model to project GenAI power demand; our model suggests a 70% CAGR in 2024-27.** In our base case, GenAI power demand grows from an avg. of <15 terawatt hours (TWh) in 2023 to 46 TWh in 2024 to 224 TWh in 2027. We believe our projected growth is conservative as we expect users of GenAI hardware will have strong incentives to maximize the utilization rate of this equipment. Using a GPU/Custom Silicon utilization rate of 60% in our base case, we estimate that 2027 GenAI power demand will be equivalent to more than 75% of the total global data center power use in 2022. In our bull case, where we increase our GPU/Custom Silicon utilization rate to 90%, we estimate 2027 GenAI power demand equal 116% of 2022 total data center power usage. **We note that, contrary to consensus, we expect the net Sustainability impacts of GenAI to be positive.** We think the impact on global carbon emissions is likely to be small, while the Sustainability benefits of GenAI are likely to be large.

**Exhibit 1:** Morgan Stanley's projected GenAI power demand and $CO_2$ emissions

| | GenAI Power as a % of 2022 Data Center Power Usage | | | | 2027e GenAI $CO_2$ Emissions | |
|---|---|---|---|---|---|---|
| **Scenario** | 2024 | 2025 | 2026 | 2027 | Tons (mn) | % of Power Sector $CO_2$ |
| **Bull Case:** High GPU/Custom Silicon utilization (90%), power sourced predominantly (80%) from renewables | 24% | 50% | 81% | 116% | 34 | 0.2% |
| **Base Case:** 60% GPU/Custom Silicon utilization, power sourced predominantly (80%) from renewables | 16% | 33% | 54% | 77% | 22 | 0.2% |
| **Bear Case:** 50% GPU/Custom Silicon utilization, power sourced equally from fossil + renewables | 13% | 28% | 45% | 64% | 47 | 0.3% |

Source: Company data, TrendForce, Morgan Stanley Research estimates

We believe the rapid power demand growth from GenAI is not well understood, and not priced into a number of stocks. **We identified the following 14 Overweight-rated stocks that we believe are well positioned to benefit from this growth:**

**Exhibit 2:** Key OW-rated beneficiaries of the rapid growth in GenAI power demand

| Ticker | Company | Analyst | Sector | Market Cap (USD in mn) | Rating | PT Currency | PT | Upside to PT | Classification of AI Exposure |
|---|---|---|---|---|---|---|---|---|---|
| *Data Center Infrastructure* | | | | | | | | | |
| 2308.TW | Delta Electronics Inc. | Shih, Sharon | Information Technology | 23,951 | Overweight | TWD | 378.00 | 29% | Beneficiary - Enabler |
| PRY.MI | Prysmian SpA | Yates, Max | Industrials | 12,258 | Overweight | EUR | 45.00 | 12% | - |
| PSTG.N | Pure Storage Inc | Marshall, Meta | Information Technology | 13,137 | Overweight | USD | 43.00 | 6% | Beneficiary - Enabler |
| 6503.T | Mitsubishi Electric | Ibara, Yoshinao | Industrials | 31,572 | Overweight | JPY | 2,300.00 | 4% | Beneficiary - Adopter |
| PLD.N | Prologis, Inc. | Kamdem, Ronald | Real Estate | 117,723 | Overweight | USD | 141.00 | 10% | Beneficiary - Adopter |
| *Power Providers* | | | | | | | | | |
| BE.N | Bloom Energy Corp. | Percoco, Andrew | Industrials | 2,715 | Overweight | USD | 22.00 | 84% | Beneficiary - Enabler |
| RWEG.DE | RWE AG | Pulleyn, Robert | Utilities | 29,835 | Overweight | EUR | 60.00 | 64% | Beneficiary - Adopter |
| AES.N | AES Corp. | Arcaro, David | Utilities | 11,193 | Overweight | USD | 26.00 | 55% | Beneficiary (Enabler, Adopter, Both) |
| ORSTED.CO | Orsted A/S | Pulleyn, Robert | Utilities | 23,877 | Overweight | DKK | 500.00 | 30% | Beneficiary - Adopter |
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Source: FactSet, Morgan Stanley Research estimates. Data as of market close 1/23/24. Classification is based on our Mapping AI's Diffusion note. We also highlight names that are included in our Sustainability *Stars and Sparks* list in the Americas and EMEA: BE, CEG, AES, NEE; as well as, RWE, Prysmian, ENGIE, and Orsted

*For a full list of stocks mentioned in this report, see Exhibit 64 .*

**How do we relate rapid growth in GenAI power consumption to the stocks we list as beneficiaries? The impacts vary by business model, as follows:**

**Business Model - Data Center Infrastructure**:

**By 2027, we expect GenAI power demand to be equivalent to >75% of total global data center power in 2022.** The numbers are very large relative to the current size of both the data center industry and the business of providing power to corporate customers. It is understandably difficult to appreciate what a terawatt hour of power really means, but if we translate the volume of power into a percentage of total global business models, the impacts from GenAI growth become clearer. In our base case, 2025 GenAI power demand is equivalent to one-third of total global data center power in 2022, rising to >75% by 2027. For an industry with growth estimates that are typically around 10% p.a., this incremental power demand growth can clearly be an incremental driver of growth.

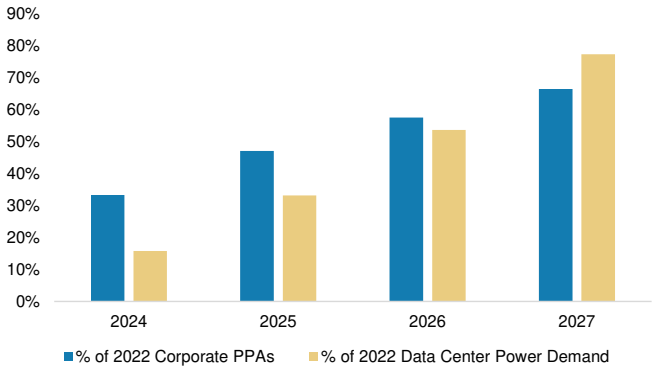
**Overweight-rated data center and related infrastructure stocks positioned to benefit from GenAI power growth:** Delta Electronics **(2308.TW),** Prologis **(PLD.N)**, Prysmian **(PRY.MI)**, Pure Storage **(PSTG.N)**,and Mitsubishi Electric **(6503.T).Equal-weight-rated beneficiaries:** Digital Realty **(DLR.N),** Equinix **(EQIX.O)**,Legrand **(LEGD.PA),** and Schneider Electric **(SCHN.PA).** Separately, we are raising our bull case value for Pure Storage based on growth upside from our analysis.

**Business Model - Power Providers:**

**By 2027, we expect GenAI incremental power growth to represent ~65% of 2022 corporate power contracts signed.** The volume of annual power projects that will need to be developed to support the growth in GenAI is no less impressive than data center growth, best illustrated by comparing this new source of power demand against the current size of the global power contract market for corporate customers. The upside to power providers from GenAI growth is large, with 2025 incremental power representing ~45%+ of 2022 total corporate power contracts signed, rising to ~65% by 2027. Our base case posits that in the US, if 80% of incremental data center power demand is sourced from renewables, then developers would need to build ~5 gigawatts (GW) of renewables in 2024, or 17% of our expected 2024 US renewables additions — a meaningful amount, but in most cases manageable. That said, we see potential challenges in some locations to delivering this volume of power; see our note on US interconnection issues (found here) for details on this issue. In this context, on-site power solution providers such as Bloom Energy should in our view be able to achieve attractive returns for their products.

**Overweight-rated power provider stocks that benefit from GenAI power growth:** AES **(AES.N)**,Bloom Energy **(BE.N)**,Constellation Energy **(CEG.O)**, Engie **(ENGIE.PA)**,NextEra Energy **(NEE.N)**,Orsted **(ORSTED.CO)**,RWE **(RWEG.DE),** SembCorp **(SCIL.SI)**, andTenaga **(TENA.KL).** Separately, we are raising our bull case values for AES,Constellation Energy,NextEra Energy,SembCorp,and Tenaga based on growth upside identified in our GenAI power demand analysis. We also highlight that Bloom Energy has exceptionally high upside to (as yet unrealized) orders from data centers.

**Exhibit 3:** GenAI power as a % of 2022 data center power, corporate power purchase agreements (PPAs)




Source: Company data, TrendForce, Morgan Stanley Research estimates

**Business Model - Regulated Utilities:**

**We also see growth potential for regulated utilities that provide the power infrastructure needed for data centers, and while this is large in some instances** — such as Dominion Energy (covered by David Arcaro), the Virginia utility providing power to the largest concentration of data centers in Northern Virginia — **in most cases, the incremental data center infrastructure is not in and of itself a very significant driver of incremental growth.** Put differently, while the incremental renewables, energy storage and conventional power needed for GenAI is large relative to the size of *competitive providers of power*, which are in many cases relatively small companies, *regulated utilities* provide power infrastructure at a massive scale, and data center power needs are still going to be a small part of utility capex budgets. While our 2027 base case GenAI power demand is ~65% of the 2022 market size for corporate power contracts, this demand in 2027e is equal to just 1.1% of 2022 global power consumption — still a small driver from the perspective of very large utilities serving all consumers of power.

**Contrary to the consensus view, we believe the net Sustainability impacts of GenAI are likely to be positive — the impact to global carbon emissions is likely to be small, while the Sustainability benefits of GenAI are likely to be large.**

**We regularly hear significant concern from investors regarding the carbon footprint relating to GenAI, but our analyses suggest this concern is overstated**. For example, in the US, total economy-wide $CO_2$ emissions in 2021 (net of offsets) was ~5.6 billion tons. To be on track to limit global warming to 2 degrees C, US emissions would need to fall to 3.3 billion tons by 2030. In our view, by 2030 the US will likely emit >1 billion tons above the level required to limit warming to 1.5 degrees C. We expect US emissions attributable to GenAI power demand to grow to just 10 million tons by 2025 in our base case, a small number driven both by the relatively small power demand (relative to total global power demand, as discussed above) and the sourcing of most of this power from renewable energy.

**We see multiple important GenAI applications that can help reduce $CO_2$ emissions and mitigate the impacts of climate change** — key benefits include materials science advances (critical for batteries and carbon capture), power grid optimization, smart agriculture, weather modeling/forecasting, analyses of ocean impacts from climate change, and (perhaps largest of all in terms of magnitude) improvement in carboncapture, utilization, and sequestration (CCUS) technologies**.** We forecast that CCUS developers will capture ~400 million tons of $CO_2$ by 2030 (see our recent report here), much larger than the +20 million ton footprint from GenAI by '27—and GenAI can in our view be leveraged by CCUS (among many other sectors) in ways that can meaningfully advance the pace, and reduce the cost, of decarbonization.

**Edge AI is an important evolution in how GenAI is used — and we believe that to power the killer apps of the AI age, computing tasks will be pushed to consumer devices.**(*Edge* refers to running AI algorithms locally, directly on users' devices.) The potential prize is large — 30 billion devices by the end of this decade, we estimate — but there are significant hurdles. In our view, the world of AI will be hybrid. Last year, 2023, was all about Generative AI, cloud, GPUs, and hyperscalers, and they will remain core to the secular machine learning trend — our CIO survey supports this view. However, to see AI's diffusion permeate throughout all aspects of consumer life and enterprise productivity, which we expect it will do, will require workloads to be pushed to devices at the edge of networks. This edge — users' devices — includes smartphones, notebooks, wearables, drones, AR/VR, and autos as the major data capturers and processors. Gartner estimates that by 2025, 50% of enterprise data will be created at the edge, across billions of battery powered devices. From a power supply perspective, Edge AI is beneficial because it involves much more "dispersed" power demand, which we think will place less strain on power systems. See our recent reports hereand herefor this important theme.

**Our Morgan Stanley GenAI Power Consumption Analysis:**

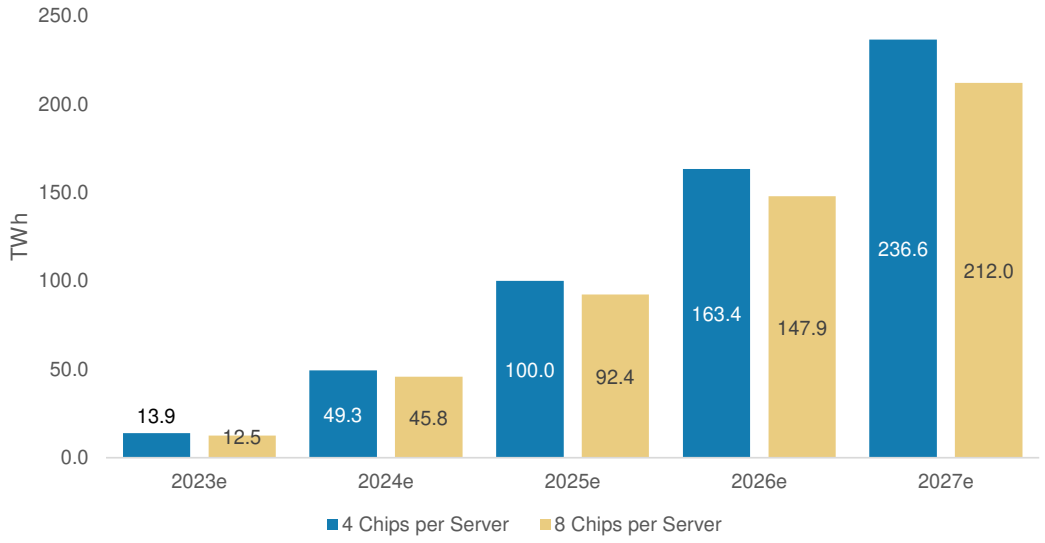
Many clients have asked us what GenAI means for power demand and how this growing demand may benefit power providers and data centers and related infrastructure names. For these reasons, we spent some time doing the analysis ourselves and leveraged the expertise of our broader research analyst teams globally. In our view, this makes our work unique and adds more context to the conversation on GenAI and power. **Those interested in reviewing our analysis and perhaps flexing your assumptions on server utilization rates; estimate GPU/Custom Silicon volume; renewables; etc. feel free to reach out to our Morgan Stanley research team here.**

# Executive Summary

**Key takeaways from our analysis of AI power demand:**

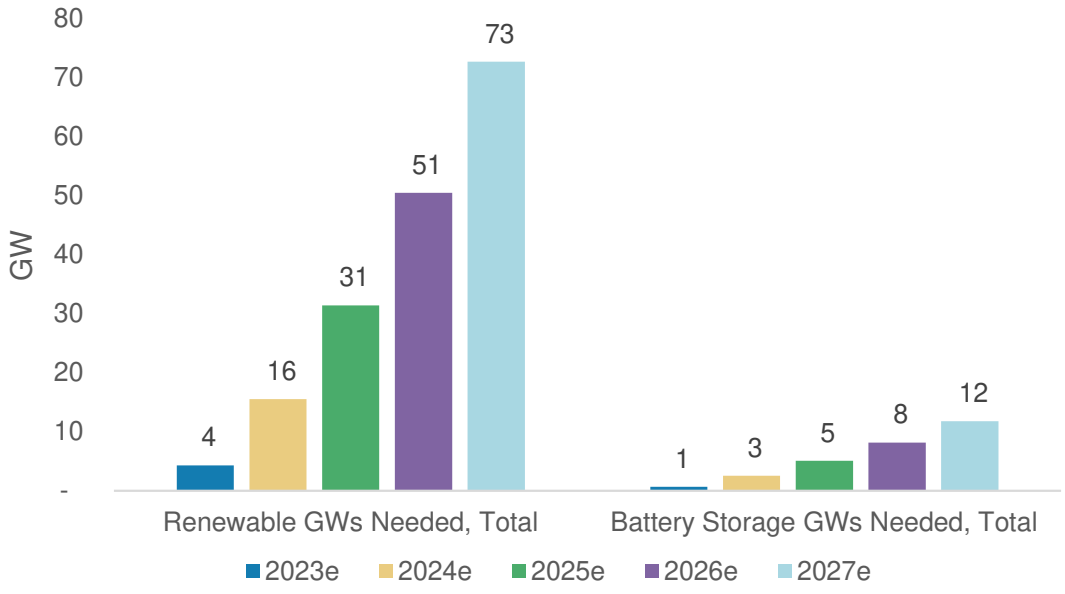
**1. We were surprised by how large our projected power usage from GenAI became within a few years.** Our proprietary analysis of likely power usage from GenAI shows surprisingly rapid growth, with a 70% CAGR in 2024-27 in our base case. By 2027, our base case GenAI power demand is 224 terawatt hours (TWh) on average, which is very close to the 2022 power consumption of Spain.

**Exhibit 4:** Global projected GenAI power demand in Morgan Stanley's base case forecast




Source: Company data, TrendForce, Morgan Stanley Research estimates

**Exhibit 5:** We estimate that an additional ~73 GW of renewable energy and ~12 GW of energy storage by 2027 would be required to power GenAI models



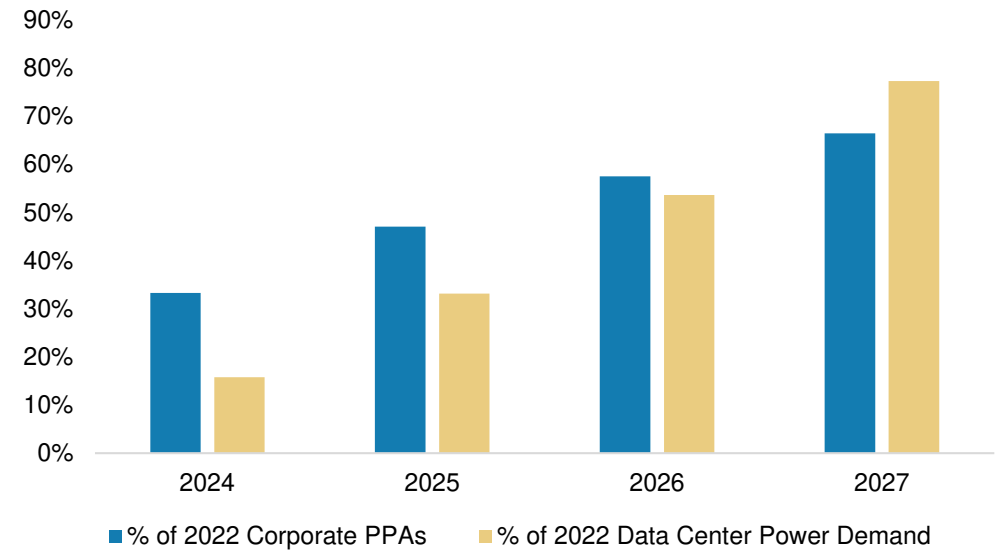

Source: Company data, TrendForce, Morgan Stanley Research estimates

**2. It can be challenging to put this GenAI power demand into a broader context of materiality, and the level of materiality depends on the sector and business model being discussed.** From a data center perspective, in our base case, 2025 GenAI power demand is equivalent to one-third of total data center power in 2022, rising to >75% by 2027. For an industry with growth estimates that are typically around 10% p.a., this incremental power demand growth can clearly be an incremental driver of growth. The volume of annual power projects that will need to be developed to support the growth in GenAI is no less impressive than data center growth, best illustrated by comparing this new source of power demand against the current size of the global power contract market for corporate customers. The upside to power providers from GenAI growth is large, with 2025 incremental power representing ~40% of 2022 total corporate power contracts signed, rising to ~60% by 2027.

**Utilities is the only business model where this power demand is generally not a material driver of growth. Why?** While the incremental renewables, energy storage and conventional power needed for **GenAI is large relative to the size of *competitive providers of power*, which are in many cases relatively small companies, *regulated utilities* provide power infrastructure at a massive scale, and data center power needs are still going to be a small part of utility capex budgets.** While our 2027 base case GenAI power demand is ~65% of the 2022 market size for corporate power contracts, this demand in 2027e is equal to just 1.1% of 2022 global power consumption — still a small driver from the perspective of very large utilities serving all consumers of power.

**3. What are the upside and downside risks to our projected GenAI power demand? We believe our projections are likely conservative, based on one key driver: GenAI server utilization.** We expect users of GenAI hardware will have strong incentives to maximize the utilization rate of this equipment. Using a GPU/Custom Silicon utilization rate of 60% in our base case, we estimate that 2027 GenAI power demand will be equivalent to more than 75% of 2022 total data center power globally. In our bull case, where we increase our GPU/Custom Silicon utilization rate to 90%, we estimate 2027 GenAI power demand equal to 116% of 2022 total data center power usage globally. However, there is downside to our projected power demand, driven by continued improvements in power efficiency of the key elements of GenAI infrastructure — most notably, GPUs and Custom Silicon, but also other elements of infrastructure such as power electronics, servers, and data storage. There has always been a tension between incremental technologies that use greater power and follow-on innovations that reduce the demand for power. However, in the near to medium term, we see users of GenAI more focused on maximizing performance/computational power, and less on primarily maximizing power efficiency — and we also expect the absolute demand for GenAI computational power to rise rapidly. An example of these dynamics in practice is the successive generation of GPUs from NVIDIA — each generation is more power-efficient (for example, measured as watts of power divided by teraflops), but the absolute demand for these GPUs is rising so rapidly that the usage of power will also rise rapidly (just not as rapidly as the teraflops of computational power will rise).

**Exhibit 6:** GenAI power as a % of 2022 data center power, corporate power purchase agreements (PPAs)




Source: Company data, TrendForce, Morgan Stanley Research estimates

## Stock Implications

We believe the rapid power demand growth from GenAI is not well understood, and not priced into a number of stocks. **We identified the following 14 Overweight-rated stocks that we believe are well positioned to benefit from this growth:**

**Exhibit 7:** Key OW-rated beneficiaries of the rapid growth in GenAI power demand

| Ticker | Company | Analyst | Sector | Market Cap (USD in mn) | Rating | PT Currency | PT | Upside to PT | Classification of AI Exposure |
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*For a full list of stocks mentioned in this report, see Exhibit 64 .*

**How do we relate rapid growth in GenAI power consumption to the stocks we list as beneficiaries? The impacts vary by business model, as follows:**

### Data Center Infrastructure

**By 2027, we expect GenAI power demand to be equivalent to >75% of total global data center power in 2022.** The numbers are very large relative to the current size of both the data center industry and the business of providing power to corporate customers. It is understandably difficult to appreciate what a terawatt hour of power really means, but if we translate the volume of power into a percentage of total global business models, the impacts from GenAI growth become clearer. In our base case, 2025 GenAI power demand is equivalent to one-third of total global data center power in 2022, rising to >75% by 2027. For an industry with growth estimates that are typically around 10% p.a., this incremental power demand growth can clearly be an incremental driver of growth.

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### Power Providers

**By 2027, we expect GenAI incremental power growth to represent ~65% of 2022 corporate power contracts signed.** The volume of annual power projects that will need to be developed to support the growth in GenAI is no less impressive than data center growth, best illustrated by comparing this new source of power demand against the current size of the global power contract market for corporate customers. The upside to power providers from GenAI growth is large, with 2025 incremental power representing ~45% of 2022 total corporate power contracts signed, rising to ~65% by 2027. Our base case posits that in the US, if 80% of incremental data center power demand is sourced from renewables, then developers would need to build ~5 gigawatts (GW) of renewables in 2024, or 17% of our expected 2024 US renewables additions — a meaningful amount, but in most cases manageable. That said, we see potential challenges in some locations to delivering this volume of power; see our note on US interconnection issues (found here) for details on this issue. In this context, on-site power solution providers such as Bloom Energy should in our view be able to achieve attractive returns for their products.

**Overweight-rated power provider stocks that benefit from GenAI power growth:** AES **(AES.N)**, Bloom Energy **(BE.N),** Constellation Energy **(CEG.O)**, Engie **(ENGIE.PA)**, NextEra Energy **(NEE.N),** Orsted **(ORSTED.CO),** RWE **(RWEG.DE),** SembCorp **(SCIL.SI),** and Tenaga **(TENA.KL).** Separately, we are raising our bull case values for AES, Constellation Energy, NextEra Energy, SembCorp, and Tenaga based on growth upside identified in our GenAI power demand analysis. We also highlight that Bloom Energy has exceptionally high upside to (as yet unrealized) orders from data centers.

**The following is a stock-by-stock summary of the direct beneficiaries of rapid GenAI power demand growth:**

## AES Corp.

**AES (AES.N) — covered by Dave Arcaro:** AES is a major large-scale renewable developer in the US, with the largest Commercial & Industrial market share. It has similar business strengths as NEE in terms of geographic coverage, scale, cost, and operational expertise that make it a strong player in the market. The company has also focused its business on the C&I customer category and has existing commercial relationships with big tech companies including Google, Microsoft, and Amazon. This could help differentiate the company in serving data center demand. **We estimate that GenAI accounts for 0% of revenue today and could grow to 3.5% by 2027.**

## Bloom Energy

**Bloom Energy (BE.N) — covered by Andrew Percoco:** In our view, fuel cells are among the most exciting alternatives to wind and solar to serve GenAI power demand. Bloom Energy provides base-load power fuel cells to data center customers. Fuel cells can operate at high capacity factors (90%+), solving the intermittency issue with renewables, are economic vs. grid-alternatives (~$0.10/kWh vs. C&I rates, which range from $0.06 to $0.24/kWh, depending on the state), and are more environmentally friendly than grid power (even when running on natural gas). Additionally, fuel cells are quick to deploy and can serve as a bridge technology for data center customers as utilities build out transmission and substation infrastructure to support increasing data center load. Assuming GenAI load were to be supported by high capacity-factor fuel cells, we estimate that 22GW would need to be deployed through 2027 to support global AI load growth in our base case scenario. This is a very significant amount of volume relative to annual installed base for most fuel cell providers. For context, we estimate that Bloom Energy, which provides base-load power fuel cells to data center customers, will deploy 300-500 MW of product, annually through 2027. **Assuming BE captures just 1% market share of the annual AI power capacity demand would imply a $750 million revenue opportunity (~35% of our 2024-27 revenue forecast).** As a result, we expect companies, such as Bloom Energy, to be significant beneficiaries of the AI-driven load growth, even if just a fraction of the incremental load is supported by fuel cells.

## Constellation Energy

**Constellation Energy (CEG.O) — covered by Dave Arcaro:** Constellation Energy is the owner of the largest nuclear fleet in the US with ~21 GW of capacity in the central US, mid-Atlantic, and Northeast. The company's plants are already operational, a potential speed advantage vs. new renewables construction. Power from nuclear plants could be priced competitively vs. non-emitting alternatives, with the combination of wind, solar, and storage potentially being costly in certain regions of the country compared with the price a nuclear plant might charge (we estimate a $10-15/MWh premium to market power prices). Nuclear plants are also highly reliable, the company has a very strong operational track record, and they have no carbon emissions.

CEG's nuclear fleet also offers an interesting opportunity for data centers to be built within a nuclear plant's campus, behind the fence line. In this way a data center could source power directly from the nuclear units with no external connection to the utility grid. Electricity would be highly reliable given two nuclear units can back each other up to run 100% of the time together. The data center would potentially avoid any transmission and distribution charges from the local utility — a cost that often represents 40-50% of the total cost of electricity. Nuclear plants also have available land, water infrastructure, and security in place that could be utilized by a data center. We think this could be a competitive offering to site new data centers with nuclear plants. **We estimate that GenAI accounts for 0% of revenue today and could increase to 2.9% by 2027.**

## Delta Electronics

**Delta Electronics (2308.TW) — covered by Sharon Shih:** Delta Electronics is a key vendor offering integrated power management solutions for data centers to include products such as power supply, power module, Uninterruptible Power Supplies (UPS), and Energy Storage Systems (ESS). Power electronics takes up ~62% of its total revenue, in addition to another ~10% from its power infrastructure related businesses. As power demand grows, in order to reduce costs, we think customers will turn to IT equipment such as Delta's to support power efficiency and for reliable backup power. An example of this is Delta's InfraSuite product, which offers a comprehensive, modular and highly integrated portfolio to the support the creation of high-performing data centers. **We estimate Delta's data center related exposure to be around 25% of total revenue in 2024 and will likely rise to 30-35% in 2027.**

## ENGIE

**Engie (ENGI.PA) — covered by Arthur Sitbon:** Engie has been very active in the corporate PPA space in the past few years thanks to the complementarity of its renewables activities, its customer-oriented services and its trading activities. We think the group is well positioned to capture potential additional demand from data centers in key regions where the group develops renewables (Europe & US in particular). **We see healthy value creation fundamentals in the renewables industry overall in these markets and we thus think this could represent a way for Engie to add value accretive options** to its growth story.

## Mitsubishi Electric

**Mitsubishi Electric (6503.T) — covered by Yoshinao Ibara:** Mitsubishi Electric is one of the leading players in the factory automation and air conditioning industries, provides a comprehensive range of products and systems for building and operating data centers related to energy savings, air conditioning, power supply, and remote monitoring. Mitsubishi Electric is expected to benefit from increased demand for AI servers and data centers which consume more electricity than before. **We estimate its revenue ratio for data centers will expand to ~1.5% from ~1.3% (¥70 billion) in F3/25.** The data center–related offerings include factory automation (energy management, control & monitoring systems), energy transmission & distribution, and optical devices.

## NextEra Energy

**NextEra Energy (NEE.N) — covered by Dave Arcaro:** NextEra Energy is the leading large scale renewable developer in the US. We think the company is well positioned to supply renewable power to new data centers. NextEra has several key capabilities that we expect to position the company favorably. The company has geographic scale, with a large pipeline of land and transmission interconnect agreements across the country that give it speed to market with new projects. NEE's costs are highly competitive due to its purchasing power, highly sophisticated operating services functions, and renewable resource modeling. It has the capability to integrate wind, solar, and storage, and the software to optimize these technologies. We think these factors along with the company's reputation and track record will position it to be a major player in the renewables buildout for data center demand. **We estimate that GenAI could grow from 0% of revenue today to 2.2% by 2027.**

## Orsted & RWE

**Orsted (ORSTED.CO) and RWE (RWEG.DE) — covered by Rob Pulleyn:** We expect the growth in GenAI to positively impact Renewables power demand, especially supporting corporate PPA markets, which are likely to underpin solar and wind project economics. As leading players in Renewables, both Orsted and RWE would benefit, having 2030e installed capacity exposure of respectively 38% and 31% to US Renewables, and 57% and 35% to European RES. **Currently, RWE and Orsted stocks do not value/price in any future growth beyond known projects in renewables capacity, whether from US/ AI data centre PPA's or elsewhere.**

## Prologis

**Prologis (PLD.N) — covered by Ronald Kamdem:** Prologis is the largest global industrial and logistics landlord with a 1.2 million SF portfolio (85% US, 15% international). Given $40 billion of build out land bank potential and a favorable cost of capital with a self-funding business model, Prologis has positioned itself for between $7-$8 billion of data center development over the next 5 years. Indeed, given the company's development track record ($45 billion of development over the past 20 years at a ~30% development margin), we see potential for data center development to become a potential value driver for the business. Expect value creation to be unlocked primarily through the company's well positioned land bank as well as through conversion opportunities which should drive lower all in development costs (and higher yields on development). The company expects to develop and sell stabilized data centers back to data center operators upon completion at a margin 1.5-2.0x that of traditional industrial development margins. PLD has identified 20 opportunities for data center development (3 GW of power) over the next 5 years and sees >100 opportunities (10 GW of power) on a longer-term basis. **Currently, we estimate that data centers account for 0% of NOI today and is expected to grow to 3-4% of total NOI on $4 billion of spend by 2027.** However, we expect that Prologis will likely only retain 10-20% of these returns on its balance sheet and sell the majority falling to 40-60bps of total NOI.

## Prysmian

**Prysmian (PRY.MI) — covered by Max Yates:** Prysmian is one of the key beneficiaries of increasing spending on grid infrastructure. **Between 2023 and 2027 we expect cables for grid to rise from 35% of Prysmian's group EBITDA to 45%.** Specifically from the data center opportunity, we think Prysmian will benefit as increased power demand from data-centres will require new power sources and also more interconnections to balance power supply and

demand across regions. Prysmian has also continued to expand its presence in the US with the acquisition of General Cable in 2018 and then more recently with the announcement of capacity expansion in the US across medium voltage cable and also the new high voltage cable plant that is being constructed in Breyton Point.

## Pure Storage

**Pure Storage (PSTG.N) — covered by Meta Marshall:** Pure Storage is a pure-play on flash storage in the data center. **According to Gartner Group, storage is 20-25% of data center power usage today, growing to upwards of 40% by 2030.** Flash storage can help solve for this constraint given it is 10x more power efficient than traditional disk. With disk still addressing ~90% of cloud storage needs, we think that as clouds look for more power efficient solutions, the adoption of flash will be a natural solution. Given Pure Storage is not only a pure-play on flash, but has advantages in terms of utilization and cost from writing directly to raw flash vs. solid state drives (SSDs), we feel like they are in the best position of branded storage vendors to capture upside as the clouds look to incorporate more flash.

**Remain OW, PT to $43 from $40, bull case to $59 from $50.** As a result of the analysis in our note, we are raising our bull case to $59 from $50, assuming 30x a bull cash 25e FCF, but that the bull case FCF can be 20% higher than base case expectations as AI drives additional demand for power saving technologies vs. the 10% higher we had in the previous bull case. Our base case moves to $43 from $40, taking into account increased confidence in FY25 estimates (remain ~26x 25e FCF). Our bear case remains at $22, or 15x a bear case FCF. Biggest risks to our PT are macro weakness dampens demand, competitive differentiation in storage falls, subscription transition dampens growth rate enough to reduce interest in the name.

## Sembcorp & Tenaga

We estimate total data center power demand in ASEAN could rise to ~7 GW by 2027 (from ~1.7 GW in 2023), (~7% of total capacity in the region) driven by GenAI (business/government digital transformation, data security and edge computing) as well as the stable local geopolitical environment and supportive policies on the digital economy. We see data center demand absorbing excess power supply in Malaysia and Thailand while keeping electricity markets tighter for longer in Singapore. While GenAI is in early days of adoption in ASEAN, we see multiple levers for Singapore and Malaysia's electricity demand to grow 50bps above past decade average - examples include NVIDIA's tie up with YTL Power in Malaysia, Singapore government's AI strategy and slowly allowing build up of new data centers and multiple hyperscalers, and Chinese data centers adding capacity in ASEAN. Regulated utilities will see improvement in network efficiency, lower transmission costs and eventually acceleration in the pace of grid strengthening all resulting in higher renewables growth rates as well. We are raising our estimates for Singapore and Malaysia power demand beyond 2025 and we now expect power markets in Singapore to remain tighter until 2027 before new capacity starts up. Malaysia, which as seen reserve margins being reasonably high, due slower demand growth from industries potentially adding ~4GW of new data center electricity demand by 20xx and making the market tighter each year for the first in past one decade. What's changed? We raise Sembcorp's Singapore tariffs beyond 2025 by 5% and also reflect our views on glut in global gas markets which should help expand its margins on steam generation. For Tenaga, we lift the electricity sales volume forecasts by 50bps starting 2025. In terms of NAV, we raise the long term "g" assumption by AI, GenAI and overall data center demand have multiple effects on electricity markets, renewable supply chain and pace of renewable adoption — all which remain under appreciated. Multiples to re-rate as long term "g" for power producers in South east Asia rises 25bps for each to reflect the tightness in electricity markets.

**Sembcorp (SCI.SI) — covered by Mayank Maheshawri:** We expect SCI to be a key beneficiary of electricity market tightness which we expect to remain for the rest of the decade. SCI also previously announced a 10-year PPA with Singapore Telecom in mid-2023. Sembcorp estimates the annual contract value at S$180 million, implying a tariff of ~S$600/MWh based on 100% of Singtel's 2022 reported electricity consumption. The tariff will be based on fixed and variable components linked to fuel oil. Singtel (covered by Da Wei Lee) will also have the option to convert the power supplied to green power at a predetermined additional cost through Renewable Energy Certificates, solar, or Sembcorp's future green projects' price in the contract period. Tight electricity markets in Singapore are aiding SCI's ability to increase long-term supply contracts beyond the next capacity adds of 2026, when Keppel and SCI add ~1.2 GW+ of capacity. **Currently, we estimate that data centers account for 4.5% of total revenue in 2024 and will grow to 6.1% by 2027.**

**Tenaga (TENA.KL) — covered by Mayank Maheshwari:** We think demand growth upside is under-appreciated ~2 GW of near-term data center consumption in Malaysia should anchor demand for energy and help absorb the 40% reserves margin; it would also help TNB raise efficiency on ~60% of its capital employed. Upside to regulated returns in 2025 is not well appreciated by the stock. We see ~15% upside to earnings for its regulated business as Tenaga refocuses its capital toward transmission and distribution, which typically attracts 1.5-2.0x higher ROCEs than generation. We see upside

risks to Tenaga's regulated asset base as Malaysia advances both its energy transition and data center hub agenda, both of which requires significant incremental grid investments of ~US$20 billion over the next 5 years, while we expect the regulated WACC to remain at 7.3%. We are positive on Tenaga as we view it to be the key beneficiary for rising power demand in Malaysia from data centers. We raise our 2024e and 2025e commercial electricity demand growth to factor Tenaga's pipeline of new data center connections, hence 2024 and 2025e EPS by 2-6%. **Currently, we estimate that data centers account for 1.3% of revenue in 2024 and will grow to 4.1% by 2027.**

## Key EW-Rated Names

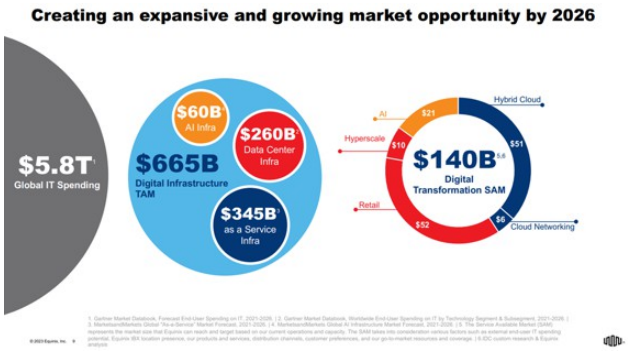
**Legrand (LEGD.PA) — covered by Aurelio Calderon Tejedor:** We see Legrand as well placed to benefit from increasing data centre equipment demand. Its **exposure has grown from 6% of sales in 2017 to >14% in 2022 and has grown at double digit rates over the last few years.** Legrand is a more focused player than Schneider and does not have a full product suite / exposure to medium voltage. It is more exposed to the white space (>90%) with products such as busways, racks, PDUs or cable management.

**Schneider Electric (SCHN.PA) — covered by Max Yates:** We view Schneider as the fastest growing large-cap Electrical equipment stock in our coverage. A key driver of this growth is Schneider's 19% exposure to data centers. Schneider offers full solutions for data centers that bring together power, cooling, racks and power, and IT management systems. **Schneider sees >10% CAGR for this end market to 2027.** At group level, Schneider is targeting 7%-10% organic revenue growth CAGR in 2023-27.

**Digital Realty (DLR.N) — covered by Simon Flannery:** We currently believe that DLR stands to benefit the most (vs. Equinix) from the US GenAI opportunity. Initial training workloads associated with GenAI are less dependent on location and latency and thus benefit DLR more due to its focus on providing wholesale capacity for training purposes. However, we would note that DLR's ability to benefit from the GenAI opportunity will somewhat be dependent on its ability to continue to raise capital at attractive rates to help delever, refinance upcoming debt maturities, and take on new data center projects. One additional impact of the rising AI demand is improved pricing trends across the data center industry especially in light of low vacancy rates. We remain Equal-weight.

**Equinix (EQIX.O) — covered by Simon Flannery:** Equinix does have exposure to hyperscale data centers via its xScale JVs, but these are primarily located in Europe and Asia. We could see Equinix look to establish a more robust Hyperscale data center presence in North America going forward. Given Equinix's predominate focus on interconnection, we believe Equinix stands to benefit more at the inference stage of GenAI, compared to the GenAI training stage. We remain Equal-weight Equinix.

**Exhibit 8:** Equinix's Overall Market and AI Opportunity Overview from Latest Investor Day




Source: Equinix

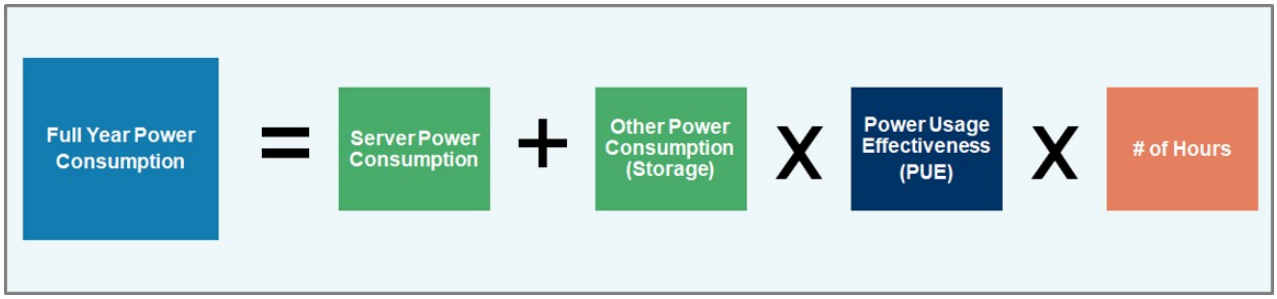
**What's in this note:**

# The Math on GenAI Power Usage

**Our approach included working with our Morgan Stanley sector teams globally, along with consultation with data centers experts/engineers to better understand power consumption at data centers.** We worked closely with many members of our sector teams globally — semiconductors, data centers/telco, utilities, clean technology, tech hardware, and many others — to build our understanding of generative AI and power consumption / demand at data centers. We also consulted data center experts, internally and externally, to ensure we have a full understanding of power dynamics at data centers. As a result of these conversations, we have created a framework to develop estimates for power consumption globally and in the US.

## Our Framework to Quantify GenAI Power

### Power Consumption Framework




**Server power consumption:** We began our analysis exploring / understanding full-year power consumption across servers. In order to do this, we leveraged Morgan Stanley analysts estimates for total unit volume for GPUs and custom silicon from our semiconductor analysts — Joe Moore and Shawn Kim. We then did a bottom-up build by flexing 4 and 8 chips per server to come to an estimate of total AI servers. From there, we made an assumption on server utilization rate (providing bull/base/bear cases) and AI server max input power (using proxy server power usage from our semiconductor team's expertise) to get total server power consumption.

**Other power consumption:** From consulting with data center experts/engineers, we learned that power is also consumed when storing data for LLMs. Our experts estimate that power consumption could be 10% of the total power consumed from AI servers.

**Power Usage Effectiveness (PUE):** PUE is often a variable to measure efficiency at a data center. A PUE closer to 1 equates to a more efficient data center. Hyperscalers typically have a PUE more efficient than other data center types — enterprise data centers and co-location data centers. Based on our conversation with experts, we assume PUE in this case includes: lights and utility plugs, cooling techniques; pumps, heating, ventilation, and air conditioning, and other IT equipment. In our analysis, we assume that over time data centers become more efficient, thus PUE decreases.

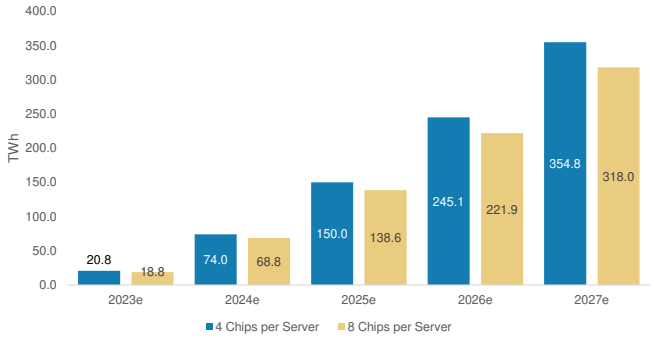
Lastly, we make key assumptions in our analysis to account for real world power usage. We gross up power consumption assuming that in the actual year of product shipment 50% of servers are used which we then assume 100% the following years. We also run a scenario analysis to include a bull/base/bear case for GPU utilization rate and Custom Silicon utilization rate to capture server power consumption. We also make an assumption on the % of power at data centers that come from renewables.

## Global Power Consumption from GenAI

We provide scenario analysis of a Bull/Bear/Base case of potential power usage from GenAI globally. Overall, we estimate that power usage from GenAI globally will continue to rise as the demand for parts and components increase and the desire to leverage GenAI capabilities grows.

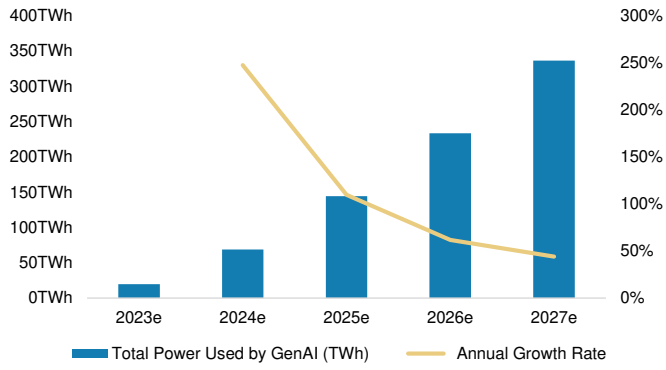
**Scenario 1 — Bull Case: We estimate that in 2025, global power usage by GenAI will grow to a range of 139-150 TWh by 2025.** We assume a 90% server utilization rate in this scenario. For perspective, these estimates mean that in 2023 GenAI will constitute as 7% of estimated global data center power usage, which we expect it to grow to 36-39% by 2025.

**Exhibit 9:** In our Bull Case, we project global power usage by GenAI in 2025 of 139-150 TWh



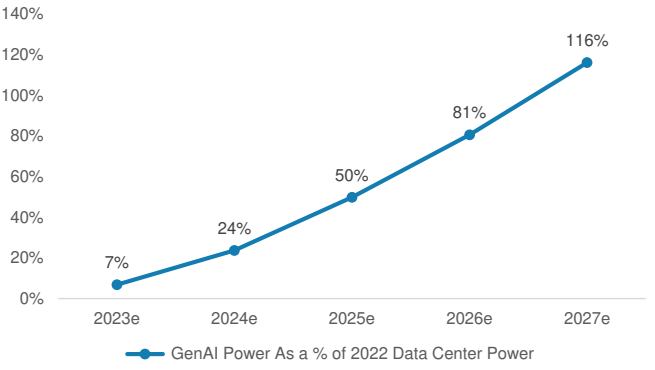

Source: Company data, TrendForce, Morgan Stanley Research estimates

**Exhibit 10:** The growth rate for GenAI power demand remains extremely high throughout the forecast period, even as the underlying power volumes become very large



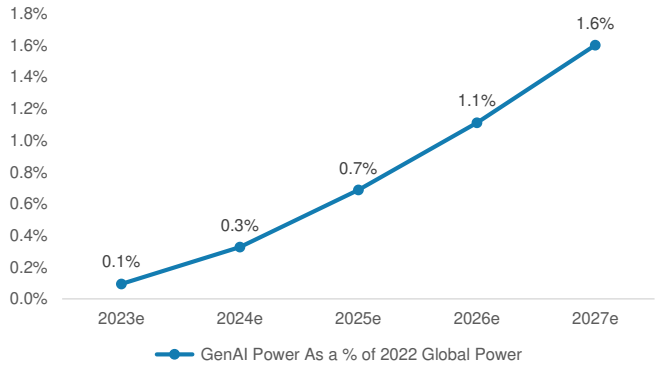

Source: Company data, TrendForce, Morgan Stanley Research estimates

**Exhibit 11:** In our Bull Case, 2025 GenAI power demand is equal to 50% of 2022 data center power usage...




Source: Company data, TrendForce, Morgan Stanley Research estimates

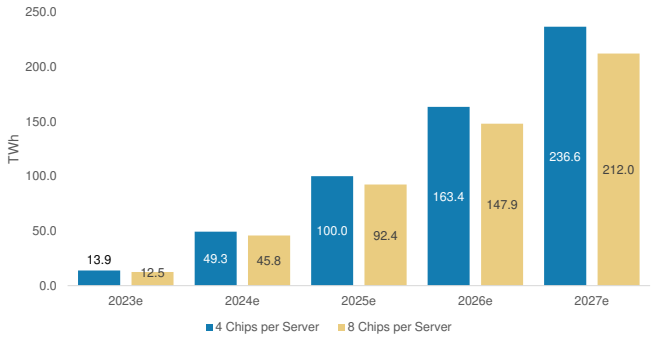
**Exhibit 12:** ...and GenAI power usage as a % of total global power demand will grow from 0.1% in 2022 to 0.7% by 2025




Source: Company data, TrendForce, Morgan Stanley Research estimates

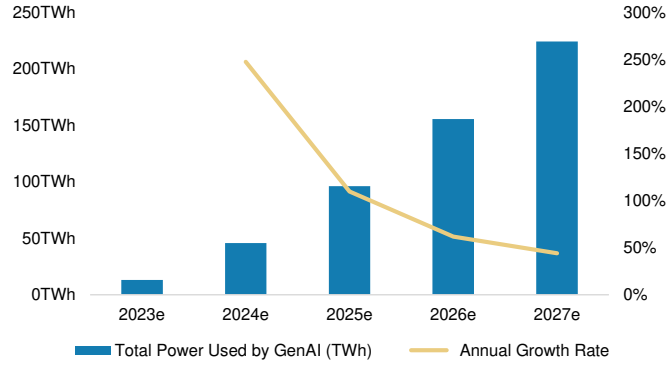
**Scenario 2 — Base Case: We estimate that in 2025, power usage by GenAI globally will be 92-100 TWh.** In this scenario, we assume a 60% sever utilization rate.

**Exhibit 13:** In our Base Case, we project GenAI power demand to be 92-100 TWh by 2025



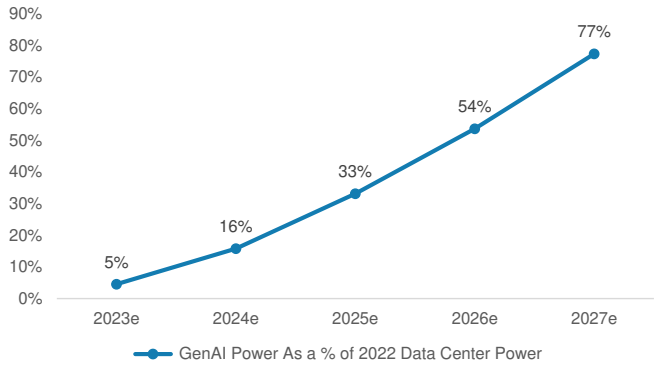

Source: Company data, TrendForce, Morgan Stanley Research estimates

**Exhibit 14:** The annual growth rate in GenAI power demand falls rapidly as the industry becomes much larger, but remains quite high throughout the forecast period



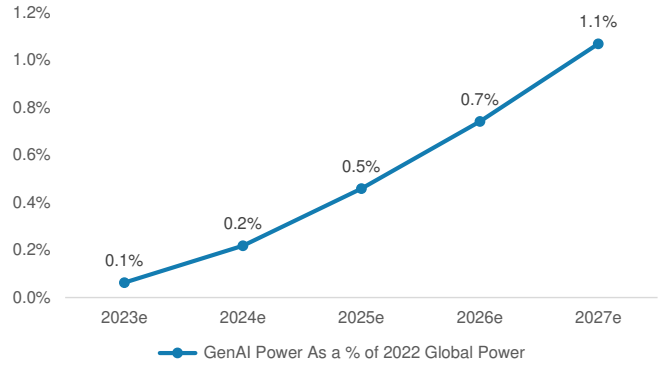

Source: Company data, TrendForce, Morgan Stanley Research estimates

**Exhibit 15:** In our Base Case, 2025 GenAI power demand is equal to 33% of 2022 data center power usage...




Source:Company data, TrendForce, Morgan Stanley Research estimates

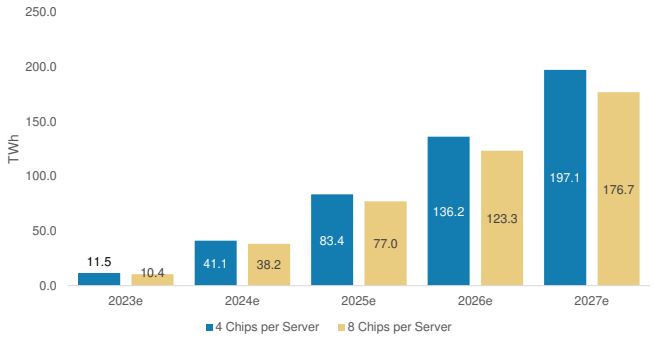
**Exhibit 16:** ...and GenAI power usage as a percent of total 2022 global power will move from 0.1% in '23 to 0.5% in '25




Source: Company data, TrendForce, Morgan Stanley Research estimates

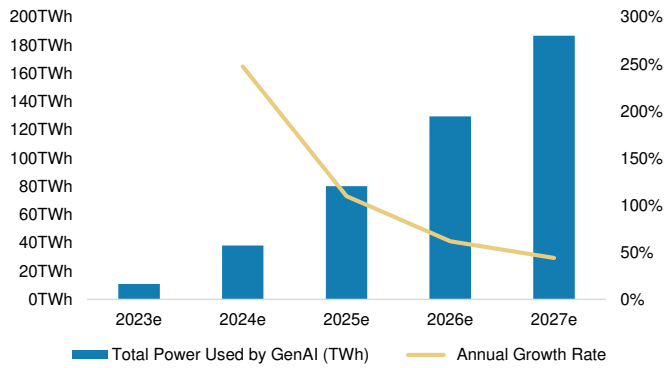
**Scenario 3 — Bear Case: We estimate that in 2025, power usage by GenAI globally will be 77-83 TWh.** This significant decrease in power usage compared to scenarios 1 and 2 is driven by the our lower (50%) server utilization rate.

**Exhibit 17:** In our Bear Case, we project GenAI power demand to be 77-83 TWh in '25



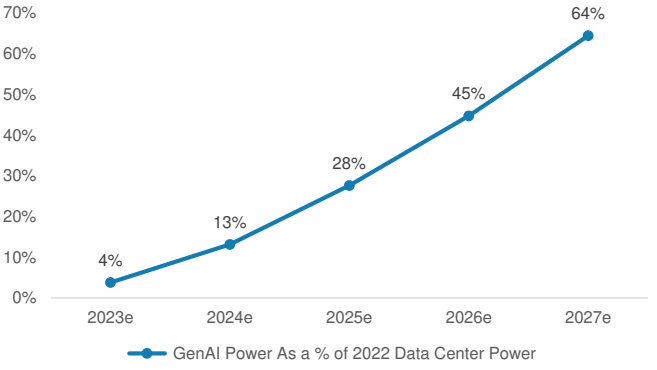

Source: Company data, TrendForce, Morgan Stanley Research estimates

**Exhibit 18:** Our GenAI power demand growth rates are very high even in our Bear case



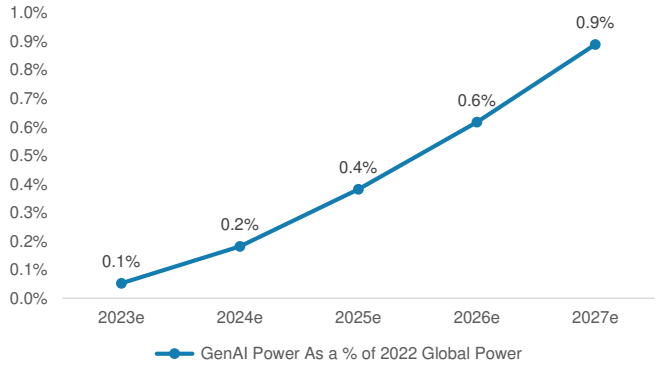

Source: Company data, TrendForce, Morgan Stanley Research estimates

**Exhibit 19:** In our Bear Case, 2025 GenAI power demand is equal to 28% of 2022 data center power usage...




Source: Company data, TrendForce, Morgan Stanley Research estimates

**Exhibit 20:** ...and GenAI power usage as a percent of total 2022 global power will move from 0.1% in '23 to 0.4% in '25




Source: Company data, TrendForce, Morgan Stanley Research estimates

**Third-Party Research: Various Studies on Power Consumption from GenAI**

Given the evolving nature of this topic, we turn to various third-party studies reviewing the power demand and consumption from GenAI at data centers. In our research, we provide various assumption on server utilization and renewable power usage. We include additional sources and their point of view on power demand from GenAI for comparison.

**Commentary: The Growing Energy Footprint of Artificial Intelligence**

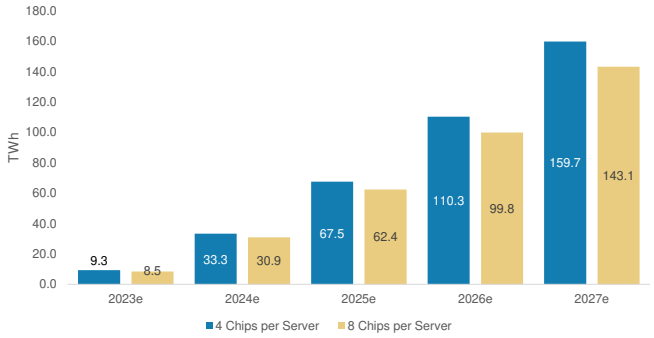
**Schneider Electric: The AI Disruption: Challenges and Guidance for Data Center Design**

## US Power Consumption from GenAI

We provide scenario analysis of a Bull/Bear/Base case of potential power usage from GenAI in the US. We assume that 45% of GenAI server power consumption will take place in the US.

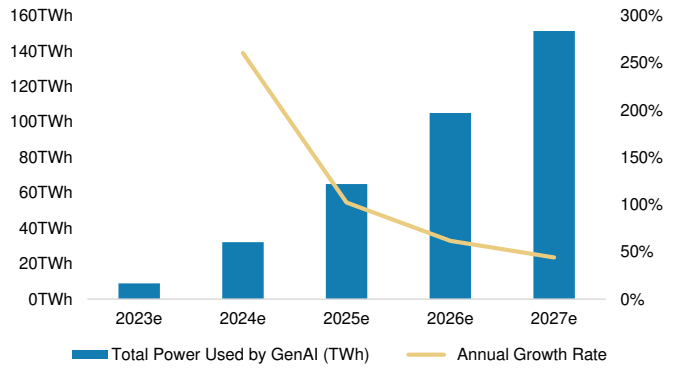
**Scenario 1 — Bull Case**: **We estimate that in 2023, power usage by GenAI in the US was in the range of 8.5-9.3 TWh and will grow to 62-68 TWh by 2025, an increase of ~7x.** We assume that 90% of the servers are utilized in this scenario. For perspective, these estimates mean that in 2023 GenAI will constitute as 9%-10% of estimated US data center power usage, which we expect it to grow to 49%-53% by 2025. Demonstrating the importance of understanding power usage in the US perspective as it seems to be more meaningful overtime.

**Exhibit 21:** We estimate that in '23, power usage by GenAI in the US was in the range of 8.5-9.3 TWh and will grow to 62-68 TWh by '25 in the US



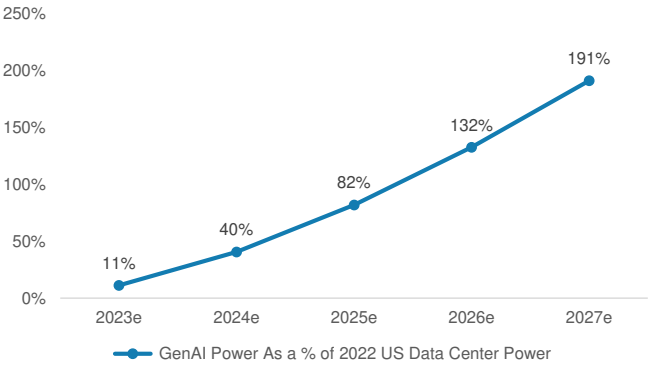

Source: Company data, TrendForce, Morgan Stanley Research estimates

**Exhibit 22:** Said another way, we think that the average power usage from GenAI in the US will be ~9 TWh in '23 and grow to 65 TWh by '25, up to 151 TWh by '27



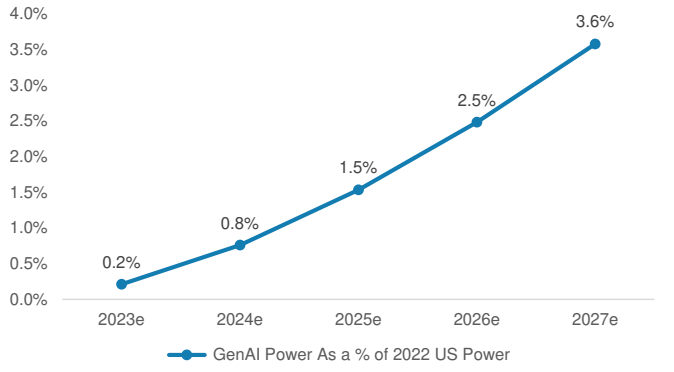

Source: Company data, TrendForce, Morgan Stanley Research estimates

**Exhibit 23:** For perspective on how meaningful this is, by '27, we expect GenAI power usage as a percent of '22 US data center power to grow to ~190%...




Source: Company data, TrendForce, Morgan Stanley Research estimates

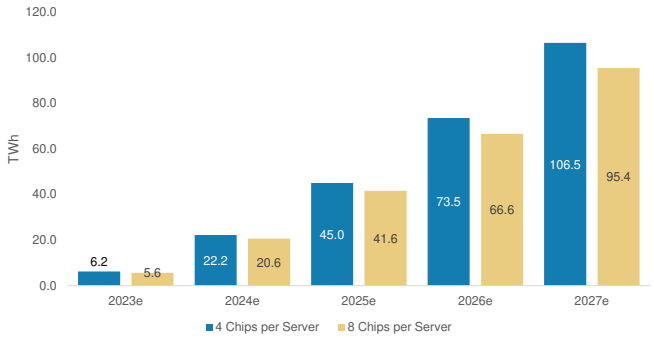
**Exhibit 24:** ...and estimate that GenAI power usage as a percent of US power will grow to 3.6% by '27




Source: Company data, TrendForce, Morgan Stanley Research estimates

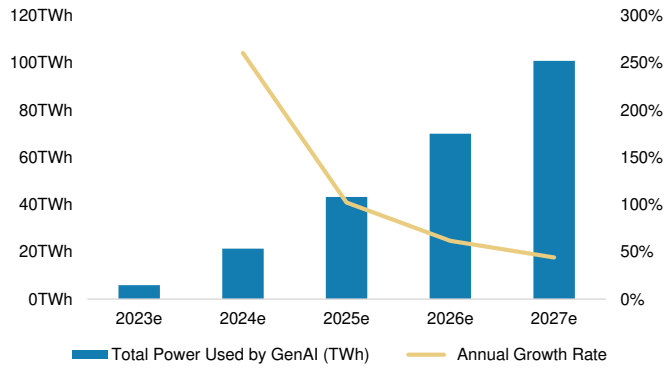
**Scenario 2 — Base Case: We estimate that in '2023 the average power usage by GenAI in the US was in the range of 5.6-6.2 TWh, and will grow to 42-45 TWh.** In this scenario, we assume a 60% server utilization rate. For perspective on what this will mean for power usage at US data centers, we estimate that in 2023 GenAI will account for 6%-7% of estimated US data center power usage and will grow to 33%-35% of estimated US data center power usage by 2025.

**Exhibit 25:** We estimate that in '23 the range of power usage by GenAI in the US was in the range of 5.6-6.2 TWh, and will grow to 42-45 TWh



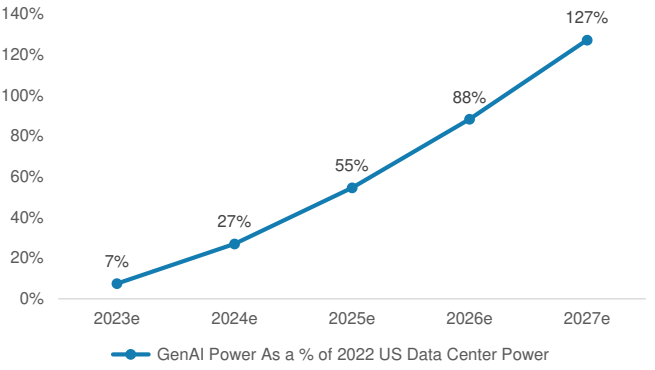

Source: Company data, TrendForce, Morgan Stanley Research estimates

**Exhibit 26:** This estimates to an average power usage of ~6 TWh in '23, growing to ~43 TWh in '25 in the US



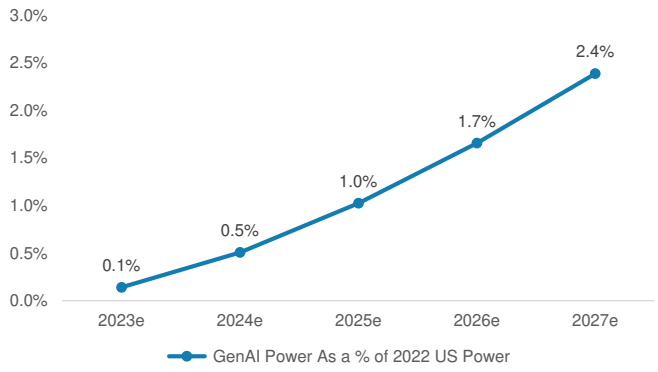

Source: Company data, TrendForce, Morgan Stanley Research estimates

**Exhibit 27:** This equates to GenAI power usage as a percent of '22 US data center power to be 7% in '23, growing to 55% by '25




Source: Company data, TrendForce, Morgan Stanley Research estimates

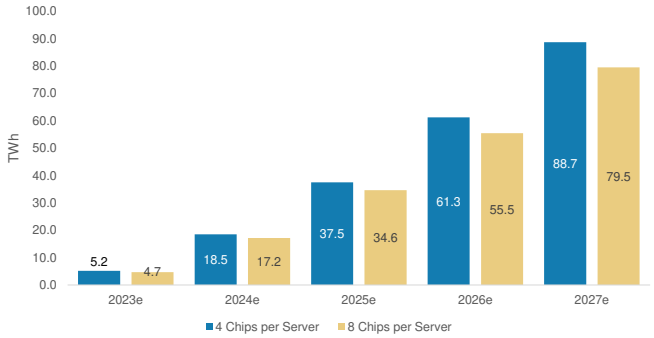
**Exhibit 28:** GenAI power usage as a percent of '22 US power was 0.1% in '23 and we expect it to grow 1.0% by '25, reaching 2.4% by '27




Source: Company data, TrendForce, Morgan Stanley Research estimates

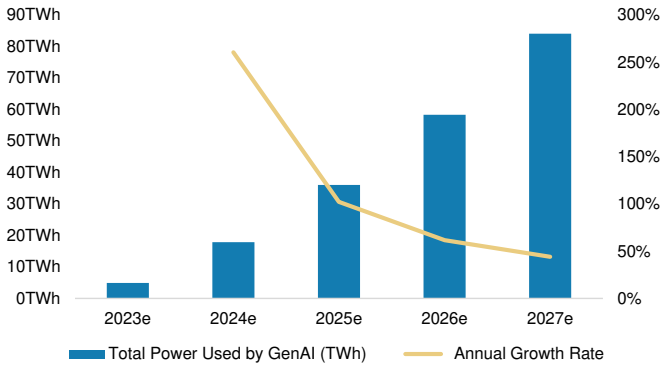
**Scenario 3 — Bear Case: We estimate that in 2023 the range of usage by GenAI in the US was in the range of 4.7-5.2 TWh, and will grow to 35-38 TWh.** This significant decrease in power usage compared to scenarios 1 and 2 is larger driven by a 50% server utilization rate. For perspective on what the growing power usage will mean to US data centers, we estimate that GenAI will account for ~5% of US data center power usage in 2023 and will grow to only 27-30% of US data center power usage. We showcase that in the US the bear case still shows meaningful power demand.

**Exhibit 29:** We estimate that in '23 the range of power usage by GenAI in the US was in the range of 4.7-5.2 TWh, and will grow to 35-38 TWh



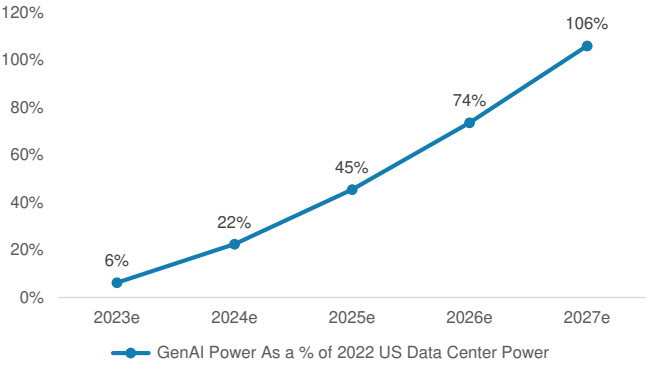

Source: Company data, TrendForce, Morgan Stanley Research estimates

**Exhibit 30:** This estimates to an average power usage of ~5 TWh in '23, growing to ~36 TWh by '25 in the US



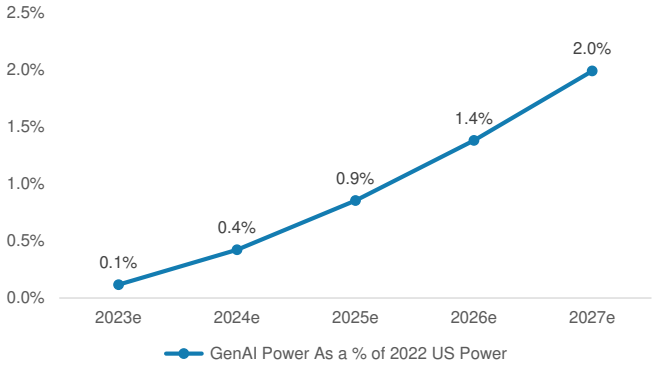

Source: Company data, TrendForce, Morgan Stanley Research estimates

**Exhibit 31:** We estimate that GenAI power usage in the US as a percent of '22 US data center power to grow from 6% in '23 to 45% in '25, up to 106% in '27




Source: Company data, TrendForce, Morgan Stanley Research estimates

**Exhibit 32:** We estimate that GenAI power usage in the US as a percent of '22 US power grows from 0.1% in '23 to 0.9% by '25, up to 2.0% by '27



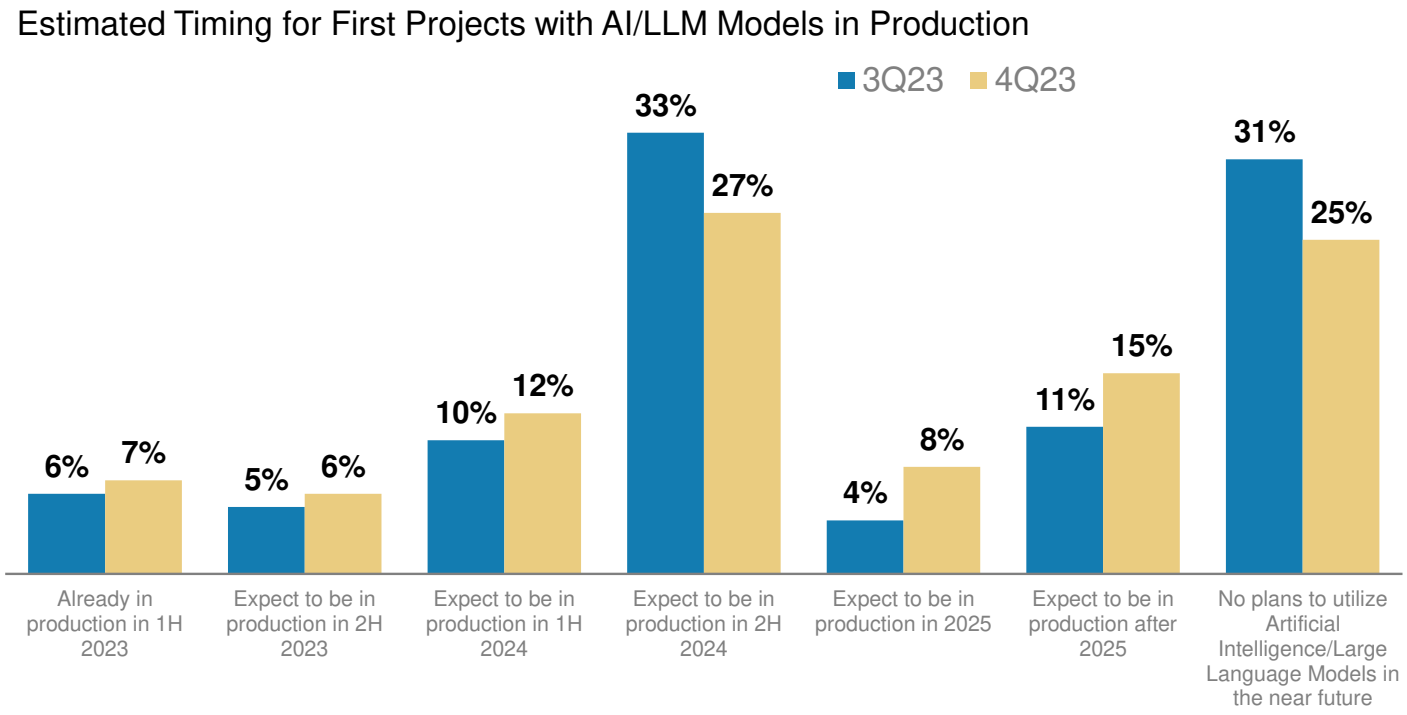

Source: Company data, TrendForce, Morgan Stanley Research estimates

## Further Thoughts on Our Methodology

**Limitations.** It Is difficult to truly quantify the power consumption from GenAI models given many moving and evolving dynamics. For instance, there could be cases where researchers re-use existing models. We do not know how much less energy would be used in that case. Additionally, data center power usage effectiveness matters and varies by data center type. It is worth mentioning that many hyperscalers have more efficient data centers than other data center types. On this similar point, we may also expect to see less energy used by chips (and other components) over time with growing customer demand for cost effective, high performing, and energy efficient equipment. Furthermore, we could also expect more data centers to leverage green solutions (more efficient algorithms, green data center design, etc.). Lastly, to truly understand the impact of power consumption from GenAI more information should be disclosed on power usage through the end-to-end process/stages of a LLMs production.

As more information becomes available, we hope to continue to update our thinking on power usage from GenAI particularly as more models go into production. For perspective on the timing of this, our recent CIO suggests that 50% of CIO's expect AI/LLMs to be in production 2H24 and beyond. We hope that this will drive more transparency on this topic.

**Exhibit 33:** Majority of CIOs (50%) expect initial projects to be in production in 2H24 and beyond




Source: AlphaWise, Morgan Stanley Research. n=100 (US and EU data)

With this in mind, we use the subsequent sections of the note to dive deeper into what additional power consumption will mean for US data centers , clean energy , and US utilities . We also include details on the power and data center dynamics in Ireland and Brazil .

# US Data Centers: GenAI Power and Total Power Leased by Tenants

We quantify what the rise in GenAI power in the United States will mean for US data centers leased by tenants. We use our team's scenario analysis - Bull/Base/Bear case to provide a range of outcomes from GenAI power.

## Scenario Analysis

### Scenario 1 — Bull Case

**For the US, we expect that the total amount of power leased by colocation data center tenants to increase from current levels of ~8.8 GW to 17.6-18.1 GW by 2027.** Our calculations include both the expected power leased by tenants and the additional power leasing demand we expect to come from GenAI. We assume that the power leased by tenants in the colocation market (excluding the effect of GenAI) will grow by only ~4.5 GW — from ~8.8 GW in 2022 to 13.5GW by 2027. We expect tenants who want to rent capacity for GenAI, will require an incremental ~4.1 GW (assuming 8 chips per server) to ~4.6 GW (assuming 4 chips per server) of power by 2027 on top.

**We project that US colocation data centers will require an additional 12.3-13.1 GW of power by 2027, to meet the incremental power leasing demand coming from tenants and GenAI.** After taking into account incremental expected power to be leased by tenants of ~8.8 GW (assuming 8 chips per server) to ~9.3 GW (assuming 4 chips per server), we apply a PUE factor of 1.5 in 2023 that gradually becomes more efficient to meet the expected leasing demand of tenants.

As a reminder, in this scenario we assume 90% of servers are utilized and that 80% of power is predominately sourced from renewables.

**Exhibit 34:** In our Bull case, we estimate that US colocation data centers will require an additional 12.3-13.1 GW of power by 2027

| Data Center Framework (GenAI - 4 Chips Per Server Scenario) | 2022e | 2023e | 2024e | 2025e | 2026e | 2027e |
|---|---|---|---|---|---|---|
| Power Leased by Tenants (MW) | 8,800 | 9,500 | 10,300 | 11,200 | 12,200 | 13,500 |
| Incremental Power from GenAI. Services and Other - 4 Chips (MW) | | 1,423 | 2,296 | 3,205 | 3,909 | 4,616 |
| **Total Power Leased by Tenants (MW)** | **8,800** | **10,923** | **12,596** | **14,405** | **16,109** | **18,116** |
| Yearly Incremental Utilized Power Leased by Tenants (MW) | | 2,123 | 1,673 | 1,809 | 1,704 | 2,007 |
| **Cumulative Incremental Utilized Power Leased by Tenants (MW)** | | **2,123** | **3,796** | **5,605** | **7,309** | **9,316** |
| | | | | | | |
| PUE | 1.50 | 1.50 | 1.45 | 1.40 | 1.35 | 1.30 |
| Yearly Incremental Utilized Power Required for DCs (MW) | | 3,185 | 2,426 | 2,533 | 2,300 | 2,609 |
| **Cumulative Incremental Utilized Power Required for DCs (MW)** | | **3,185** | **5,610** | **8,143** | **10,444** | **13,052** |

| Data Center Framework (GenAI - 8 Chips Per Server Scenario) | 2022e | 2023e | 2024e | 2025e | 2026e | 2027e |
|---|---|---|---|---|---|---|
| Power Leased by Tenants (MW) | 8,800 | 9,500 | 10,300 | 11,200 | 12,200 | 13,500 |
| Incremental Power from GenAI. Services and Other - 8 Chips (MW) | | 1,288 | 2,208 | 2,836 | 3,399 | 4,066 |
| **Total Power Leased by Tenants (MW)** | **8,800** | **10,788** | **12,508** | **14,036** | **15,599** | **17,566** |
| Yearly Incremental Utilized Power Leased by Tenants (MW) | | 1,988 | 1,720 | 1,527 | 1,563 | 1,967 |
| **Cumulative Incremental Utilized Power Leased by Tenants (MW)** | | **1,988** | **3,708** | **5,236** | **6,799** | **8,766** |
| | | | | | | |
| PUE | 1.50 | 1.50 | 1.45 | 1.40 | 1.35 | 1.30 |
| Yearly Incremental Utilized Power Required for DCs (MW) | | 2,982 | 2,495 | 2,138 | 2,110 | 2,557 |
| **Cumulative Incremental Utilized Power Required for DCs (MW)** | | **2,982** | **5,477** | **7,615** | **9,725** | **12,282** |

| US GW | 2022e | 2023e | 2024e | 2025e | 2026e | 2027e |
|---|---|---|---|---|---|---|
| Cumulative Incremental Utilized Power Required for DCs (4 Chips/Server) | | 3,185 | 5,610 | 8,143 | 10,444 | 13,052 |
| Cumulative Incremental Utilized Power Required for DCs (8 Chips/Server) | | 2,982 | 5,477 | 7,615 | 9,725 | 12,282 |

Source: McKinsey, 451 Research, TrendForce, Morgan Stanley Research estimates

## Scenario 2 — Base Case:

**For the US, we expect that the total amount of power leased by colocation data center tenants to increase from current levels of ~8.8 GW to 16.2-16.6 GW by 2027.** Our calculations include both the expected power leased by tenants and the additional power leasing demand we expect to come from GenAI. We assume that the power leased by tenants in the colocation market (excluding the effect of GenAI) will grow by only ~4.5 GW — from ~8.8 GW in 2022 to 13.5 GW by 2027. We expect tenants who want to rent capacity for GenAI, will require an incremental ~2.7 GW (assuming 8 chips per server) to ~3.1 GW (assuming 4 chips per server) of power by 2027 on top.

**We project that US colocation data centers will require an additional 10.4-10.9 GW of power by 2027 to meet the incremental power leasing demand coming from tenants and GenAI.** After taking into account incremental expected power to be leased by tenants of ~7.4 GW (assuming 8 chips per server) to ~7.8 GW (assuming 4 chips per server), we apply a PUE factor of 1.5 in 2023 that gradually becomes more efficient to meet the expected leasing demand of tenants.

As a reminder, in this scenario we assume 60% of servers are utilized and that 80% of power is predominately sourced from renewables.

**Exhibit 35:** In our Base case, we estimate that US colocation data centers will require an additional 10.4-10.9 GW of power by 2027

| Data Center Framework (GenAI - 4 Chips Per Server Scenario) | 2022e | 2023e | 2024e | 2025e | 2026e | 2027e |
|---|---|---|---|---|---|---|
| Power Leased by Tenants (MW) | 8,800 | 9,500 | 10,300 | 11,200 | 12,200 | 13,500 |
| Incremental Power from GenAI. Services and Other - 4 Chips (MW) | | 949 | 1,531 | 2,137 | 2,606 | 3,077 |
| **Total Power Leased by Tenants (MW)** | **8,800** | **10,449** | **11,831** | **13,337** | **14,806** | **16,577** |
| Yearly Incremental Utilized Power Leased by Tenants (MW) | | 1,649 | 1,382 | 1,506 | 1,469 | 1,771 |
| **Cumulative Incremental Utilized Power Leased by Tenants (MW)** | | **1,649** | **3,031** | **4,537** | **6,006** | **7,777** |
| | | | | | | |
| PUE | 1.50 | 1.50 | 1.45 | 1.40 | 1.35 | 1.30 |
| Yearly Incremental Utilized Power Required for DCs (MW) | | 2,473 | 2,004 | 2,109 | 1,984 | 2,303 |
| **Cumulative Incremental Utilized Power Required for DCs (MW)** | | **2,473** | **4,477** | **6,585** | **8,569** | **10,872** |

| Data Center Framework (GenAI - 8 Chips Per Server Scenario) | 2022e | 2023e | 2024e | 2025e | 2026e | 2027e |
|---|---|---|---|---|---|---|
| Power Leased by Tenants (MW) | 8,800 | 9,500 | 10,300 | 11,200 | 12,200 | 13,500 |
| Incremental Power from GenAI. Services and Other - 8 Chips (MW) | | 859 | 1,472 | 1,890 | 2,266 | 2,710 |
| **Total Power Leased by Tenants (MW)** | **8,800** | **10,359** | **11,772** | **13,090** | **14,466** | **16,210** |
| Yearly Incremental Utilized Power Leased by Tenants (MW) | | 1,559 | 1,414 | 1,318 | 1,375 | 1,745 |
| **Cumulative Incremental Utilized Power Leased by Tenants (MW)** | | **1,559** | **2,972** | **4,290** | **5,666** | **7,410** |
| | | | | | | |
| PUE | 1.50 | 1.50 | 1.45 | 1.40 | 1.35 | 1.30 |
| Yearly Incremental Utilized Power Required for DCs (MW) | | 2,338 | 2,050 | 1,845 | 1,857 | 2,268 |
| **Cumulative Incremental Utilized Power Required for DCs (MW)** | | **2,338** | **4,388** | **6,233** | **8,090** | **10,358** |

| US GW | 2022e | 2023e | 2024e | 2025e | 2026e | 2027e |
|---|---|---|---|---|---|---|
| Cumulative Incremental Utilized Power Required for DCs (4 Chips/Server) | | 2,473 | 4,477 | 6,585 | 8,569 | 10,872 |
| Cumulative Incremental Utilized Power Required for DCs (8 Chips/Server) | | 2,338 | 4,388 | 6,233 | 8,090 | 10,358 |

Source: McKinsey, 451 Research, TrendForce, Morgan Stanley Research estimates

## Scenario 3 — Bear Case:

**For the US, we expect that the total amount of power leased by colocation data center tenants to increase from current levels of ~8.8 GW to 15.8-16.1 GW by 2027.** Our calculations include both the expected power leased by tenants and the additional power leasing demand we expect to come from GenAI. We assume that the power leased by tenants in the colocation market (excluding the effect of GenAI) will grow by only 4.5 GW — from ~8.8 GW in 2022 to 13.5 GW by 2027. We expect tenants who want to rent capacity for GenAI, will require an incremental ~2.3 GW (assuming 8 chips per server) to ~2.6 GW (assuming 4 chips per server) of power by 2027 on top.

**We project that US colocation data centers will require an additional 9.8-10.1 GW of power by 2027, to meet the incremental power leasing demand coming from tenants and GenAI.** After taking into account incremental expected power to be leased by tenants of ~7 GW (assuming 8 chips per server) to ~7.2 GW (assuming 4 chips per server), we apply a PUE factor of 1.5 in 2023 that gradually becomes more efficient to meet the expected leasing demand of tenants.

As a reminder, in this scenario we assume 50% of servers are utilized and that 50% of power is predominately sourced from renewables.

**Exhibit 36:** In our Bear case, we estimate that US colocation data centers will require an additional 9.8-10.1 GW of power by 2027

| Data Center Framework (GenAI - 4 Chips Per Server Scenario) | 2022e | 2023e | 2024e | 2025e | 2026e | 2027e |
|---|---|---|---|---|---|---|
| Power Leased by Tenants (MW) | 8,800 | 9,500 | 10,300 | 11,200 | 12,200 | 13,500 |
| Incremental Power from GenAI. Services and Other - 4 Chips (MW) | | 791 | 1,275 | 1,781 | 2,172 | 2,564 |
| **Total Power Leased by Tenants (MW)** | **8,800** | **10,291** | **11,575** | **12,981** | **14,372** | **16,064** |
| Yearly Incremental Utilized Power Leased by Tenants (MW) | | 1,491 | 1,285 | 1,405 | 1,391 | 1,693 |
| **Cumulative Incremental Utilized Power Leased by Tenants (MW)** | | **1,491** | **2,775** | **4,181** | **5,572** | **7,264** |
| | | | | | | |
| PUE | 1.50 | 1.50 | 1.45 | 1.40 | 1.35 | 1.30 |
| Yearly Incremental Utilized Power Required for DCs (MW) | | 2,236 | 1,863 | 1,967 | 1,878 | 2,200 |
| **Cumulative Incremental Utilized Power Required for DCs (MW)** | | **2,236** | **4,099** | **6,066** | **7,944** | **10,145** |

| Data Center Framework (GenAI - 8 Chips Per Server Scenario) | 2022e | 2023e | 2024e | 2025e | 2026e | 2027e |
|---|---|---|---|---|---|---|
| Power Leased by Tenants (MW) | 8,800 | 9,500 | 10,300 | 11,200 | 12,200 | 13,500 |
| Incremental Power from GenAI. Services and Other - 8 Chips (MW) | | 716 | 1,227 | 1,575 | 1,888 | 2,259 |
| **Total Power Leased by Tenants (MW)** | **8,800** | **10,216** | **11,527** | **12,775** | **14,088** | **15,759** |
| Yearly Incremental Utilized Power Leased by Tenants (MW) | | 1,416 | 1,311 | 1,248 | 1,313 | 1,671 |
| **Cumulative Incremental Utilized Power Leased by Tenants (MW)** | | **1,416** | **2,727** | **3,975** | **5,288** | **6,959** |
| | | | | | | |
| PUE | 1.50 | 1.50 | 1.45 | 1.40 | 1.35 | 1.30 |
| Yearly Incremental Utilized Power Required for DCs (MW) | | 2,123 | 1,902 | 1,748 | 1,772 | 2,172 |
| **Cumulative Incremental Utilized Power Required for DCs (MW)** | | **2,123** | **4,025** | **5,773** | **7,545** | **9,717** |

| US GW | 2022e | 2023e | 2024e | 2025e | 2026e | 2027e |
|---|---|---|---|---|---|---|
| Cumulative Incremental Utilized Power Required for DCs (4 Chips/Server) | | 2,236 | 4,099 | 6,066 | 7,944 | 10,145 |
| Cumulative Incremental Utilized Power Required for DCs (8 Chips/Server) | | 2,123 | 4,025 | 5,773 | 7,545 | 9,717 |

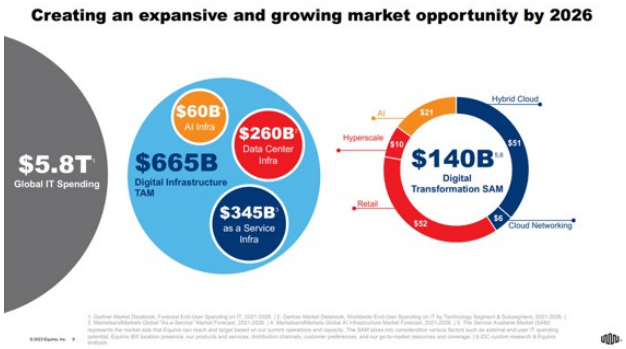
Source: McKinsey, 451 Research, TrendForce, Morgan Stanley Research estimates

## Key Beneficiaries

**Digital Realty (DLR.N) — covered by Simon Flannery:** We currently believe that DLR stands to benefit the most (vs. Equinix) from the US GenAI opportunity. Initial training workloads associated with GenAI are less dependent on location and latency and thus benefit DLR more due to its focus on providing wholesale capacity for training purposes. However, we would note that DLR's ability to benefit from the GenAI opportunity will somewhat be dependent on its ability to continue to raise capital at attractive rates to help delever, refinance upcoming debt maturities, and take on new data center projects. One additional impact of the rising AI demand is improved pricing trends across the data center industry especially in light of low vacancy rates. We remain Equal-weight.

**Equinix (EQIX.O) — covered by Simon Flannery:** Equinix does have exposure to hyperscale data centers via its xScale JVs, but these are primarily located in Europe and Asia. We could see Equinix look to establish a more robust Hyperscale data center presence in North America going forward. Given Equinix's predominate focus on interconnection, we believe Equinix stands to benefit more at the inference stage of AI, compared to the GenAI training stage. We remain Equal-weight Equinix.

**Exhibit 37:** Equinix's Overall Market and AI Opportunity Overview from Latest Investor Day




Source: Equinix

# GenAI Implications for Clean Energy

**Key Insights:** Incremental GenAI-driven load growth will likely be supported by a combination of clean energy technology including, but not limited to, wind, solar, energy storage, fuel cells, and eventually, small modular nuclear reactors. Based on the various scenarios laid out below, we estimate 38-109 GW of renewable energy capacity with 4-18 GW of energy storage capacity, or 11-32 GW of nuclear and high capacity-factor fuel cells, will need to be built globally to support the growing power demands of AI.

**Supporting GenAI-driven power needs with clean energy.** We expect a large portion of the incremental power needs for AI will be sourced from zero or low-carbon generation technologies as many data center owners and operators have decarbonization and net zero targets in place. As a result, we believe the surge in AI-driven power demand could serve as an underappreciated demand tailwind for large-scale and distributed clean energy technology manufacturers and developers of wind, solar, energy storage and fuel cells.

**Energy storage and fuel cells will be a critical piece of technology to reach a low-carbon and 24/7 clean energy solution for data centers.** We expect energy storage and fuel cell technology will be one of the most critical components in enabling data center load to be supported by clean energy. Wind and solar, while both cheap sources of electricity when compared to coal or natural gas, are intermittent in nature and offer a 25-40% capacity factor (i.e., percentage of hours in a year generating electricity). As a result energy storage, fuel cells, or a combination of both will likely be needed to smooth out the intermittent nature of wind and solar to provide 24/7 clean power.

## Global Clean Energy and Energy Storage Capacity Needed to Support GenAI Power Demand

We have developed three scenarios for GenAI data center utilization and commensurate power demand sourced from renewable electricity, summarized in Exhibit 38 , Exhibit 42 , and Exhibit 46 . Even in the most aggressive scenario, 90% GPU server utilization where 80% of power is sourced from renewables, the cumulative amount of renewables and energy storage capacity needed is relatively manageable on a global basis. That said, if data centers are cited in clusters, as is seen in the US, these volumes can be quite substantial relative to local utility and renewable developer pipelines.

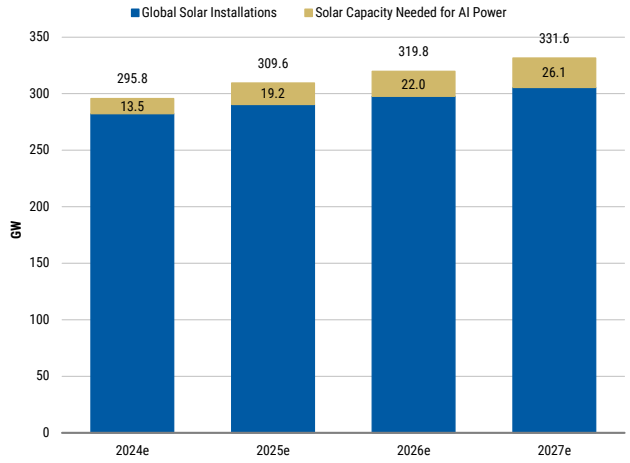
**Scenario 1: 90% GPU Server Utilization Rate, 80% of Power Sourced from Renewables —** In this scenario, we estimate 109 GW of renewable energy capacity (86 GW solar and 23 GW wind) and 18 GW of energy storage capacity will need to be deployed through 2027 to support the power demand needs of GenAI. Cumulatively this would imply a $150 billion capex investment based on our estimated wind, solar and battery storage costs. While large in nominal terms, the solar, wind, and energy storage volumes that we estimate are needed is a relatively small fraction of the total volumes that our global teams forecast will be added to the grid over that time period; see Exhibit 38 , Exhibit 39 , Exhibit 40 , and Exhibit 41 .

**Exhibit 38:** Scenario 1: Global power capacity needs and associated capex

| Part IIA. Global Results | 2023e | 2024e | 2025e | 2026e | 2027e |
|---|---|---|---|---|---|
| **Power Usage Data** | | | | | |
| Total Power Used by GenAI (TWh) | 20 | 69 | 144 | 233 | 336 |
| *Annual Growth Rate* | | *248%* | *110%* | *62%* | *44%* |
| ***GenAI Power As a % of 2022 Data Center Power*** | ***7%*** | ***24%*** | ***50%*** | ***81%*** | ***116%*** |
| ***GenAI Power As a % of 2022 Global Power*** | ***0.1%*** | ***0.3%*** | ***0.7%*** | ***1.1%*** | ***1.6%*** |
| **Renewables Data** | | | | | |
| Renewable GWs Needed, Total | 6 | 23 | 47 | 76 | 109 |
| ***Capex on Renewables, Total ($b)*** | ***$ 7.0*** | ***$ 24.3*** | ***$ 48.6*** | ***$ 77.7*** | ***$ 110.3*** |
| Renewable GWs Needed, Incremental | 6 | 17 | 24 | 29 | 33 |
| **Capex on Renewables, Incremental ($b)** | **$ 7.0** | **$ 17.3** | **$ 24.3** | **$ 29.1** | **$ 32.7** |
| Battery Storage GWs Needed, Total | 1 | 4 | 8 | 12 | 18 |
| ***Capex on Storage, Total ($b)*** | ***$ 3.0*** | ***$ 10.0*** | ***$ 18.8*** | ***$ 28.7*** | ***$ 39.9*** |
| Battery Storage GWs Needed, Incremental | 1 | 3 | 4 | 5 | 5 |
| ***Capex on Storage, Incremental ($b)*** | **$ 3.0** | **$ 7.0** | **$ 8.8** | **$ 9.9** | **$ 11.2** |
| ***Incremental Renewables as % of 2022 Corporate PPAs*** | ***19%*** | ***50%*** | ***71%*** | ***85%*** | ***99%*** |
| **Fossil Power Data** | | | | | |
| Fossil GWs Needed, Total | 1 | 3 | 7 | 11 | 15 |
| ***Capex on Fossil Power, Total ($b)*** | ***$ 0.9*** | ***$ 3.3*** | ***$ 6.6*** | ***$ 10.7*** | ***$ 15.4*** |
| Fossil; GWs Needed, Incremental | 1 | 2 | 3 | 4 | 5 |
| **Capex on Fossil Power, Incremental ($b)** | **$ 0.9** | **$ 2.4** | **$ 3.3** | **$ 4.1** | **$ 4.7** |
| Total Fossil $CO_2$ Emissions (million tons) | 2 | 7 | 14 | 23 | 34 |
| ***GenAI $CO_2$ Emissions as a % of 2022 Global Power Emissions*** | ***0.01%*** | ***0.05%*** | ***0.10%*** | ***0.16%*** | ***0.23%*** |

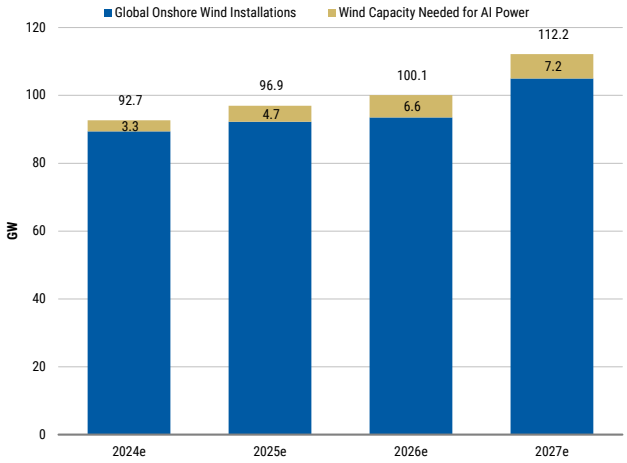
Source: Company data, TrendForce, Morgan Stanley Research estimates

**Exhibit 39:** Scenario 1: Large-Scale Solar



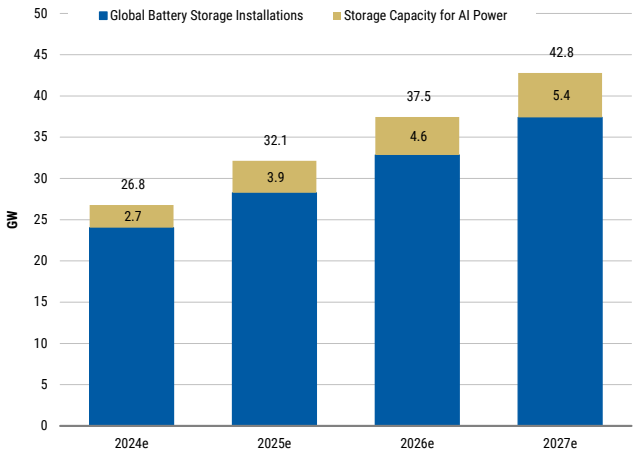

Source: Morgan Stanley Research estimates

**Exhibit 40:** Scenario 1: Onshore Wind




Source: Morgan Stanley Research estimates

**Exhibit 41:** Scenario 1: Battery Storage




Source: Morgan Stanley Research estimates

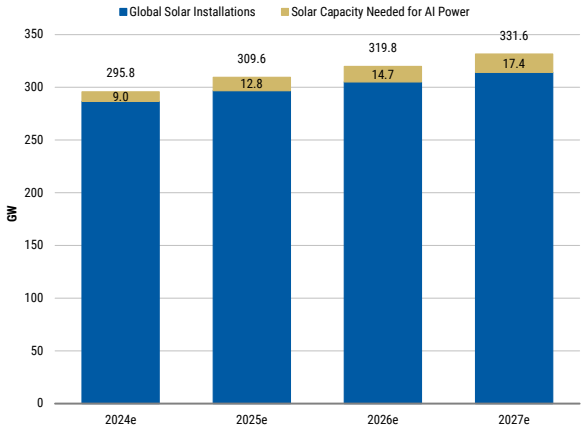
**Scenario 2: 60% GPU Server Utilization Rate, 80% of Power Sourced from Renewables —** In this scenario, we estimate 73 GW of renewable energy capacity (57 GW solar and 15 GW wind) and 12 GW of energy storage capacity will need to be deployed through 2027 to support the power demand needs of GenAI. Cumulatively this would imply a $100 billion capex investment; see Exhibit 42 , Exhibit 43 , Exhibit 44 , and Exhibit 45 .

**Exhibit 42:** Scenario 2: Global power capacity and associated needs and capex

| Part IIA. Global Results | 2023e | 2024e | 2025e | 2026e | 2027e |
|---|---|---|---|---|---|
| **Power Usage Data** | | | | | |
| Total Power Used by GenAI (TWh) | 13 | 46 | 96 | 156 | 224 |
| *Annual Growth Rate* | | *248%* | *110%* | *62%* | *44%* |
| ***GenAI Power As a % of 2022 Data Center Power*** | ***5%*** | ***16%*** | ***33%*** | ***54%*** | ***77%*** |
| ***GenAI Power As a % of 2022 Global Power*** | ***0.1%*** | ***0.2%*** | ***0.5%*** | ***0.7%*** | ***1.1%*** |
| **Renewables Data** | | | | | |
| Renewable GWs Needed, Total | 4 | 16 | 31 | 51 | 73 |
| ***Capex on Renewables, Total ($b)*** | ***$ 4.7*** | ***$ 16.2*** | ***$ 32.4*** | ***$ 51.8*** | ***$ 73.6*** |
| Renewable GWs Needed, Incremental | 4 | 11 | 16 | 19 | 22 |
| **Capex on Renewables, Incremental ($b)** | **$ 4.7** | **$ 11.5** | **$ 16.2** | **$ 19.4** | **$ 21.8** |
| Battery Storage GWs Needed, Total | 1 | 3 | 5 | 8 | 12 |
| ***Capex on Storage, Total ($b)*** | ***$ 2.0*** | ***$ 6.6*** | ***$ 12.5*** | ***$ 19.1*** | ***$ 26.6*** |
| Battery Storage GWs Needed, Incremental | 1 | 2 | 3 | 3 | 4 |
| ***Capex on Storage, Incremental ($b)*** | **$ 2.0** | **$ 4.7** | **$ 5.9** | **$ 6.6** | **$ 7.5** |
| ***Incremental Renewables as % of 2022 Corporate PPAs*** | ***13%*** | ***33%*** | ***47%*** | ***57%*** | ***66%*** |
| **Fossil Power Data** | | | | | |
| Fossil GWs Needed, Total | 1 | 2 | 4 | 7 | 10 |
| ***Capex on Fossil Power, Total ($b)*** | ***$ 0.6*** | ***$ 2.2*** | ***$ 4.4*** | ***$ 7.1*** | ***$ 10.2*** |
| Fossil; GWs Needed, Incremental | 1 | 2 | 2 | 3 | 3 |
| **Capex on Fossil Power, Incremental ($b)** | **$ 0.6** | **$ 1.6** | **$ 2.2** | **$ 2.7** | **$ 3.1** |
| Total Fossil $CO_2$ Emissions (million tons) | 1 | 5 | 10 | 16 | 22 |
| ***GenAI $CO_2$ Emissions as a % of 2022 Global Power Emissions*** | ***0.01%*** | ***0.03%*** | ***0.07%*** | ***0.11%*** | ***0.15%*** |

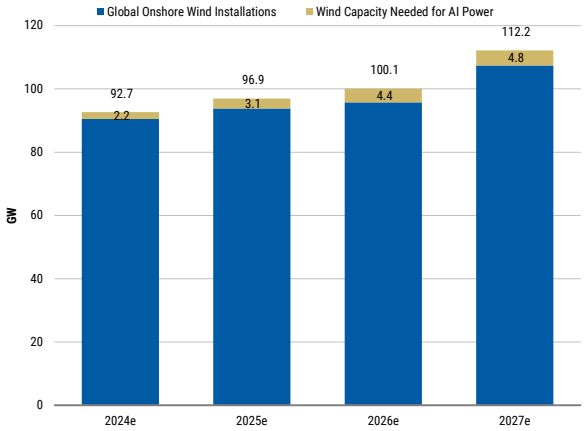
Source: Company data, TrendForce, Morgan Stanley Research estimates

**Exhibit 43:** Scenario 2: Large-scale Solar



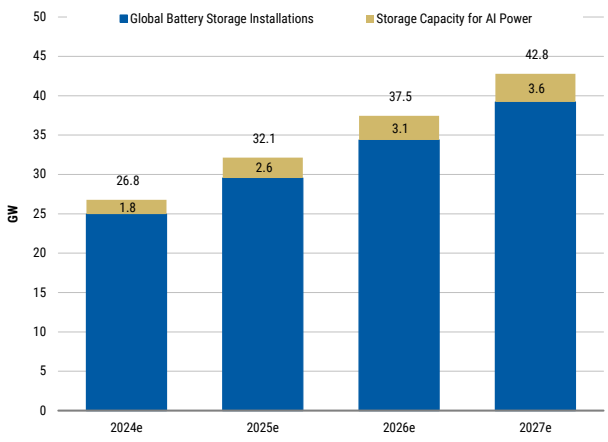

Source: Morgan Stanley Research estimates

**Exhibit 44:** Scenario 2: Onshore Wind




Source: Morgan Stanley Research estimates

**Exhibit 45:** Scenario 2: Battery Storage




Source: Morgan Stanley Research estimates

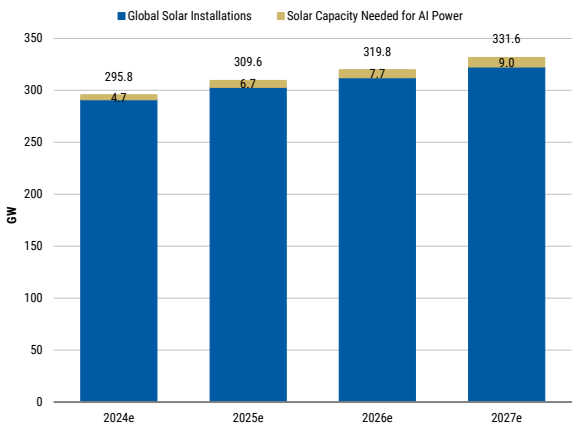
**Scenario 3: 50% GPU Server Utilization Rate, 50% of Power Sourced from Renewables —** In this scenario, we estimate 38 GW of renewable energy capacity (30 GW solar and 8 GW wind) and 4 GW of energy storage capacity will need to be deployed through 2027 to support the power demand needs of AI. Cumulatively this would imply a $48 billion capex investment; see Exhibit 46 , Exhibit 47 , Exhibit 48 , and Exhibit 49 .

**Exhibit 46:** Scenario 3: Global power capacity needs and associated capex

| Part IIA. Global Results | 2023e | 2024e | 2025e | 2026e | 2027e |
|---|---|---|---|---|---|
| **Power Usage Data** | | | | | |
| Total Power Used by GenAI (TWh) | 11 | 38 | 80 | 130 | 187 |
| *Annual Growth Rate* | | *248%* | *110%* | *62%* | *44%* |
| ***GenAI Power As a % of 2022 Data Center Power*** | ***4%*** | ***13%*** | ***28%*** | ***45%*** | ***64%*** |
| ***GenAI Power As a % of 2022 Global Power*** | ***0.1%*** | ***0.2%*** | ***0.4%*** | ***0.6%*** | ***0.9%*** |
| **Renewables Data** | | | | | |
| Renewable GWs Needed, Total | 2 | 8 | 16 | 26 | 38 |
| ***Capex on Renewables, Total ($b)*** | ***$ 2.4*** | ***$ 8.4*** | ***$ 16.9*** | ***$ 27.0*** | ***$ 38.3*** |
| Renewable GWs Needed, Incremental | 2 | 6 | 8 | 10 | 12 |
| **Capex on Renewables, Incremental ($b)** | **$ 2.4** | **$ 6.0** | **$ 8.4** | **$ 10.1** | **$ 11.3** |
| Battery Storage GWs Needed, Total | 0 | 1 | 2 | 3 | 4 |
| ***Capex on Storage, Total ($b)*** | ***$ 0.7*** | ***$ 2.3*** | ***$ 4.4*** | ***$ 6.7*** | ***$ 9.3*** |
| Battery Storage GWs Needed, Incremental | 0 | 1 | 1 | 1 | 1 |
| ***Capex on Storage, Incremental ($b)*** | **$ 0.7** | **$ 1.6** | **$ 2.1** | **$ 2.3** | **$ 2.6** |
| ***Incremental Renewables as % of 2022 Corporate PPAs*** | ***7%*** | ***17%*** | ***25%*** | ***29%*** | ***34%*** |
| **Fossil Power Data** | | | | | |
| Fossil GWs Needed, Total | 1 | 5 | 9 | 15 | 21 |
| ***Capex on Fossil Power, Total ($b)*** | ***$ 1.3*** | ***$ 4.5*** | ***$ 9.2*** | ***$ 14.8*** | ***$ 21.3*** |
| Fossil; GWs Needed, Incremental | 1 | 3 | 5 | 6 | 7 |
| **Capex on Fossil Power, Incremental ($b)** | **$ 1.3** | **$ 3.3** | **$ 4.6** | **$ 5.7** | **$ 6.5** |
| Total Fossil $CO_2$ Emissions (million tons) | 3 | 10 | 20 | 32 | 47 |
| ***GenAI $CO_2$ Emissions as a % of 2022 Global Power Emissions*** | ***0.02%*** | ***0.07%*** | ***0.14%*** | ***0.22%*** | ***0.32%*** |

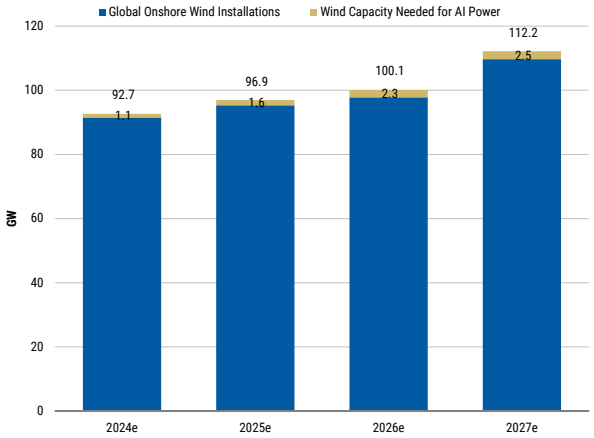
Source: Company data, TrendForce, Morgan Stanley Research estimates

**Exhibit 47:** Scenario 3: Large-scale Solar



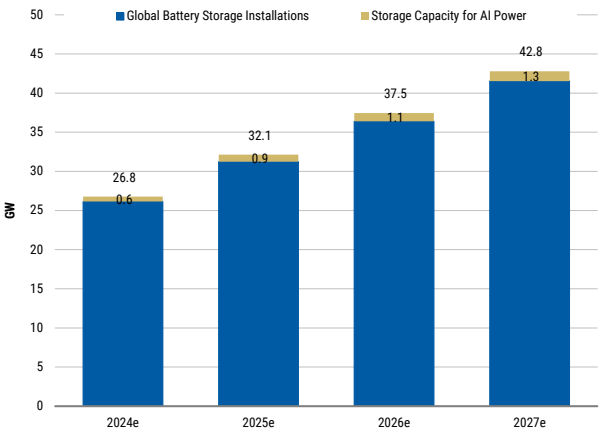

Source: Morgan Stanley Research estimates

**Exhibit 48:** Scenario 3: Onshore Wind




Source: Morgan Stanley Research estimates

**Exhibit 49:** Scenario 3: Battery Storage




Source: Morgan Stanley Research estimates

# US Clean Energy and Energy Storage to Support GenAI Power Demand

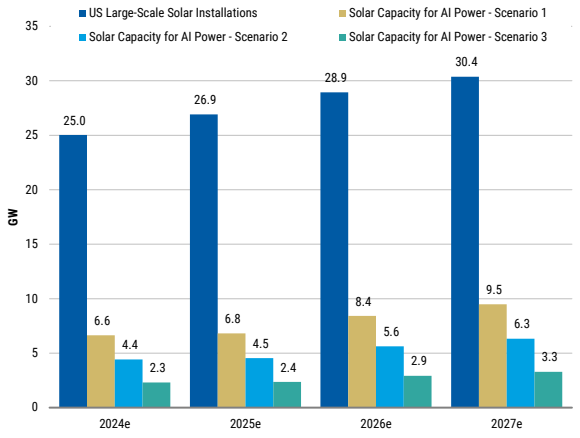
**While on a global basis, the volume of renewable energy power capacity needed is manageable, the volumes required in the US are more substantial relative to our forecasted annual renewables growth.** Based on initial research and conversations with our colleagues covering the data center/AI sector, we estimate that ~45% of the incremental data centers supporting AI will be built in the US. Under that framework, when applying the three scenarios laid out above to the US market, the estimated amount of clean energy and storage capacity needed is fairly meaningful relative to our annual install expectations.

**Scenario 1: 90% GPU Server Utilization Rate, 80% of Power Sourced from Renewables —** We estimate in this scenario that in the US 47 GW of renewable energy capacity (34 solar and 14 wind) and 7 GW of energy storage capacity will need to be deployed through 2027 to support the power demand needs of GenAI. This renewables and storage capacity required for powering AI accounts for 26% of solar and wind installations and 15% of energy storage installations through 2027. Using our estimated wind, solar, and battery costs, these levels of renewables and storage required would imply a $117 billion capex investment.

**Scenario 2: 60% GPU Server Utilization Rate, 80% of Power Sourced from Renewables —** In this scenario we estimate that the US would require 31 GW of renewable energy capacity (22 GW solar and 9 GW wind) and 5 GW of energy storage capacity deployed through 2027 to support the power demand needs of GenAI, which accounts for 17% of renewables and 10% of energy storage installed through 2027. This leads to an implied cumulative capex investment of $78 billion.

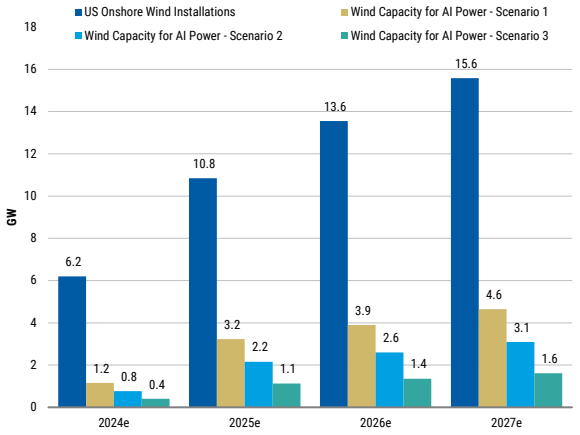
**Scenario 3: 50% GPU Server Utilization Rate, 50% of Power Sourced from Renewables —** In the US for this scenario, we estimate that GenAI power demand would require 16 GW of renewable energy capacity (12 GW solar and 5 GW wind) and 2 GW of energy storage capacity deployed through 2027, accounting for 9% of renewables and 3% of energy storage installed through 2027. The implied total capex investment amounts to $34 billion.

**Exhibit 50:** US large-scale Solar capacity needed for GenAI Power vs. annual large-scale solar installations



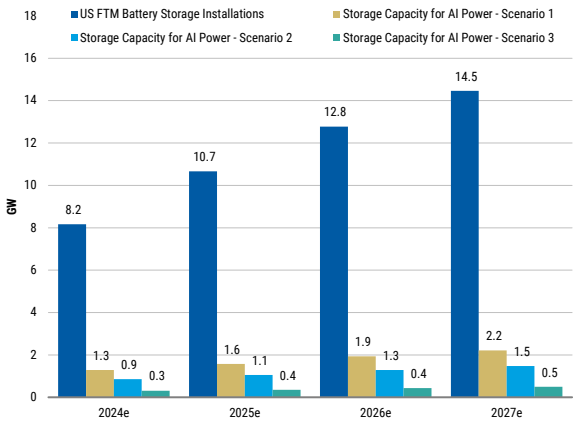

Source: Morgan Stanley Research estimates

**Exhibit 51:** US Onshore Wind capacity needed for GenAI power vs. annual Onshore Wind installations




Source: Morgan Stanley Research estimates

**Exhibit 52:** US Battery Storage capacity needed for GenAI Power vs. annual large-scale Battery Storage installations




Source: Morgan Stanley Research estimates

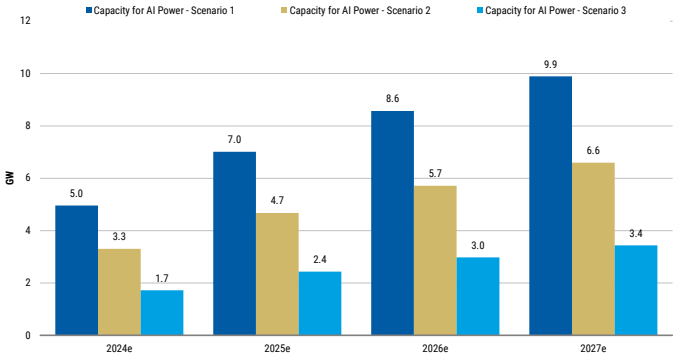
## Low-Emission, High Capacity-Factor Generation Alternatives Could Play a Key Role in Powering GenAI

**Low or zero-emission fuel cells.** In our view, one of the most exciting alternatives to wind and solar to serve GenAI power demand are fuel cells. Fuel cells can operate at a high capacity factor (90%+), solving the intermittency issue with renewables, are economic vs. grid-alternatives (~$0.10/kWh vs. C&I rates, which range from $0.06 to $0.24/kWh in the continental US), and are more environmentally friendly than grid power (even when running on natural gas). Additionally, fuel cells are quick to deploy and can serve as a bridge technology for data center customers as utilities build out transmission and substation infrastructure to support increasing data center load.

Assuming GenAI load were to be supported by high capacity-factor fuel cells, we estimate that 20.5 GW would need to be deployed through 2027 to support global GenAI load growth in our base case scenario. This is a very significant amount of volume relative to annual installed base for most fuel cell providers. For context, we estimate that Bloom Energy (BE), which provides base-load power fuel cells to data center customers, will deploy 300-500 MW of product, annually through 2027. Assuming BE just captures 1% market share of the annual AI power capacity demand would imply a $700m revenue opportunity (~35% of our 2024-27 revenue forecast). As a result, we expect companies, such as Bloom Energy, to be significant beneficiaries of the GenAI-driven load growth, even if just a fraction of the incremental load is supported by fuel cells.

**Small Modular Nuclear Reactors could play a role in power data centers longer term.** The combination of increasing electricity demand (i.e., load) and decarbonization goals is driving renewed interest in nuclear. Note that Microsoft recently signed an agreement with Constellation Energy (covered by David Arcaro) for hourly carbon-free electricity. Furthermore, small modular reactors (SMR) are of particular interest at data centers given their modular nature and base-load electricity characteristics (95% capacity factor). That said, SMRs are in their infancy of commercialization, with some recent high-profile project cancelations, which have cast some doubt on the viability of this technology. While we see a potential pathway for SMRs to become commercially viable options, we would not expect this technology to be adopted this decade.

**Exhibit 53:** Global Fuel Cell/Nuclear capacity needed for GenAI power




Source: Morgan Stanley Research estimates. Assumes a 95% capacity factor for fuel cell generation.

# US Utilities: Enablers and Beneficiaries of GenAI Power Growth

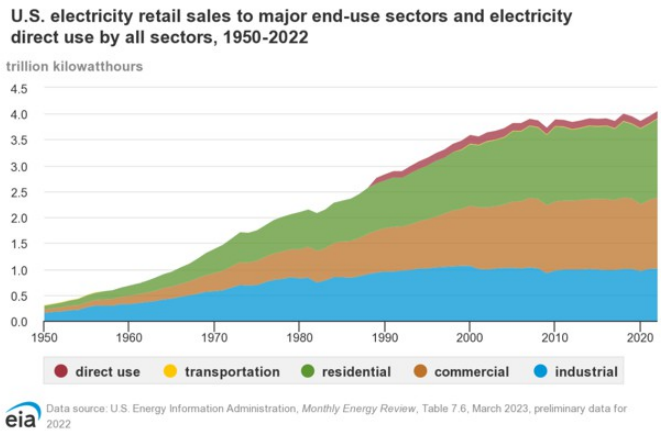
**GenAI needs power and electric infrastructure, driving several attractive benefits for US utilities.** The utility industry will be involved in multiple ways to enable the expansion of generative AI, providing grid infrastructure and power generation to supply new data centers. We see several key benefits for utilities: Faster load growth, which lowers customer bills and improves profitability (lower regulatory lag), and the buildout of new generation capacity to supply the increased load offers enhanced earnings growth. The industry will also likely see investment opportunities in the transmission and distribution systems to enable power flow into new data centers, increasing earnings growth — a topic for a follow-up report. While the total amount of power demand from GenAI on a national scale is manageable, at ~0.15% of total US power generation, location will be key. Concentrated pockets of data centers can have outsized impacts on individual utilities so we explore key potential markets below. **Biggest potential beneficiaries: AES, CEG, and NEE for the potential opportunity to build new renewables for data center demand or sell power at premium prices from existing nuclear capacity.**

## Load Growth

**We estimate ~0.4% to 0.5% faster load growth in the US driven by GenAI power demand.** US electricity usage has been stagnant over the past 15 years after growing steadily since 1950. Energy efficiency has played a key role in dampening electricity sales growth and offsetting the positive drivers of population growth, economic growth, and greater electrification. Data centers overall are expected to be a bigger contributor to load growth going forward, and our GenAI calculations suggest even further upside. We estimate 95-107 TWh of electricity usage by data centers for generative AI by 2027, relative to the total 2022 US electricity consumption of 4,200 TWh. This alone offers a new 0.4% to 0.5% CAGR in electricity growth over the period — a meaningful impact on an industry that has been experiencing negligible volume growth for more than a decade. GenAI will add an incremental 2-3% to US power consumption in aggregate by 2027.

**Faster load growth improves profitability and increases earnings growth for utilities**. From a technical perspective, increasing load growth from 0% to 0.5% improves regulatory lag by 20 bps. Utilities often have authorized returns of equity (ROE) set around 9.5%, but many also have state policies or structural challenges that prevent them from achieving the full authorized level. Load growth increases

**Exhibit 54:** US electricity demand 1950 - 2022

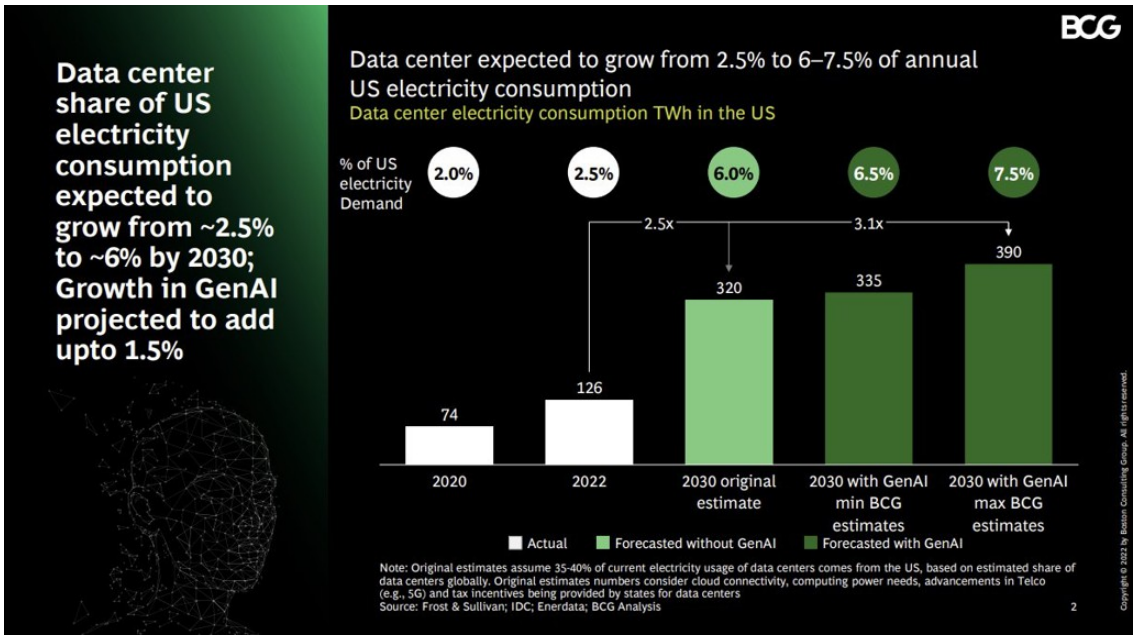



Source: EIA

the amount of revenue a utility receives between rate cases. For a typical utility, this additional revenue would increase the company's ROE by 0.2%, a meaningful level relative to the 9.5% return target. From a different lens, 0.5% load growth also drives ~2% earnings growth for periods during which the utility is not in rate cases. The addition of sales volumes and revenue with limited incremental operating costs leads to a fairly direct boost to the bottom line for utilities that benefit from higher AI-related data center power usage. Utilities with less regulatory lag will also exhibit smoother earnings trajectories over time since EPS does not dip between rate cases as much as it would for utilities will slower load growth and greater regulatory lag. Smoother earnings year to year is a factor that contributes to a valuation premium for utilities.

**Generative AI power usage adds to the broader growth in data center power demand.** According to the US Department of Energy, Data Centers account for ~2% of the total US electricity use. Total US electricity consumption in 2022 was about ~4.2 million GWh and data centers consumed ~84,000 GWh of electricity in 2022. In the past few years, the need for data centers has rapidly increased, fueled by changing work habits and the growth of cloud-based technologies. In 2022, primary market supply grew 17% year-over-year to 3,928.7 MW. In 1H23, primary market supply grew 19% year-over-year to ~4,420 MW (491.5 MW increase through 1H23). Primary data center markets account for 40-50% of the US data center market. BCG is forecasting an increase in data center power usage from 2% of total US electricity to 6% by 2030 before considering GenAI. Data center power usage is expected to grow at a 12% baseline CAGR over the period.

**Exhibit 55:** Data center power use growing at a 12% CAGR through 2030 before considering AI

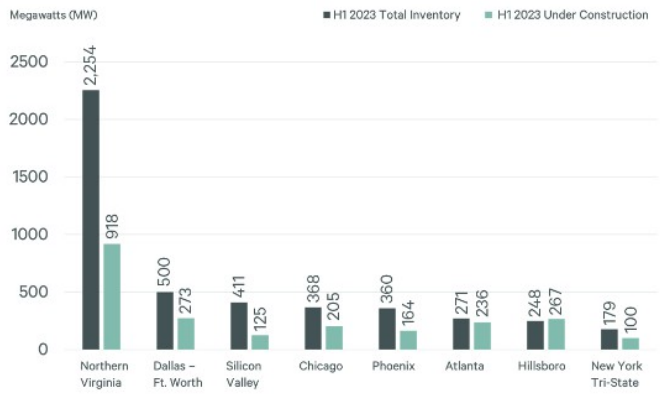



Source: BCG Research

Geographic Markets

**Location will be key: Concentrated additions of new data centers can have an even bigger impact on individual utilities than the overall US data would suggest.** Certain US regions have dominated the data center buildout given optimal resources to support the industry. For example, access to electricity for power usage, water for cooling infrastructure, fiber networks for efficient connectivity, and available real estate/land are some of the main elements required to build out and maintain a data center facility. Other important factors include favorable environmental conditions, vacancy rates, and affordability. The US had ~2,700 data centers in 2022, the largest number in the world, followed by Germany with ~500 data centers. Of the total US Data Center market, ~50% are in primary data center markets, or US regions with the highest concentration of data centers, while the remaining ~50% are scattered throughout many smaller secondary data center markets. According to CBRE, the primary markets with the highest data center inventory and current construction projects include locations found in Virginia, Texas, Nevada, Illinois, Arizona, Georgia, Oregon, and New York. Through the first half of 2023 an all-time high of 2,288 MW was under construction in primary markets, a 25% year-over-year increase.

**Exhibit 56:** Total Inventory vs. Under-Construction capacity by primary market – 1H23

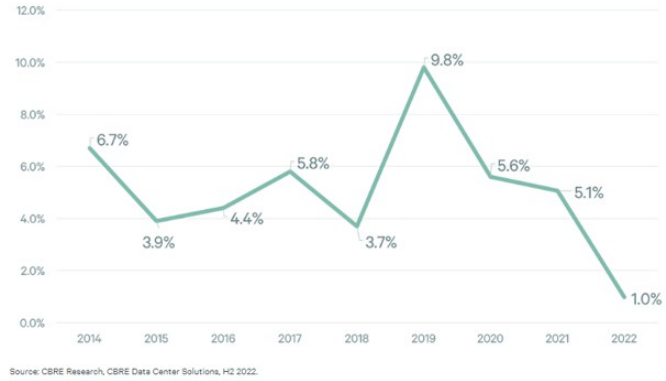



Source: CBRE Research

**Looking ahead, US regions that are expected to accommodate further data center growth will include a mix of developed primary and fast-growing secondary markets.** Northern Virginia is the largest US data center market partly because of its proximity to a major geographical resources and physical infrastructure. VA jumped from ~284 MW of capacity under construction in Q4 2020, to 918 MW in Q2 2023 up nearly 400% during this time. Even with all-time low vacancy rates and infrastructure availability, VA data center construction demand has remained strong. In addition, primary markets like Dallas, Texas, and Chicago, Illinois, have also seen a surge in under-construction capacity, growing by 1,686% and 508% respectively, over the past three years. However, emerging/secondary markets play a pivotal role as available infrastructure and resources falls over time in primary markets. The largest secondary markets include central Washington State; Austin, Texas; South

Carolina; and Seattle. We expect to see data centers built throughout the rest of the country, as part of an effort to bring them closer to customers and take advantage of increasing availability of high-speed networks in rural areas and smaller cities. Secondary markets such as Omaha, Nebraska; Charlotte, North Carolina; Austin; central Washington State; and Iowa offer renewable power availability, as well as a ramp up in hyper scale data center construction. Developers are less likely in our view to develop and invest in the Northeast region due to location and land constraints. This region did not receive any hyper scale development in 2022 likely owing to space constraints in building these facilities, especially in regions with traditionally high demand, such as New York and New Jersey.

**Exhibit 57:** Northern Virginia historical vacancy rates

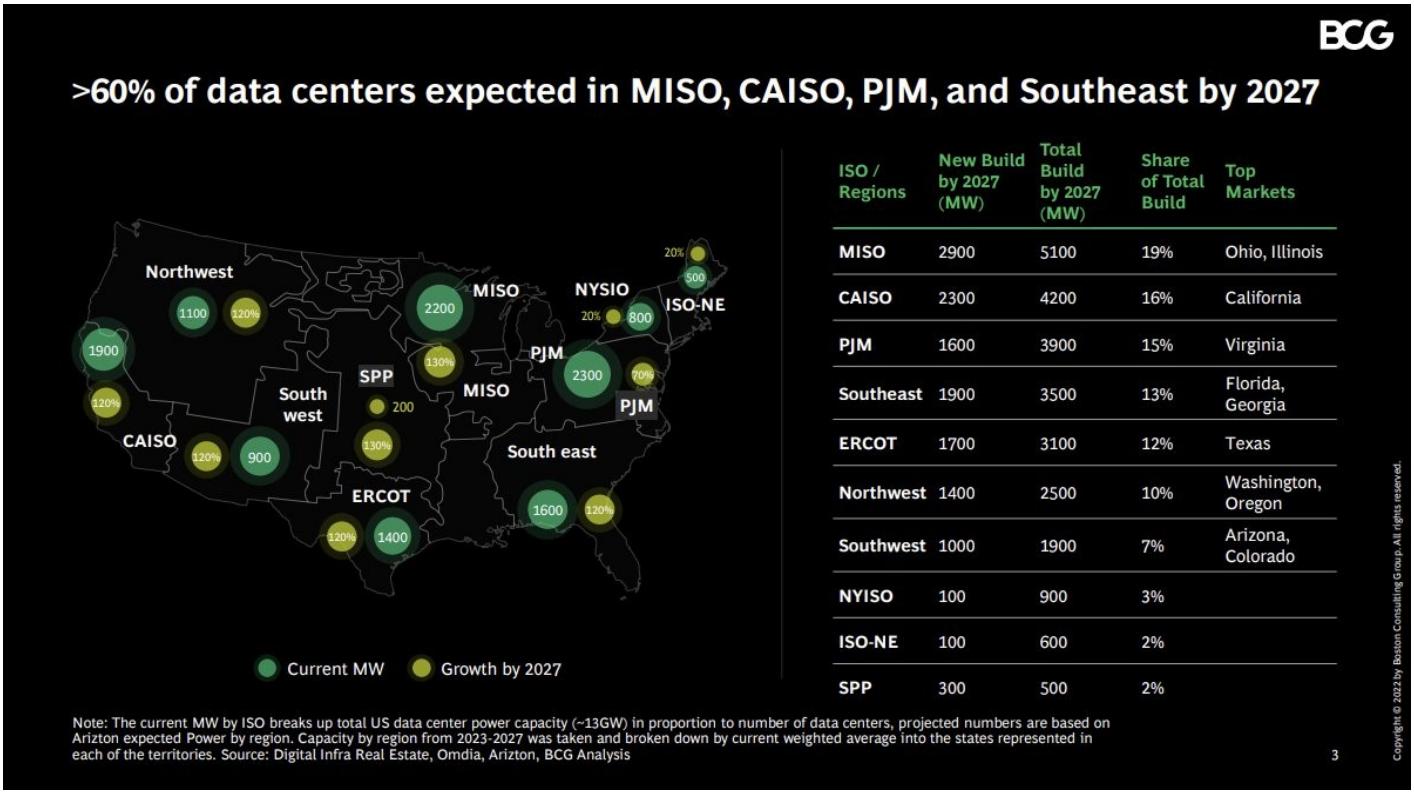



Source: CBRE Research

**Exhibit 58:** Total Inventory vs. Under-Construction capacity by secondary market – 1H23


Source: CBRE Research

**Exhibit 59:** BCG forecasts suggest a fairly dispersed data center landscape over the next 5 years




| ISO / Regions | New Build by 2027 (MW) | Total Build by 2027 (MW) | Share of Total Build | Top Markets |
|---|---|---|---|---|
| MISO | 2900 | 5100 | 19% | Ohio, Illinois |
| CAISO | 2300 | 4200 | 16% | California |
| PJM | 1600 | 3900 | 15% | Virginia |
| Southeast | 1900 | 3500 | 13% | Florida, Georgia |
| ERCOT | 1700 | 3100 | 12% | Texas |
| Northwest | 1400 | 2500 | 10% | Washington, Oregon |
| Southwest | 1000 | 1900 | 7% | Arizona, Colorado |
| NYISO | 100 | 900 | 3% | |
| ISO-NE | 100 | 600 | 2% | |
| SPP | 300 | 500 | 2% | |

Source: BCG Research

## Capital Investment

**Utilities will play a role in building out power generation for data center demand and the capex investment and corresponding earnings could be meaningful.** In the previous section of this report , we laid out the clean energy investment needed to support our GenAI forecasts, and here we translate this into potential utility opportunity. Solar and wind capacity needed for GenAI by 2027 represents about 1% of the existing US generation fleet in aggregate (inclusive of all existing power plants). The clean energy need also represents 25-35% of the baseline outlook for new renewable additions over the next 5 years — so it represents about one-third higher installations annually for the clean energy industry. The capex investment represents roughly $5-10 billion annually in the US depending on the technology type. This represents a meaningful amount relative to the total ~$45 billion annual generation investment made by US utilities. If utilities were solely responsible for new generation additions to support GenAI, it could increase the capex budgets for generation by 10-20% annually. **We expect non-regulated companies like NEE and AES to be major participants in this market but regulated utilities will still likely have a meaningful investment opportunity.**

**Exhibit 60:** Renewable demand from GenAI relative to the total US and the annual baseline renewable installation outlook

| Power Consumption: 4 GPUs | 2023e | 2024e | 2025e | 2026e | 2027e |
|---|---|---|---|---|---|
| Solar + Wind Installations | 24 | 31.23 | 37.76 | 42.49 | 45.96 |
| Solar + Wind Capaity Needed for AI Power | 3 | 8.03 | 10.49 | 13.14 | 15.08 |
| S+W Capacity Needed / Installations (%) | 13% | 26% | 28% | 31% | 33% |
| Total Existing US Utility Plant Capacity | 1,231 | 1,259 | 1,288 | 1,319 | 1,319 |
| S+W Capacity Needed / Exisiting US Capacity (%) | 0.24% | 0.65% | 0.83% | 1.02% | 1.14% |

| Power Consumption: 8 GPUs | 2023e | 2024e | 2025e | 2026e | 2027e |
|---|---|---|---|---|---|
| Solar + Wind Installations | 24 | 31.23 | 37.76 | 42.49 | 45.96 |
| Solar + Wind Capaity Needed for AI Power | 3 | 7.54 | 9.62 | 11.50 | 13.19 |
| S+W Capacity Needed / Installations (%) | 13% | 24% | 25% | 27% | 29% |
| Total Existing US Utility Plant Capacity | 1,231 | 1,259 | 1,288 | 1,319 | 1,319 |
| S+W Capacity Needed / US Plant Capacity (%) | 0.24% | 0.61% | 0.76% | 0.89% | 1.00% |

Source: Morgan Stanley Research

## Potential Constraints

**Data center growth expectations rely heavily on the expansion of the power grid.** A major concern around the highly anticipated growth in data centers is the availability of grid connections necessary to support new data center capacity. Several issues include limited power line capacity, delays in planning and permitting for new transmission and distribution projects, as well as supply chain bottlenecks. According to the Lawrence Berkeley National Laboratory, upgrading existing transmission lines can take three years or more due to time-consuming regulatory hurdles. As a result, increasing the generation and grid capacity in smaller secondary markets are strategies being pursued to more quickly enable data center expansion.

**We highlight several case studies of utility responses to data center demand and grid limitations**: Dominion Energy has been analyzing its network and working with customers to provide incremental capacity for new data center projects. For a long-term solution, Dominion is accelerating work on a 500 kV transmission line in Southern Loudoun County, which is expected to be completed in 2026 and will relieve many of the transmission bottlenecks that are limiting new connections for data centers in Eastern Loudoun. In addition, Dominion's Integrated Resource Plan includes over 5,000 MW of offshore wind, over 14,000 MW of solar and 2,700 MW of storage available by 2037. It will spend $7 billion in "Electric Grid Transformation" expenses for transmission, grid transformation and strategic undergrounding to ease transmission and distribution bottlenecks. Recently adopted federal legislation provides $2.5 billion in public funding for this effort. Additionally, the Federal Energy Regulatory Commission (FERC) plans to study and address these ongoing issues. Utility companies are working with regulators, city officials, operators, and developers throughout the US to improve interconnections.

**At an industry level, we think the risk of grid constraints are manageable**. Dominion in northern Virginia faces a unique situation given the extreme density of data center load in its region. Across the rest of the US there is a greater dispersion of data centers and fewer instances of severe transmission bottlenecks. As highlighted above, the total AI power demand would represent roughly 2-3% of total US power generation, and could require new capacity equal to 1% of total US power plant capacity. When taken in the US as a whole this is a manageable endeavor, while individual states or service territories could have specific constraints if large concentrations of data centers get built.

## Key Beneficiaries

**Within the utility space, NEE, AES, and CEG are key potential beneficiaries of AI power demand.**

**NEE:** NextEra Energy is the leading large scale renewable developer in the US. We think the company is well positioned to supply renewable power to new data centers. NextEra has several key capabilities that we expect to position the company favorably. The company has geographic scale, with a large pipeline of land and transmission interconnect agreements across the country that give it speed to market with new projects. NEE's costs are highly competitive due to its purchasing power, highly sophisticated operating services functions, and renewable resource modeling. It has the capability to integrate wind, solar, and storage, and the software to optimize these technologies. We think these factors along with the company's reputation and track record will position it to be a major player in the renewables buildout for data center demand.

**AES:** AES is a major large-scale renewable developer in the US, with the largest Commercial & Industrial market share. It has similar business strengths as NEE in terms of geographic coverage, scale, cost, and operational expertise that make it a strong player in the market. The company has also focused its business on the C&I customer category and has existing commercial relationships with big tech companies including Google, Microsoft, and Amazon. This could help differentiate the company in serving data center demand.

**CEG:** Constellation Energy is the owner of the largest nuclear fleet in the US with ~21 GW of capacity in the central US, mid-Atlantic, and Northeast. The company's plants are already operational, a potential speed advantage vs. new renewables construction. Power from nuclear plants could be priced competitively vs. non-emitting alternatives, with the combination of wind, solar, and storage potentially being costly in certain regions of the country compared with the price a nuclear plant might charge (we estimate a $10-15/MWh premium to market power prices). Nuclear plants are also highly reliable, the company has a very strong operational track record, and they have no carbon emissions.

CEG's nuclear fleet also offers an interesting opportunity for data centers to be built within a nuclear plant's campus, behind the fence line. In this way a data center could source power directly from the nuclear units with no external connection to the utility grid. Electricity would be highly reliable given two nuclear units can back each other up to run 100% of the time together. The data center would potentially avoid any transmission and distribution charges from the local utility — a cost that often represents 40-50% of the total cost of electricity. Nuclear plants also have available land, water infrastructure, and security in place that could be utilized by a data center. We think this could be a competitive offering to site new data centers with nuclear plants.

# Preview of Data Centers and Power in Ireland and Brazil

## Ireland

**Background:** Ireland is one of Europe's leading DC markets. Indeed, Ireland's capital, Dublin, is one of the core five European FLAPD markets (Frankfurt, London, Amsterdam, Paris, Dublin). Irish data center demand has been driven by the fact that the Irish capital houses the European HQs of many US Hyperscalers, pharma and Medtech companies. Many data centers have been built by the end user, next to Tech companies' European campuses (e.g., Amazon, Meta and TikTok), while Dublin hosts some clients' pan-European Cloud requirement.

**All major global DC operators are present in Dublin**: In terms of global players that have established DC operations in the Irish capital, we note:

- Amazon/AWS operates DCs across eight European clusters — Dublin was the first such cluster, started in 2007;
- Dublin was also Microsoft's first European DC location;
- Meta's largest European DC facility is based in Clonee, just outside Dublin (built at a cost of €1.5bn);
- Digital Realty has 9 DCs in Dublin, while Equinix has 5;
- Two of Google's hyperscale locations are based in Dublin;
- Social media giant TikTok recently opened its first European data center, in Dublin, with plans to open a second location in Ireland;
- Apple operates just one data center in Europe (Denmark), but is in the development phase of a further site in Ireland.

**DC energy usage is perhaps most extreme in Dublin / Ireland:** The presence of so many global DC players has triggered significant power requirements, driven by DC growth, but also because Ireland is a relatively small country (with a population of just 5mn people). Interestingly, Irish DC energy consumption increased by +30% YoY during 2022, but perhaps more interestingly, by a cumulative +400% since 2015.

Data centers accounted for ca 18% of national Irish energy consumption in 2022 (5,200 GWh of DC power usage, vs total Irish consumption of 29,500 GWh). This compares with DC's 5% consumption of the grid in 2015 (source: Irish Central Statistics Office), and also with a global average of 1-2%. Irish media has reported that DCs could end up consuming as much as 30% of national / Irish power (Data centres could end up using 30% of Ireland's energy supply, activist claims (breakingnews.ie)).

**Moratorium on building new DCs in Dublin:** As a result of spiking DC energy consumption, some European city zones — notably Dublin, Amsterdam and Frankfurt - have imposed a limitation on new data center build. This has been driven by pressure on power grids, and prioritizing the needs of local residential markets (houses, schools, etc.).

In Ireland, a de facto moratorium on new DC build has been imposed by Eirgrid, the owner of the Irish power transmission network. As illustration, Equinix has been refused planning permission for building a new DC in Dublin (along with 30 other projects from other DC operators). Planning rejections have been imposed regardless of whether the DC operator commits to supplying its own power (for example, via PPAs).

**A number of follow-on consequences — the emergence of new European DC markets:**

- We note that some Irish DC projects have been approved (e.g., three new AWS data centers, which will use 73MW of power) - essentially the door is not fully closed.
- We believe that Irish data center construction could still potentially proceed, but outside of Dublin, in other cities / counties. Amazon has built a data center in Drogheda, County Meath — <100km from Dublin, while construction has started on a ~85,000-sq-ft DC facility in Cork (S Europe).
- We believe that the moratorium will accelerate a shift in new DC build toward non-FLAPD markets — these include the Nordics, Madrid, Milan, Poland, Berlin etc. Some of these markets benefit from cooler climate (Nordics, Poland), cheaper real estate costs, availability of clean energy (PPAs, from wind / solar / hydro) and lower labour costs.

## Brazil

In Brazil, we see potentially positive effects for the rapid adoption of GenAI and, as a result, the acceleration of power consumption from data centers. We note, however, that the estimates for incremental power consumption from data centers in Brazil are too incipient to quantify the impact for electric utilities, so we are keeping a qualitative assessment for the region.

**1) In generation, positive impact to power prices:** If the accelerated pace of AI adoption drives the same electricity consumption growth of 2.5-3.5% by 2027, estimated for the US, we believe this could enable the reduction of the existing oversupply in Brazil (~20% for 2027) and accelerate the recovery in power prices. This could benefit Brazil generation companies that are highly uncontracted. In our coverage, the largest OW-rated name with exposure to long-term power prices is Eletrobras (**ELET3.SA,** Top Pick). The company has more than 70% of its total energy portfolio available for sale after 2027.

**Sensitivities:** Every ~R$10/MWh change in our long-term power price assumption of R$150/MWh (from 2028 onward) would change ELET's price target by 5.8%.

**2) In distribution, potential efficiency gains: In distribution, the potential incremental demand from data centers could have two impacts: i)** higher electricity consumption, which translates into incremental EBITDA, as the volume risk/upside is typically assumed by the disco within the regulatory cycle; **ii)** for those concessions where the development of data centers are more relevant, investments in new infrastructure would be incorporated in the regulatory asset base, increasing long-term EBITDA.

Still in distribution, AI could improve the identification of suspect patterns in client's consumption profile, helping to identify commercial losses (i.e., electricity theft) and accelerating the company's measures to combat or prevent them. Other potential benefits are improving grid management through better demand forecasts, or identifying weaknesses in equipment that could need maintenance or upgrade. In our coverage the most exposed names to distribution are OW-rated Equatorial (**EQTL3.SA**) and Energisa (**ENGI11.SA**).

**Exhibit 61:** Eletrobras' Fair value sensitivity: upside to price target at different Power Price assumptions

| Power Prices Sensitivity | | | | | | | |
|---|---|---|---|---|---|---|---|
| (+/-) Change in Power Prices (R$/MWh) vs MS Base case of R$150/MWh in the long-term | (30) | (20) | (10) | 0 | 10 | 20 | 30 |
| Upside (downside) to ELET's fair value (R$/sh) | (9.5) | (6.4) | (3.2) | 0.0 | 3.2 | 6.4 | 9.5 |
| Upside (downside) to ELET's fair value (%) | (17.3%) | (11.5%) | (5.8%) | 0.0% | 5.8% | 11.5% | 17.3% |

Source: Morgan Stanley Research estimates.

# OW-Rated Stocks to Benefit from Growing GenAI Power Demand

We highlight the following GenAI power demand beneficiaries that we expect to see demand lead revenue grow / increased customer demand.

## AES Corp.

**AES (AES.N) — covered by Dave Arcaro:** AES is a major large-scale renewable developer in the US, with the largest Commercial & Industrial market share. It has similar business strengths as NEE in terms of geographic coverage, scale, cost, and operational expertise that make it a strong player in the market. The company has also focused its business on the C&I customer category and has existing commercial relationships with big tech companies including Google, Microsoft, and Amazon. This could help differentiate the company in serving data center demand. **We estimate that GenAI accounts for 0% of revenue today and will grow to 3.5% by 2027.**

## Bloom Energy

**Bloom Energy (BE.N) — covered by Andrew Percoco:** In our view, fuel cells are among the most exciting alternatives to wind and solar to serve GenAI power demand. Bloom Energy provides base-load power fuel cells to data center customers. Fuel cells can operate at high capacity factors (90%+), solving the intermittency issue with renewables, are economic vs. grid-alternatives (~$0.10/kWh vs. C&I rates, which range from $0.06 to $0.24/kWh, depending on the state), and are more environmentally friendly than grid power (even when running on natural gas). Additionally, fuel cells are quick to deploy and can serve as a bridge technology for data center customers as utilities build out transmission and substation infrastructure to support increasing data center load. Assuming GenAI load were to be supported by high capacity-factor fuel cells, we estimate that 22GW would need to be deployed through 2027 to support global AI load growth in our base case scenario. This is a very significant amount of volume relative to annual installed base for most fuel cell providers. For context, we estimate that Bloom Energy, which provides base-load power fuel cells to data center customers, will deploy 300-1,100MW of product, annually through 2030. **Assuming BE captures just 1% market share of the annual AI power capacity demand would imply a $750 million revenue opportunity (~40% of our 2024-27 revenue forecast).** As a result, we expect companies, such as Bloom Energy, to be significant beneficiaries of the AI-driven load growth, even if just a fraction of the incremental load is supported by fuel cells.

## Constellation Energy

**Constellation Energy (CEG.O) — covered by Dave Arcaro:** Constellation Energy is the owner of the largest nuclear fleet in the US with ~21 GW of capacity in the central US, mid-Atlantic, and Northeast. The company's plants are already operational, a potential speed advantage vs. new renewables construction. Power from nuclear plants could be priced competitively vs. non-emitting alternatives, with the combination of wind, solar, and storage potentially being costly in certain regions of the country compared with the price a nuclear plant might charge (we estimate a $10-15/MWh premium to market power prices). Nuclear plants are also highly reliable, the company has a very strong operational track record, and they have no carbon emissions.

CEG's nuclear fleet also offers an interesting opportunity for data centers to be built within a nuclear plant's campus, behind the fence line. In this way a data center could source power directly from the nuclear units with no external connection to the utility grid. Electricity would be highly reliable given two nuclear units can back each other up to run 100% of the time together. The data center would potentially avoid any transmission and distribution charges from the local utility — a cost that often represents 40-50% of the total cost of electricity. Nuclear plants also have available land, water infrastructure, and security in place that could be utilized by a data center. We think this could be a competitive offering to site new data centers with nuclear plants. **We estimate that GenAI accounts for 0% of revenue today and will increase to 2.9% by 2027.**

## Delta Electronics

**Delta Electronics (2308.TW) — covered by Sharon Shih:** Delta Electronics is a key vendor offering integrated power management solutions for data centers to include products such as power supply, power module, Uninterruptible Power Supplies (UPS), and Energy Storage Systems (ESS). Power electronics takes up ~62% of its total revenue, in addition to another ~10% from its power infrastructure related businesses. As power demand grows, in order to reduce costs, we think customers will turn to IT equipment such as Delta's to support power efficiency and for reliable backup power. An example of this is Delta's InfraSuite product, which offers a comprehensive, modular and highly integrated portfolio to the support the creation of high-performing data centers. **We estimate Delta's data**

**center related exposure to be around 25% of total revenue in 2024 and will likely rise to 30-35% in 2027.**

## ENGIE

**Engie (ENGI.PA) — covered by Arthur Sitbon:** Engie has been very active in the corporate PPA space in the past few years thanks to the complementarity of its renewables activities, its customer-oriented services and its trading activities. We think the group is well positioned to capture potential additional demand from data centers in key regions where the group develops renewables (Europe & US in particular). **We see healthy value creation fundamentals in the renewables industry overall in these markets and we thus think this could represent a way for Engie to add value accretive options** to its growth story.

## Mitsubishi Electric

**Mitsubishi Electric (6503.T) — covered by Yoshinao Ibara:** Mitsubishi Electric is one of the leading players in the factory automation and air conditioning industries, provides a comprehensive range of products and systems for building and operating data centers related to energy savings, air conditioning, power supply, and remote monitoring. Mitsubishi Electric is expected to benefit from increased demand for AI servers and data centers which consume more electricity than before. **We estimate its revenue ratio for data centers will expand to ~1.5% from ~1.3% (¥70 billion) in F3/25.** The data center–related offerings include factory automation (energy management, control & monitoring systems), energy transmission & distribution, and optical devices.

## NextEra Energy

**NextEra Energy (NEE.N) — covered by Dave Arcaro:** NextEra Energy is the leading large scale renewable developer in the US. We think the company is well positioned to supply renewable power to new data centers. NextEra has several key capabilities that we expect to position the company favorably. The company has geographic scale, with a large pipeline of land and transmission interconnect agreements across the country that give it speed to market with new projects. NEE's costs are highly competitive due to its purchasing power, highly sophisticated operating services functions, and renewable resource modeling. It has the capability to integrate wind, solar, and storage, and the software to optimize these technologies. We think these factors along with the company's reputation and track record will position it to be a major player in the renewables buildout for data center demand. **We estimate that GenAI will grow from 0% of revenue today to 2.2% by 2027.**

## Orsted & RWE

**Orsted (ORSTED.CO) and RWE (RWEG.DE) — covered by Rob Pulleyn:** We expect the growth in GenAI to positively impact Renewables power demand, especially supporting corporate PPA markets, which are likely to underpin solar and wind project economics. As leading players in Renewables, both Orsted and RWE would benefit, having 2030e installed capacity exposure of respectively 38% and 31% to US Renewables, and 57% and 35% to European RES. **Currently, RWE and Orsted stocks do not value/price in any future growth beyond known projects in renewables capacity, whether from US/ AI data centre PPA's or elsewhere.**

## Prologis

**Prologis (PLD.N) — covered by Ronald Kamdem:** Prologis is the largest global industrial and logistics landlord with a 1.2 million SF portfolio (85% US, 15% international). Given $40 billion of build out land bank potential and a favorable cost of capital with a self-funding business model, Prologis has positioned itself for between $7-$8 billion of data center development over the next 5 years. Indeed, given the company's development track record ($45 billion of development over the past 20 years at a ~30% development margin), we see potential for data center development to become a potential value driver for the business. Expect value creation to be unlocked primarily through the company's well positioned land bank as well as through conversion opportunities which should drive lower all in development costs (and higher yields on development). The company expects to develop and sell stabilized data centers back to data center operators upon completion at a margin 1.5-2.0x that of traditional industrial development margins. PLD has identified 20 opportunities for data center development (3 GW of power) over the next 5 years and sees >100 opportunities (10 GW of power) on a longer-term basis. **Currently, we estimate that data centers account for 0% of NOI today and is expected to grow to 3-4% of total NOI on $4 billion of spend by 2027.** However, we expect that Prologis will likely only retain 10-20% of these returns on its balance sheet and sell the majority falling to 40-60bps of total NOI.

## Prysmian

**Prysmian (PRY.MI) — covered by Max Yates:** Prysmian is one of the key beneficiaries of increasing spending on grid infrastructure. **Between 2023 and 2027 we expect cables for grid to rise from 35% of Prysmian's group EBITDA to 45%.** Specifically from the data center opportunity, we think Prysmian will benefit as increased power demand from data-centres will require new power sources and also more interconnections to balance power supply and

demand across regions. Prysmian has also continued to expand its presence in the US with the acquisition of General Cable in 2018 and then more recently with the announcement of capacity expansion in the US across medium voltage cable and also the new high voltage cable plant that is being constructed in Breyton Point.

## Pure Storage

**Pure Storage (PSTG.N) — covered by Meta Marshall:** Pure Storage is a pure-play on flash storage in the data center. **According to Gartner Group, storage is 20-25% of data center power usage today, growing to upwards of 40% by 2030.** Flash storage can help solve for this constraint given it is 10x more power efficient than traditional disk. With disk still addressing ~90% of cloud storage needs, we think that as clouds look for more power efficient solutions, the adoption of flash will be a natural solution. Given Pure Storage is not only a pure-play on flash, but has advantages in terms of utilization and cost from writing directly to raw flash vs. solid state drives (SSDs), we feel like they are in the best position of branded storage vendors to capture upside as the clouds look to incorporate more flash.

**Remain OW, PT to $43 from $40, bull case to $59 from $50.** As a result of the analysis in our note, we are raising our bull case to $59 from $50, assuming 30x a bull cash 25e FCF, but that the bull case FCF can be 20% higher than base case expectations as AI drives additional demand for power saving technologies vs. the 10% higher we had in the previous bull case. Our base case moves to $43 from $40, taking into account increased confidence in FY25 estimates (remain ~26x 25e FCF). Our bear case remains at $22, or 15x a bear case FCF. Biggest risks to our PT are macro weakness dampens demand, competitive differentiation in storage falls, subscription transition dampens growth rate enough to reduce interest in the name.

## Sembcorp & Tenaga

We estimate total data center power demand in ASEAN could rise to ~7 GW by 2027 (from ~1.7 GW in 2023), (~7% of total capacity in the region) driven by GenAI (business/government digital transformation, data security and edge computing) as well as the stable local geopolitical environment and supportive policies on the digital economy. We see data center demand absorbing excess power supply in Malaysia and Thailand while keeping electricity markets tighter for longer in Singapore. While GenAI is in early days of adoption in ASEAN, we see multiple levers for Singapore and Malaysia's electricity demand to grow 50bps above past decade average - examples include NVIDIA's tie up with YTL Power in Malaysia, Singapore government's AI strategy and slowly allowing build up of new data centers and multiple hyperscalers, and Chinese data centers adding capacity in ASEAN. Regulated utilities will see improvement in network efficiency, lower transmission costs and eventually acceleration in the pace of grid strengthening all resulting in higher renewables growth rates as well. We are raising our estimates for Singapore and Malaysia power demand beyond 2025 and we now expect power markets in Singapore to remain tighter until 2027 before new capacity starts up. Malaysia, which as seen reserve margins being reasonably high, due slower demand growth from industries potentially adding ~4 GW of new data center electricity demand by 20xx and making the market tighter each year for the first in past one decade. What's changed? We raise Sembcorp's Singapore tariffs beyond 2025 by 5% and also reflect our views on glut in global gas markets which should help expand its margins on steam generation. For Tenaga, we lift the electricity sales volume forecasts by 50bps starting 2025. In terms of NAV, we raise the long term "g" assumption by AI, GenAI and overall data center demand have multiple effects on electricity markets, renewable supply chain and pace of renewable adoption — all which remain under appreciated. Multiples to re-rate as long term "g" for power producers in South east Asia rises 25bps for each to reflect the tightness in electricity markets.

**Sembcorp (SCI.SI) — covered by Mayank Maheshawri:** We expect SCI to be a key beneficiary of electricity market tightness which we expect to remain for the rest of the decade. SCI also previously announced a 10-year PPA with Singapore Telecom in mid-2023. Sembcorp estimates the annual contract value at S$180 million, implying a tariff of ~S$600/MWh based on 100% of Singtel's 2022 reported electricity consumption. The tariff will be based on fixed and variable components linked to fuel oil. Singtel (covered by Da Wei Lee) will also have the option to convert the power supplied to green power at a predetermined additional cost through Renewable Energy Certificates, solar, or Sembcorp's future green projects' price in the contract period. Tight electricity markets in Singapore are aiding SCI's ability to increase long-term supply contracts beyond the next capacity adds of 2026, when Keppel and SCI add ~1.2 GW+ of capacity. **Currently, we estimate that data centers account for 4.5% of total revenue in 2024 and will grow to 6.1% by 2027.**

**Tenaga (TENA.KL) — covered by Mayank Maheshwari:** We think demand growth upside is under-appreciated ~2 GW of near-term data center consumption in Malaysia should anchor demand for energy and help absorb the 40% reserves margin; it would also help TNB raise efficiency on ~60% of its capital employed. Upside to regulated returns in 2025 is not well appreciated by the stock. We see ~15% upside to earnings for its regulated business as Tenaga refocuses its capital toward transmission and distribution, which typically attracts 1.5-2.0x higher ROCEs than generation. We see upside

risks to Tenaga's regulated asset base as Malaysia advances both its energy transition and data center hub agenda, both of which requires significant incremental grid investments of ~US$20 billion over the next 5 years, while we expect the regulated WACC to remain at 7.3%. We are positive on Tenaga as we view it to be the key beneficiary for rising power demand in Malaysia from data centers. We raise our 2024e and 2025e commercial electricity demand growth to factor Tenaga's pipeline of new data center connections, hence 2024 and 2025e EPS by 2-6%. **Currently, we estimate that data centers account for 1.3% of revenue in 2024 and will grow to 4.1% by 2027.**

## Key EW-Rated Names

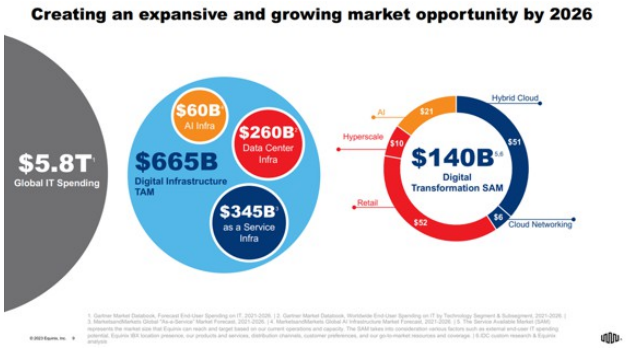
**Legrand (LEGD.PA) — covered by Aurelio Calderon Tejedor:** We see Legrand as well placed to benefit from increasing data centre equipment demand. Its **exposure has grown from 6% of sales in 2017 to >14% in 2022 and has grown at double digit rates over the last few years.** Legrand is a more focused player than Schneider and does not have a full product suite / exposure to medium voltage. It is more exposed to the white space (>90%) with products such as busways, racks, PDUs or cable management.

**Schneider Electric (SCHN.PA) — covered by Max Yates:** We view Schneider as the fastest growing large-cap Electrical equipment stock in our coverage. A key driver of this growth is Schneider's 19% exposure to data centers. Schneider offers full solutions for data centers that bring together power, cooling, racks and power, and IT management systems. **Schneider sees >10% CAGR for this end market to 2027.** At group level, Schneider is targeting 7%-10% organic revenue growth CAGR in 2023-27.

**Digital Realty (DLR.N) — covered by Simon Flannery:** We currently believe that DLR stands to benefit the most (vs. Equinix) from the US GenAI opportunity. Initial training workloads associated with GenAI are less dependent on location and latency and thus benefit DLR more due to its focus on providing wholesale capacity for training purposes. However, we would note that DLR's ability to benefit from the GenAI opportunity will somewhat be dependent on its ability to continue to raise capital at attractive rates to help delever, refinance upcoming debt maturities, and take on new data center projects. One additional impact of the rising AI demand is improved pricing trends across the data center industry especially in light of low vacancy rates. We remain Equal-weight.

**Equinix (EQIX.O) — covered by Simon Flannery:** Equinix does have exposure to hyperscale data centers via its xScale JVs, but these are primarily located in Europe and Asia. We could see Equinix look to establish a more robust Hyperscale data center presence in North America going forward. Given Equinix's predominate focus on interconnection, we believe Equinix stands to benefit more at the inference stage of GenAI, compared to the GenAI training stage. We remain Equal-weight Equinix.

**Exhibit 62:** Equinix's Overall Market and AI Opportunity Overview from Latest Investor Day




Source: Equinix

# Appendix

**Exhibit 63:** Full list of key beneficiaries of the rapid growth in GenAI power demand

| Ticker | Company | Analyst | Sector | Market Cap (USD in mn) | Rating | Currency | PT | Upside to PT | Classification of AI Exposure |
|---|---|---|---|---|---|---|---|---|---|
| *Data Center Infrastructure* | | | | | | | | | |
| 2308.TW | Delta Electronics Inc. | Shih, Sharon | Information Technology | 24,350 | Overweight | TWD | 378.00 | 29% | Beneficiary - Enabler |
| PRY.MI | Prysmian SpA | Yates, Max | Industrials | 12,003 | Overweight | EUR | 45.00 | 12% | - |
| PSTG.N | Pure Storage Inc | Marshall, Meta | Information Technology | 12,866 | Overweight | USD | 43.00 | 6% | Beneficiary - Enabler |
| 6503.T | Mitsubishi Electric | Ibara, Yoshinao | Industrials | 31,886 | Overweight | JPY | 2,300.00 | 4% | Beneficiary - Adopter |
| PLD.N | Prologis, Inc. | Kamdem, Ronald | Real Estate | 118,278 | Overweight | USD | 141.00 | 10% | Beneficiary - Adopter |
| LEGD.PA | Legrand | Calderon Tejedor, Aurelio | Industrials | 25,855 | Equal-Weight | EUR | 98.00 | 8% | Beneficiary - Enabler |
| EQIX.O | Equinix Inc. | Flannery, Simon | Real Estate | 75,013 | Equal-Weight | USD | 767.00 | (4%) | Beneficiary - Enabler |
| SCHN.PA | Schneider Electric | Yates, Max | Industrials | 111,496 | Equal-Weight | EUR | 168.00 | (7%) | Beneficiary - Enabler |
| DLR.N | Digital Realty Trust Inc. | Flannery, Simon | Real Estate | 42,102 | Equal-Weight | USD | 100.00 | (28%) | Beneficiary - Enabler |
| *Power Providers* | | | | | | | | | |
| BE.N | Bloom Energy Corp. | Percoco, Andrew | Industrials | 2,673 | Overweight | USD | 22.00 | 84% | Beneficiary - Enabler |
| RWEG.DE | RWE AG | Pulleyn, Robert | Utilities | 29,547 | Overweight | EUR | 60.00 | 64% | Beneficiary - Adopter |
| AES.N | AES Corp. | Arcaro, David | Utilities | 11,256 | Overweight | USD | 26.00 | 55% | Beneficiary (Enabler, Adopter, Both) |
| ORSTED.CO | Orsted A/S | Pulleyn, Robert | Utilities | 23,538 | Overweight | DKK | 500.00 | 30% | Beneficiary - Adopter |
| NEE.N | NextEra Energy Inc | Arcaro, David | Utilities | 117,727 | Overweight | USD | 78.00 | 36% | Beneficiary (Enabler, Adopter, Both) |
| ENGIE.PA | ENGIE | Sitbon, Arthur | Utilities | 40,362 | Overweight | EUR | 19.00 | 24% | Beneficiary - Adopter |
| SCIL.SI | SembCorp Industries Ltd | Maheshwari, Mayank | Utilities | 7,048 | Overweight | SGD | 6.40 | 21% | Beneficiary - Adopter |
| TENA.KL | Tenaga Nasional | Maheshwari, Mayank | Utilities | 12,855 | Overweight | MYR | 12.24 | 17% | Beneficiary - Adopter |
| CEG.O | Constellation Energy Corporation | Arcaro, David | Utilities | 37,907 | Overweight | USD | 136.00 | 15% | Beneficiary - Adopter |

Source: FactSet, Morgan Stanley Research. Data as of market close 1/23/24. We also highlight names that are included in our *Stars and Sparks* list in the Americas and EMEA: BE, CEG, AES, NEE; as well as, RWE, Prysmian, ENGIE, and Orsted

**Exhibit 64:** Full list of stocks - share price

| Ticker | Company | Analyst | Sector | Rating | Currency | Share Price |
|---|---|---|---|---|---|---|
| *Data Center Infrastructure* | | | | | | |
| 2308.TW | Delta Electronics Inc. | Shih, Sharon | Information Technology | Overweight | TWD | 293.50 |
| PRY.MI | Prysmian SpA | Yates, Max | Industrials | Overweight | EUR | 40.07 |
| PSTG.N | Pure Storage Inc | Marshall, Meta | Information Technology | Overweight | USD | 40.72 |
| 6503.T | Mitsubishi Electric | Ibara, Yoshinao | Industrials | Overweight | JPY | 2,205.00 |
| PLD.N | Prologis, Inc. | Kamdem, Ronald | Real Estate | Overweight | USD | 128.01 |
| LEGD.PA | Legrand | Calderon Tejedor, Aurelio | Industrials | Equal-Weight | EUR | 90.40 |
| EQIX.O | Equinix Inc. | Flannery, Simon | Real Estate | Equal-Weight | USD | 799.00 |
| SCHN.PA | Schneider Electric | Yates, Max | Industrials | Equal-Weight | EUR | 179.68 |
| DLR.N | Digital Realty Trust Inc. | Flannery, Simon | Real Estate | Equal-Weight | USD | 139.02 |
| *Power Providers* | | | | | | |
| BE.N | Bloom Energy Corp. | Percoco, Andrew | Industrials | Overweight | USD | 11.93 |
| RWEG.DE | RWE AG | Pulleyn, Robert | Utilities | Overweight | EUR | 36.67 |
| AES.N | AES Corp. | Arcaro, David | Utilities | Overweight | USD | 16.81 |
| ORSTED.CO | Orsted A/S | Pulleyn, Robert | Utilities | Overweight | DKK | 385.40 |
| NEE.N | NextEra Energy Inc | Arcaro, David | Utilities | Overweight | USD | 57.38 |
| ENGIE.PA | ENGIE | Sitbon, Arthur | Utilities | Overweight | EUR | 15.30 |
| SCIL.SI | SembCorp Industries Ltd | Maheshwari, Mayank | Utilities | Overweight | SGD | 5.31 |
| TENA.KL | Tenaga Nasional | Maheshwari, Mayank | Utilities | Overweight | MYR | 10.50 |
| CEG.O | Constellation Energy Corporation | Arcaro, David | Utilities | Overweight | USD | 118.69 |
| *Other Stocks Mentioned* | | | | | | |
| ELET3.SA | Eletrobras | Rodrigues, Miguel | Utilities | Overweight | BRL | 41.03 |
| ENGI11.SA | Energisa SA | Rodrigues, Miguel | Utilities | Overweight | BRL | 50.32 |
| EQTL3.SA | Equatorial Energia SA | Rodrigues, Miguel | Utilities | Overweight | BRL | 34.11 |

Source: FactSet, Morgan Stanley Research. Data as of market close 1/23/24

*Morgan Stanley is acting as financial advisor to Centrais Eletricas Brasileiras S.A. ("Eletrobras") in connection with the potential sale of its gas thermal portfolio, as announced on July 7, 2023. There is no guarantee that any transaction will be consummated. Eletrobras is expected to pay fees to Morgan Stanley for its financial services which are contingent upon the consummation of the transaction. Please refer to the notes at the end of this report.*

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|---|---|---|---|---|---|---|---|
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| Overweight/Buy | 1346 | 37% | 266 | 41% | 20% | 605 | 39% |
| Equal-weight/Hold | 1668 | 46% | 317 | 49% | 19% | 717 | 46% |
| Not-Rated/Hold | 3 | 0% | 0 | 0% | 0% | 1 | 0% |
| Underweight/Sell | 598 | 17% | 61 | 9% | 10% | 224 | 14% |
| Total | 3,615 | | 644 | | | 1547 | |

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