Goldman Sachs

EQUITY RESEARCH | April 28, 2024 | 10:34PM EDT

Generational growth

AI, data centers and the coming US power demand surge

Driven by AI, broader demand and a deceleration in the pace of energy efficiency gains, global data center power demand is poised to more than double by 2030 after being flattish in 2015-20. This growth is the primary catalyst alongside increasing manufacturing/industrial production and broader electrification trends, to an acceleration in US electricity demand CAGR to 2.4% through the end of the decade from 0% in the last decade. We believe supporting data center driven load growth will require investment by Utilities of $50 bn in new power generation capacity. We assume a 60/40 split between gas and renewables, which we expect to drive ~3.3 bcf/d incremental natural gas demand by 2030. While investor interest in the AI revolution theme is not new, we believe downstream investment opportunities in utilities, renewable generation and industrials whose investment and products will be needed to support this growth are underappreciated. We highlight 16 Buy-rated stocks levered to the US power demand surge.

Utilities: NEE, XEL, SRE, SO
Clean Technology: FSLR, FLNC
Midstream: KMI
Energy Services: PWR, MYRG
Commodities: CCJ, EQT
Industrials: GEV, ETN, NVT, CAT
Industrial Tech: VRT

Carly Davenport
+1(212)357-1914
carly.davenport@gs.com
Goldman Sachs & Co. LLC

Brian Singer, CFA
+1(212)902-8259
brian.singer@gs.com
Goldman Sachs & Co. LLC

Neil Mehta
+1(212)357-4042
neil.mehta@gs.com
Goldman Sachs & Co. LLC

Brian Lee, CFA
+1(917)343-3110
brian.k.lee@gs.com
Goldman Sachs & Co. LLC

John Mackay
+1(212)357-5379
john.mackay@gs.com
Goldman Sachs & Co. LLC

The Goldman Sachs Group, Inc.

See full list of authors inside

Authors

Carly Davenport
+1 212 357-1914
carly.davenport@gs.com
Goldman Sachs & Co. LLC

Brian Lee, CFA
+1 917 343-3110
brian.k.lee@gs.com
Goldman Sachs & Co. LLC

Brendan Corbett
+1 415 249-7440
brendan.corbett@gs.com
Goldman Sachs & Co. LLC

Joe Ritchie
+1 212 357-8914
joseph.ritchie@gs.com
Goldman Sachs & Co. LLC

Jaskaran Jaiya
+1 332 245-7709
jaskaran.jaiya@gs.com
Goldman Sachs India SPL

Varsha Venugopal
+1 415 393-7554
varsha.venugopal@gs.com
Goldman Sachs & Co. LLC

Nick Cash
+1 212 357-6372
nick.cash@gs.com
Goldman Sachs & Co. LLC

Olivia Halferty
+1 801 212-7314
olivia.halferty@gs.com
Goldman Sachs & Co. LLC

Brian Singer, CFA
+1 212 902-8259
brian.singer@gs.com
Goldman Sachs & Co. LLC

John Mackay
+1 212 357-5379
john.mackay@gs.com
Goldman Sachs & Co. LLC

John Miller
+1 646 446-0292
john.y.miller@gs.com
Goldman Sachs & Co. LLC

Mark Delaney, CFA
+1 212 357-0535
mark.delaney@gs.com
Goldman Sachs & Co. LLC

Neil Mehta
+1 212 357-4042
neil.mehta@gs.com
Goldman Sachs & Co. LLC

Ati Modak
+1 212 902-9365
ati.modak@gs.com
Goldman Sachs & Co. LLC

Toshiya Hari
+1 646 446-1759
toshiya.hari@gs.com
Goldman Sachs & Co. LLC

Jerry Revich, CFA
+1 212 902-4116
jerry.revich@gs.com
Goldman Sachs & Co. LLC

Our views on 5 key questions on the coming data center/AI power surge

How significant will the power demand growth from AI/data centers be?

We forecast a **15% CAGR in data center power demand from 2023-2030**, driving data centers to make up **8% of total US power demand by 2030 from about 3% currently**. We now see a **2.4% CAGR in US power demand growth** through 2030 from 2022 levels **vs. ~0% over the last decade**. Of the 2.4%, about 90 bps of that is tied to data centers.

How much generation and overall capital investment will be required to support data center power demand growth?

We estimate about **47 GW of incremental power generation capacity** will be required to support US data center power demand growth cumulatively through 2030, met with about 60% gas and 40% renewable sources. We expect this to drive about **$50 bn of capital investment in US power generation capacity** cumulatively through 2030.

Will there be bottlenecks in generation or transmission/interconnection that constrain growth?

Initial conversations with utilities under coverage do not suggest material concerns on supply chain on the generation kit or transmission side over the current five-year planning period, though there have been concerns from investors that issues around solar in recent years could reemerge. Further, **lengthy interconnection queues remain a challenge to connecting new projects to the grid**, and expediting the permitting/approval process for transmission projects will be key to alleviate it. Elsewhere, we see similar potential growth constraints from natural gas transmission infrastructure construction, specifically long-dated timelines, permitting challenges, and environmental / landowner litigation. In our view, **the most top of mind constraint for natural gas is construction and permitting timelines** where we see an average lag of ~4 years from the project announcement date to in-service date which means the earliest capacity additions, if announced today, would not be in-service until ~2028.

If not, what will be the constraint to growth: AI budgets, demand or neither?

The answer to this will be critical to the trajectory for AI power demand. The lack of any constraint would be the most bullish for power consumption — i.e., if corporate technology spending budgets are unlimited, then server shipments would remain otherwise unchanged even as new generations of chips/servers come available that cost more money but provide greater compute speed/consume more power (with efficiencies). Demand as the constraint would be the most bearish, as, all else equal, fewer more efficient servers would be able to meet a fixed level of demand. Our estimates imply budgets are a constraint, i.e., **buyers shift towards more productive products within their budgets**.

What stocks levered to the power demand growth remain underappreciated?

We highlight 16 **Buy rated stocks** across our Utility, Clean Technology, Midstream, Energy Services, Industrials, and Industrial Tech companies that we believe have leverage to power demand growth that is underappreciated at current levels.

- **Utilities:** NEE, XEL, SRE, SO
- **Clean Technology:** FSLR, FLNC
- **Midstream:** KMI
- **Energy Services:** PWR, MYRG
- **Commodities:** CCJ, EQT
- **Industrials:** GEV, ETN, NVT, CAT
- **Industrial Tech:** VRT

Where to read more

- Sustainability impact on emissions, AI benefits and global stocks — GS SUSTAIN: AI/data centers' power surge and the Sustainability impact
- AI/Data center outlook to Europe power demand — Powering Up Europe: AI datacenters and Electrification imply +c.40% in consumption

US DATA CENTER POWER DEMAND

KEY BUY-RATED STOCKS

Power Demand Growth Beneficiaries

Vertiv Holdings (VRT)	Strong market share (and backlog) in thermal cooling and power management products
NextEra Energy (NEE)	Renewable segment uniquely positioned for AI data load & interconnection queues available
Fluence Energy (FLNC)	Supplier of clean energy storage solutions as back-up power for data centers
Cameco Corp. (CCJ)	Uranium producer & nuclear fuel supplier to benefit from increasing nuclear power capacity
EQT Corp. (EQT)	Natural gas producer positioned to benefit from increased demand from electric load growth

Power Generation Capacity Additions

Xcel Energy (XEL)	Regulated utility exposed to power generation needs to support data center growth in MISO
First Solar Inc. (FSLR)	Key manufacturer & supplier of solar panels to utility scale solar farms within the US
Southern (SO)	Regulated utility regionally positioned to serve data center load growth via generation spend
GE Vernova (GEV)	Beneficiary of secular growth as supplier of power generation assets

Power Infrastructure Investment Needs

Quanta Services (PWR)	Specialty contractor involved in utilities construction that should benefit from higher power demand
MYR Group (MYRG)	Exposure to data centers via T&D work and positioning as a leader in electrical contracting
Sempra (SRE)	Utility that is spending significant capex on T&D to support data center growth in Texas
Kinder Morgan (KMI)	Largest US natural gas pipeline operator to benefit from gas-fired generation demand growth

Industrial Supply Chain Beneficiaries

Eaton Corp. (ETN)	Electrical component manufacturer to benefit from secular growth in power demand
nVENT Electric (NVT)	Liquid cooling play with double digit business growth expected in Data Solutions
Caterpillar Inc. (CAT)	Construction equipment co. that can supply generator sets to data centers for backup power

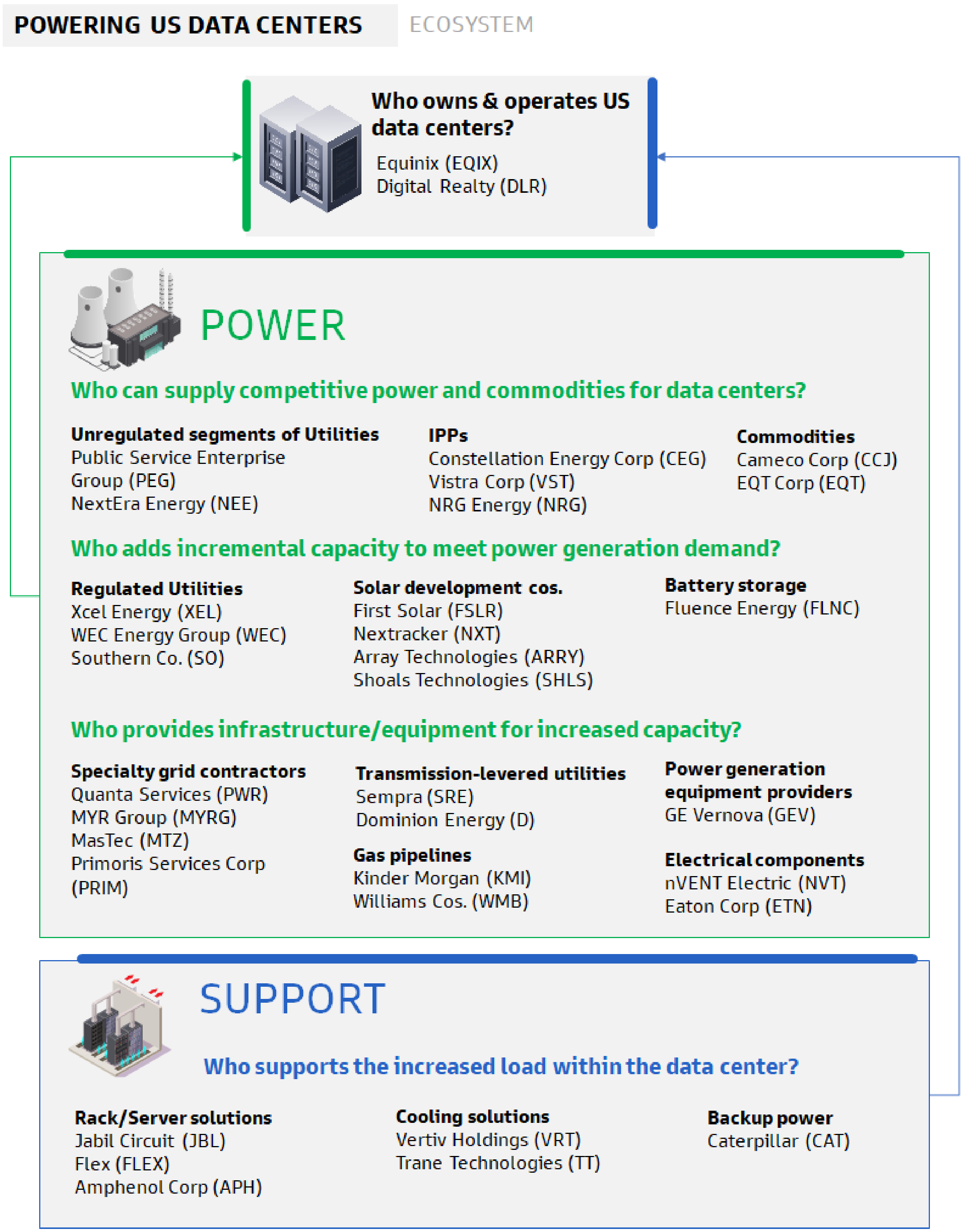
Finding the downstream beneficiaries of AI and data center growth in the power supply chain

US power demand likely to experience growth not seen in a generation. Not since the start of the century has US electricity demand grown 2.4% over an eight-year period, with US annual power generation over the last 20 years averaging less than 0.5% growth. We believe this is on track to change through the end of the decade, led by a surge in data center demand for power and complemented by electrification, industrial reshoring/manufacturing activity. Growth from AI, broader data demand and a deceleration of power efficiency gains is leading to a power surge from data centers, with data center electricity use expected to more than double by 2030, pushing data centers to 8% of US power demand vs. 3% in 2022. We believe this is unlocking underappreciated equity investment opportunities throughout the power supply chain, and regulated Utilities that will benefit from rate-based growth have continued to trade more on cyclical factors like interest rates than on the secular generational growth that is likely to drive earnings. In our report we forecast AI and broader power demand and highlight 16 Buy-rated stocks across sectors exposed to the US data center power demand surge.

Where we see opportunity. Investor interest in the data center growth is not new, but differentiation among enablers, Utility volume growth beneficiaries, Utility capex growth beneficiaries and regionalization will likely be the next area of focus. Technology companies will likely accelerate underwriting power purchase agreements (PPAs), where the companies sign contracts to buy power from utilities or independent power producers, for renewable generation. And infrastructure contractors and industrials making products that support needed transmission, generation and distribution are likely to benefit.

Potential drivers of upside and downside. A key driver of AI power demand is whether the constraint to growth is demand, budgets or neither. New generation AI servers consume more power and provide more compute speed, even as the power intensity has fallen meaningfully. There could be meaningful upside to our base case if appetite for purchase and utilization of servers is unconstrained. There could be downside to our base case if power efficiency is higher than expected or if power/compute speed efficiencies lead to fewer servers purchased than expected.

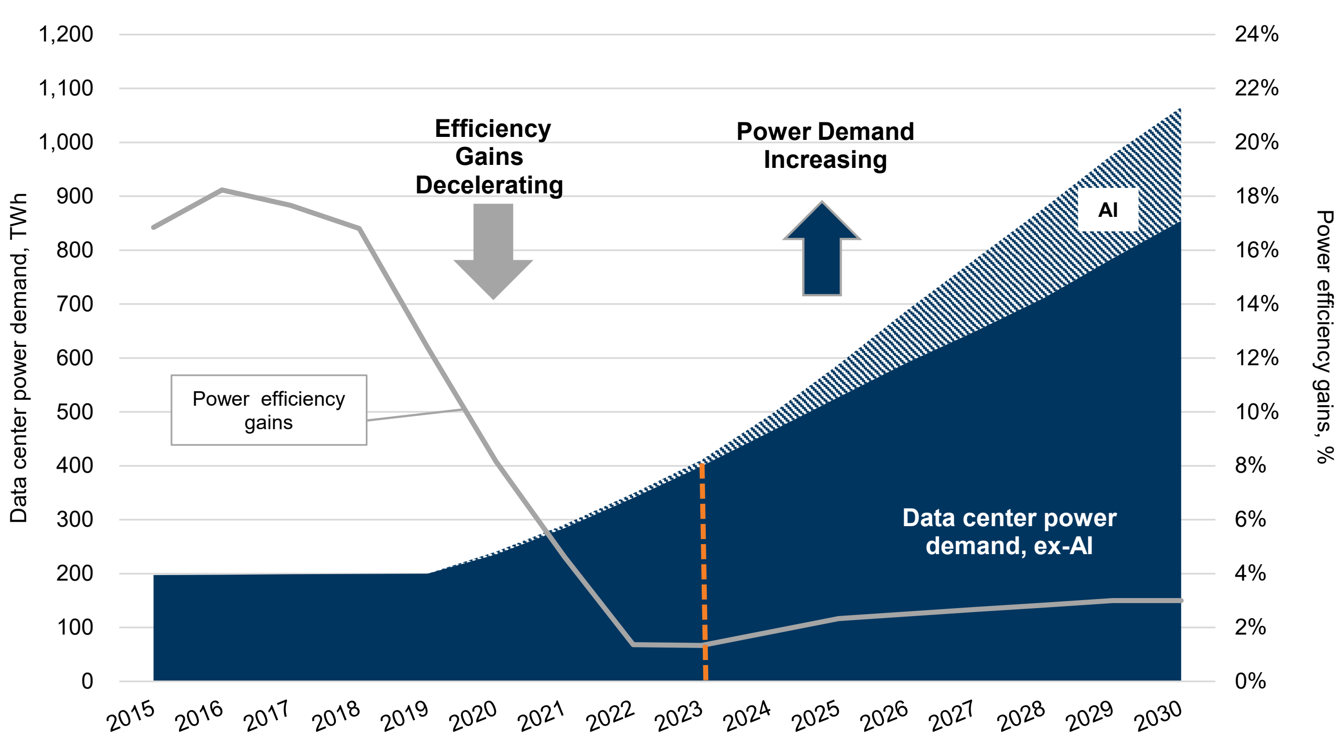
We highlight a number of companies across industries that will benefit from the growth of data centers
Data center ecosystem



This is a group of select stocks where GS sees leverage to data centers and power demand, we recognize this is not an exhaustive list.

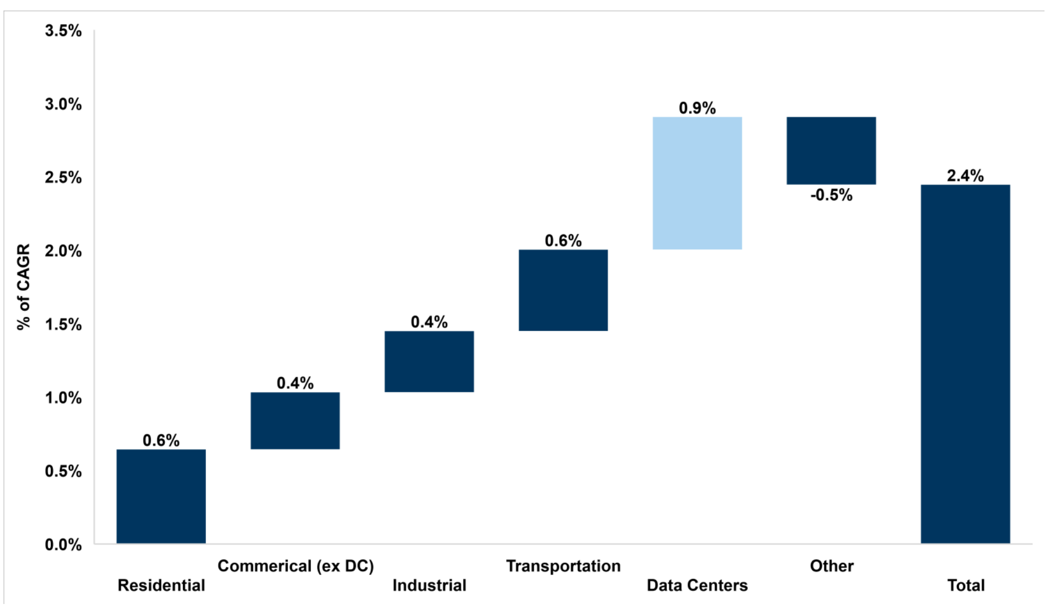
Source: Goldman Sachs Global Investment Research

Exhibit 1: After being flattish for 2015-19, we see power demand from data centers more than tripling in 2030 vs. 2020, with an upside case more than double the base case depending in part on product efficiencies and AI demand
Data center electricity consumption, TWh (LHS) and 3-year rolling average power efficiency gains yoy, % (RHS)



Source: Masanet et al. (2020), Cisco, IEA, Goldman Sachs Global Investment Research

Exhibit 2: Data centers contribute 90 bps to our 2.4% US power demand CAGR from 2022-2030
Composition of US power demand CAGR, 2022-2030, %



Source: Goldman Sachs Global Investment Research, EIA

THE US POWER DEMAND SURGE in numbers

DATA-CENTERED

0% → **1.7%** → **2.4%**

0%
Average US power demand growth in the last decade.

1.7%
Our estimate for the US electricity demand CAGR through 2030 prior to AI/data center considerations.

2.4%
Our latest estimate for the US electricity demand CAGR through 2030, factoring in expectations for data center and AI growth.

3% → **160%** → **8%**

3%
Data centers' current share of US power demand.

160%
The expected growth in data center power demand (excluding cryptocurrency) between 2023 and 2030.

8%
Data centers' 2030E share of US power demand.

WATTS UP

47GW
The incremental power generation required through 2030 to support data center demand growth.

INPUT

$50bn
The amount of capex we expect in US power generation capacity through 2030.

GAS VS GREEN

60%/ 40%
The amount of incremental power generation that we expect to be met with gas/renewables, respectively.

3.3bcf/d
Our expectations for data-center-driven daily incremental natural gas demand by 2030.

AI'S ROLE

20%
AI's share of total data center power demand by 2030, in our base case.

POWER EFFICIENCY

0.2KW
The amount of power Nvidia's DGX B200 server requires per petaflop, representing 15x the compute speed over today's servers for only 2x the power.

Who benefits: The power demand supply chain

We broadly bucket beneficiaries of this power demand uptick on the back of data center/AI growth into two areas. The first is **demand growth beneficiaries**. This includes companies that are levered to power needs/prices, including unregulated power producers, gas companies, energy storage players, and those that provide power solutions to data centers. It also includes companies that are involved in building power generation capacity to help meet this growing load, including regulated utilities, merchant power producers, renewables companies, and generation kit suppliers.

The second bucket is **supply chain/infrastructure beneficiaries.** This includes companies that are positioned to invest in infrastructure or equipment to help facilitate the build out of power infrastructure and support grid reliability. We highlight Buy rated stocks that we believe fit into these categories below.

Demand growth beneficiaries

- **FSLR.** As a large domestic panel manufacturer, FSLR should benefit from the projected increase in utility scale projects needed to support increased demand. Companies will likely look domestically for their panels to be able to benefit from domestic content bonus. In some cases, FSLR even partners directly with companies that own the data centers such as MSFT.
- **FLNC.** FLNC will likely benefit from on site deployment at datacenters supplying clean energy storage solutions as back-up power for data centers in case of outages. FLNC has collaborated with (GOOGL) to supply and optimize zero-emission back-up systems for a hyperscale data center.
-
- **GEV.** GEV's installed base of turbines (gas, steam, nuclear, hydro, wind, etc.) and aeroderivatives currently provide ~30% of the world's electricity. We expect GEV to benefit from secular growth trends as demand for electricity accelerates (IEA expecting 100% capacity growth in next 20 years).
- **NEE.** NextEra's unregulated renewable business NextEra Energy Resources (NEER) is uniquely positioned to capitalize on the growth of data centers. NEE has noted it is already serving 6 GWs of load from data centers, and it expects this number to grow. NEER has 150 GWs of interconnection queues already reserved for its projects, which removes one of the primary barriers for building out new generation, and is capable of building these projects all across the nation.
- **SO.** Southern's largest subsidiary Georgia Power is expecting 9% load growth annually starting in 2026, largely driven by data centers. SO has identified 6.6 GWs on incremental load that it will have to serve by 2030 in this service territory. GA Power filed an off-cycle resource plan to support near term load growth, and we anticipate its 2025 resource plan will request significant amount of both generation and grid spend largely to support data centers.
- **VRT.** Vertiv is a global leader in the design and manufacturing of critical infrastructure products including providing thermal cooling and power management products for

datacenters. We believe Vertiv is well positioned for AI datacenter growth given its backlog (~$5.5 bn), strong market share in thermal and power management products, and the increased opportunity from high density workloads (~$3.0-3.5 mn per MW) as compared to traditional compute ($2.5-3.0 mn per MW).

- **XEL.** Given XEL is a vertically integrated utility, we see benefits on both the generation investment and infrastructure investment side. BCG has highlighted MISO as having the highest regional share of data centers built through 2027, where XEL has exposure. NERC reserve margins suggest a tight MISO market, so we expect significant transmission and power generation investment in that market, where XEL's Northern States Power utility operates, supporting rate base and earnings growth.
- **CCJ.** Cameco is a fully-integrated uranium producer and nuclear fuel supplier with operations in Canada, United States, Australia and Kazakhstan. We see the focus on clean, safe and reliable baseload power generation as supportive for the broader nuclear story, as increasing sustainable load growth demand should continue to support fewer US nuclear reactor closures and increase reliance on nuclear power generation globally, which will drive positive estimate revisions for the Cameco story. Given increasing demand for uranium and nuclear fuel across the globe, we see CCJ's operational footprint as well-positioned to capture market share in the medium-longer term given (a) competitive positioning on the global cost curve, (b) lower relative geopolitical risk vs peers and (c) ability to ramp production.
- **EQT.** EQT is the largest, low-cost producer of natural gas in the US, producing ~6 Bcfe/d (~6% of current US gas production) out of the Appalachian Basin in the Northeast US. The company is levered to increased gas demand from various sources including international LNG export and domestic industrial consumption and power generation requirements. We believe an increase in power demand from datacenters and the subsequent impact on load growth could result in a need for incremental gas-based generation, where we believe EQT stands to benefit from its competitive positioning as a leader in the US. We believe an incremental ~3.3 Bcf/d of gas is likely required (as noted in this note), or a ~3% increase in supply needed from current levels and view the company as well positioned to capture a meaningful share of that increase given its advantaged cost position and inventory.

Supply chain/infrastructure beneficiaries

- **CAT.** Applying the same proportion of Electric Power sales as for Cummins implies $2.4 bn in revenue, or 3-4% of total company sales. If the end market growth outlook of 20% growth continues, the tailwind to CAT's growth profile in the medium term is nearly +1% per year.
- **ETN.** For ETN, Data Centers and Distributed IT is a $34bn addressable market with a 2023-2028 market CAGR of 10.8% (ETN had $3.3bn sales in 2023 in this market). ETN is starting to get longer visibility into Data Center customer plans with some customers already talking about 2026-2028 demand planning.
- **KMI.** In the energy infrastructure space, we see Kinder Morgan (KMI, Buy) as particularly well-positioned to benefit from the step-up in natural gas demand. We

see power needs for data centers driving ~3.3 bcf/d of incremental natural gas demand by 2030; this is roughly a ~10% increase in the amount of gas consumed in the power market vs. today, and represents a ~50% increase vs. our prior growth expectations for power demand for gas. KMI, as the largest transporter of gas in the US with considerable market share in key regions like Texas, should capture a considerable portion of this growth.

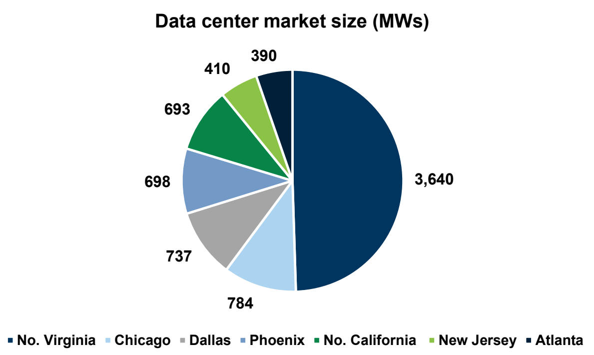
- **MYRG.** Through MYRG's T&D work and positioning as a leader in electrical contracting, we believe the stock offers unique exposure to data center growth. We see compelling growth opportunities for the company and are constructive on its direct exposure to key macro themes.
- **NVT.** NVT's Data Solutions business represents ~13% of total company sales (as of 2023) and management expects this business to grow +DD going forward (> $500mn in 2024). To capitalize on this opportunity, management has accelerated capacity investments to effectively double their liquid cooling capability.
- **PWR.** We believe large-cap PWR is a primary beneficiary of increased power demand and we see potential for positive estimate revisions given increasing load growth from data centers and subsequent need for grid modernization.
- **SRE.** SRE's regulated utilities in both California and Texas will have to increase grid spend to support data centers, but we expect the impact to be mostly at its Texas utility Oncor. SRE has significantly raised the capital plan at Oncor in recent years, and we believe there is further upside for incremental capex, particularly around transmission, as data centers continue to grow in its service territory.

Case study: How Dominion is handling power demand growth from data centers in Northern Virginia

Northern Virginia has been the data center capital in the US by a fairly significant margin. Northern Virginia currently has more data centers than the next five biggest markets in the US combined. The explosive growth of data centers in this region over the last decade or so was due to a number of factors including low cost of energy on a relative basis, and state tax incentives for data centers. Although these data centers are a positive for the local and state economy, they present a significant challenge and opportunity for the local utility Dominion Energy (D, Not Rated). These data centers are primarily located within Eastern Loudoun County, which is known as "data center alley", and having so many energy intensive buildings in one small area can create issues for the local utility.

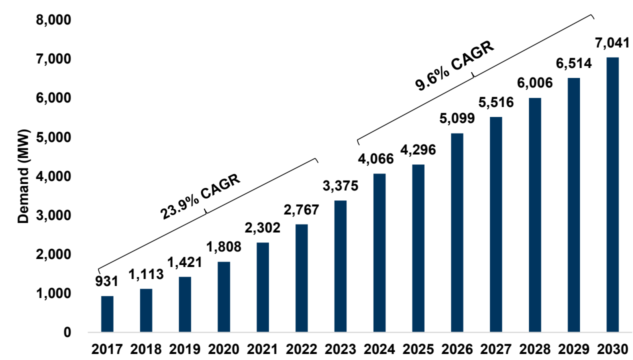
D presented PJM with a 15-year forecast for data centers in 2023, which highlighted the extreme growth that it has seen in data center alley over the last 7 years. The data center power demand in D's service territory grew at a nearly 24% CAGR from 2017-2023, and the forecast it presented implies just under a 10% CAGR going forward. The lower CAGR is largely due to the larger base, as the average MWs added each year are higher in 2024-2030 than is previous years. The rise of AI is expected to accelerate the growth of data centers, and some of D's latest forecasts have the power demand from data centers increasing by 109% by 2030. The company has stated that although the extra load from the data centers is great, commercial margins are relatively low, so the primary benefit for the utility is the supporting investment into the grid and/or into generation.

Exhibit 3: Northern Virginia is the largest data center market in the US by a large margin
MW demand by region



Source: JLL, Data compiled by Goldman Sachs Global Investment Research

Exhibit 4: Dominion's forecast of load from data centers indicates that the rapid growth it has seen will not slow down for the foreseeable future
Dominion 15-year data center forecast

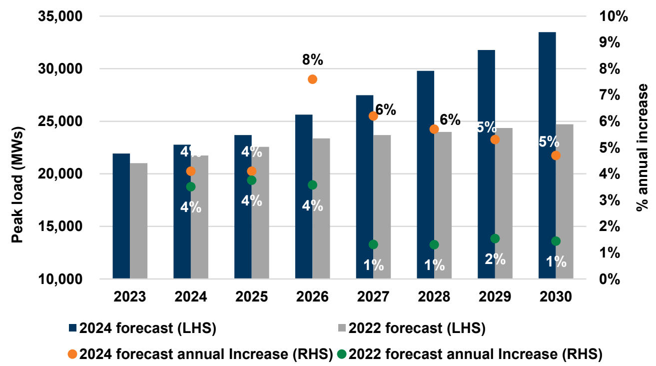


Source: PJM , Data compiled by Goldman Sachs Global Investment Research, Company data

In 2022, management stated that it had transmission constraints that could impact its ability to provide power to data centers in the coming years. Transmission projects can take years to permit and build, and thus D temporarily paused connections for new data centers to assess how to proceed. The company's concern was not that existing data centers would not receive power, but that if D does not proactively address the constraint it would have issues going forward. The issue only impacted Data Center Alley, and did not impact D's ability to service the remainder of its service territory.

The company determined that two 500-KV transmission lines should be sufficient to relieve the constraint and support the upcoming power demand, but getting two transmission projects done in short timeline is not a guarantee. D worked with the PJM Interconnection ("PJM", regional transmission organization that coordinates the movement of wholesale electricity in all or parts of 13 states and DC, including Virginia) to expedite the process for these transmission projects, and was successful in doing so. Management told investors on the 4Q2023 earnings call that one of these transmission projects was already under construction, and the other is in the regulatory process. They also stated that one of these projects should be enough to relieve the constraint, and the pause on accepting new data center connections had ended.

Exhibit 5: PJM's power demand forecast in the DOM Zone in Virginia implies significant peak power demand growth going forward
PJM DOM Zone load growth forecast

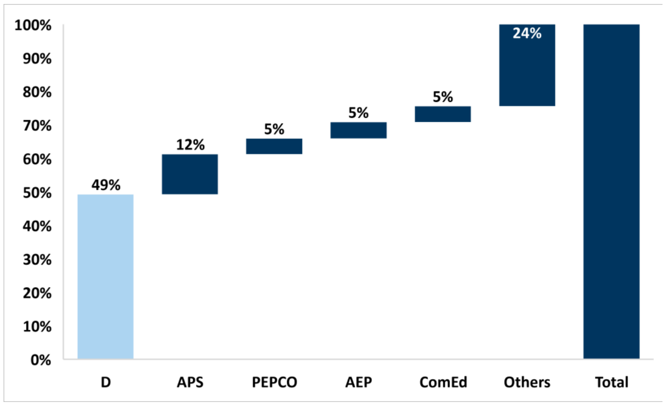


Source: PJM, Data compiled by Goldman Sachs Global Investment Research

To address long term needs, PJM opened a competitive auction for transmission projects in that region. Although D was able to reconcile the short term constraints that data center alley faced, neither the utility nor PJM want to rely on having to expedite transmission projects to ensure reliability. The end result was $5bn of transmission projects, split between several notable utilities but with D receiving the largest portion of the bunch, at ~$2.5 bn. PJM stated that the auction was necessary not only because of the 7.5 GWs of expected demand from data centers, but also because of the 11 GWs of generation retirements expected in that region. It also notes that the majority of the projects utilize existing right of ways, which should reduce cost and speed up the process. D highlights some of these projects in its 1Q2023 slide deck, with many being just some form of upgrade to the existing grid. This is expected to support system needs through 2028, and should provide a solid baseline for any necessary incremental grid spend for beyond that time period.

Transmission is one of the major bottlenecks for the clean energy transition, and the addition of data centers and AI could exacerbate this. Not all RTOs (regional transmission organizations, that oversee/coordinate movement of wholesale electricity across a certain area) will need the same level of investment as PJM, but we look to the transmission auction that it held as an example of the potential investment needed for the transmission grid. If we are to assume that the same cost of $5bn to support 7,500 MWs of demand in PJM applies to other RTOs, our base case data center estimate would imply that the grid would need $19bn of transmission capex through 2030 to support growth. Although this is a relatively small portion of industry transmission spend, this spend will likely be concentrated in specific regions and therefore could be impactful for the local utility. This does not include the potential incremental distribution and generation spend that could be necessary, which again could provide meaningful upside to utility growth over the long term.

Exhibit 6: D won a significant portion of PJM's $5bn transmission auction
% split of transmission projects by spend



Source: PJM, Data compiled by Goldman Sachs Global Investment Research

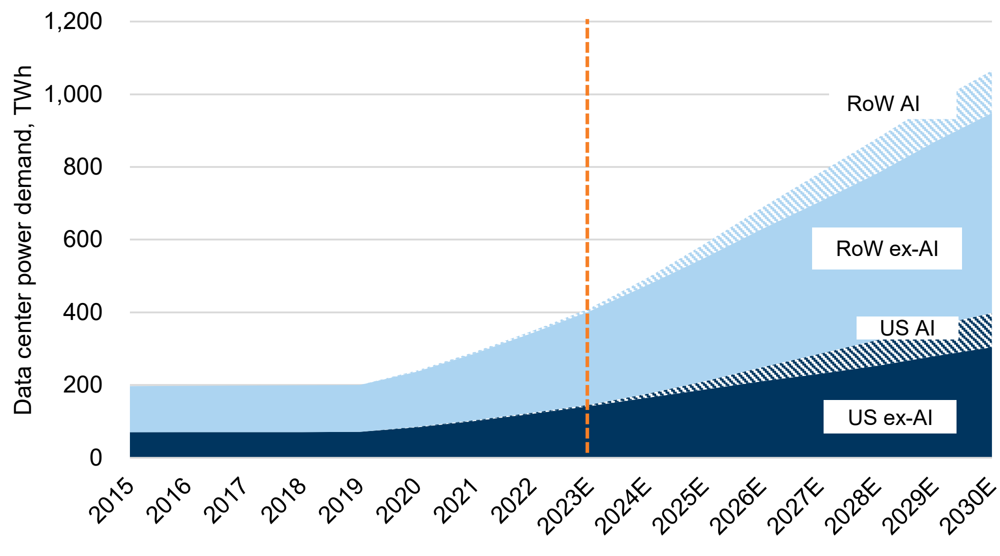
The rapid growth of data centers could pose similar issues for other utilities across the US without proactive investment. The US power grid is built to maintain some level of reserve supply in the event of increased demand, but data centers are unusually power intensive and clusters of these in one region can surpass the reserves available. We believe that looking how D handled the situation provides useful context for the potential implications of this trend, and the end result gives us confidence that utilities, regulators, and RTOs can collaborate to overcome near term challenges. Northern Virginia remains a unique region due to the incentives that attract data centers, but we believe other RTOs could require similar transmission auctions to support growth, which could provide further upside to utility growth going forward.

Data center power demand and the AI catalyst

GS SUSTAIN

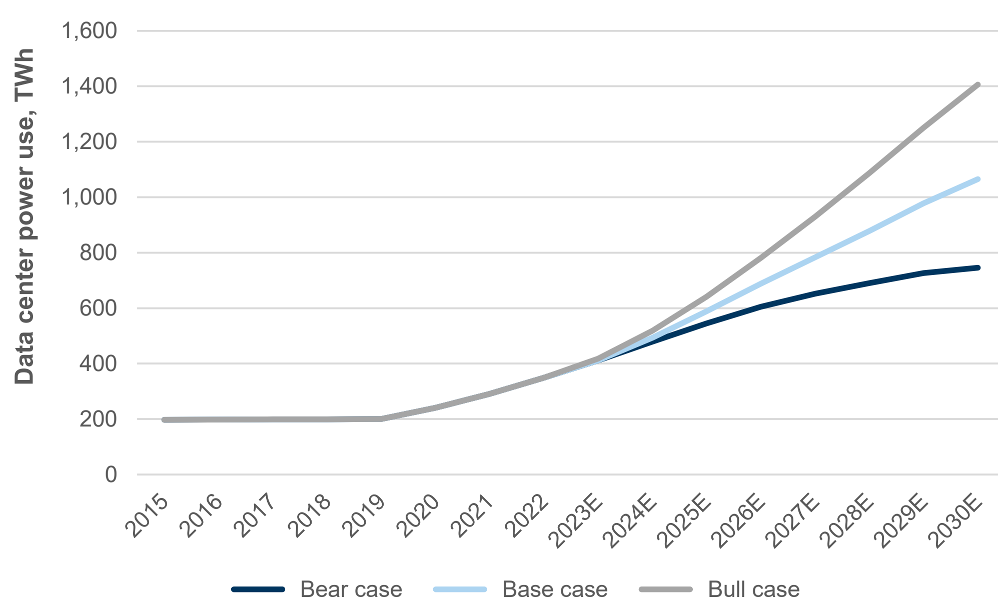
The combination of AI, ex-AI increases in data demand and a material slowdown in power efficiency gains is making data centers a critical driver of accelerating global and US electricity demand growth. We assume data center power demand excluding cryptocurrency will grow by 160% in 2030 vs. 2023 levels (bear/bull range of 80%-240% growth), representing an increase of about 650 TWh by 2030 in our base case (330/1,000 TWh in our bear/bull cases). Data centers alone will contribute a 0.9% CAGR to overall US power demand and a 0.3% CAGR to overall global power demand, in our base case, with a bull case contribution of 1.3%/0.5%. Our base case implies data center power demand moves from 1%-2% of overall global power demand to 3%-4% by 2030. The increase in the US is even greater — from 3% to 8%. Our estimates for overall data center power demand are above IEA forecasts (2026), and our outlook for AI to represent about 19% of data center power demand in 2028 is above recent corporate forecast.

Exhibit 7: After being flat for 2015-19, we have seen data center power demand accelerate in 2021-23 and expect a 160% increase through the rest of the decade
Global data center electricity consumption, TWh; includes AI and excludes cryptocurrency



Source: Masanet et al. (2020), Cisco, IEA, Goldman Sachs Global Investment Research

Exhibit 8: We see 2030 power use from data centers 1.8x-3.4x 2023 levels in our bear/bull case
Electricity demand from data centers in TWh, base case, bear case and bull case



Source: Masanet et. al (2020), Cisco, IEA, Goldman Sachs Global Investment Research

Data demand has been growing, but until recently power demand from data centers was flattish. Between 2015 and 2019, data center workload demand nearly tripled while data center power demand was relatively flat. There were two main drivers of this:

1. Power consumption efficiency gains (i.e., pace of lower power intensity) within

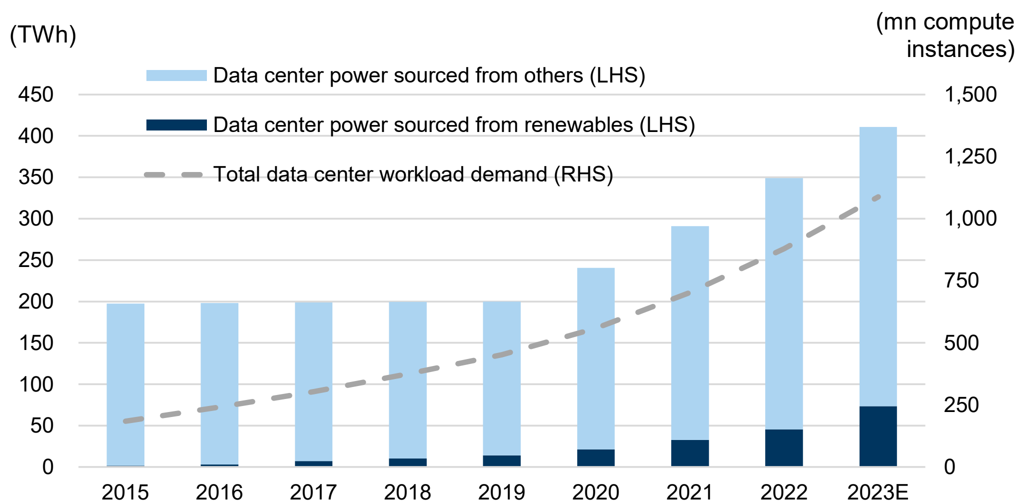
cloud and hyperscale data centers. Annual efficiency gains averaged about 15%.

2. Mix shift towards cloud and hyperscale data centers which have materially lower power consumption intensity than traditional data centers. By 2020 more than 90% of data center workload demand was at cloud/hyperscale centers.

We estimate in 2020 data center power demand was about 240 TWh, based on data from the IEA, Cisco and academic sources.

Exhibit 9: Data center workload demand nearly tripled between 2015-2019 but electricity consumption from data centers was flat

Data center workload demand (RHS) in million compute instances; data center power demand (LHS) in TWh

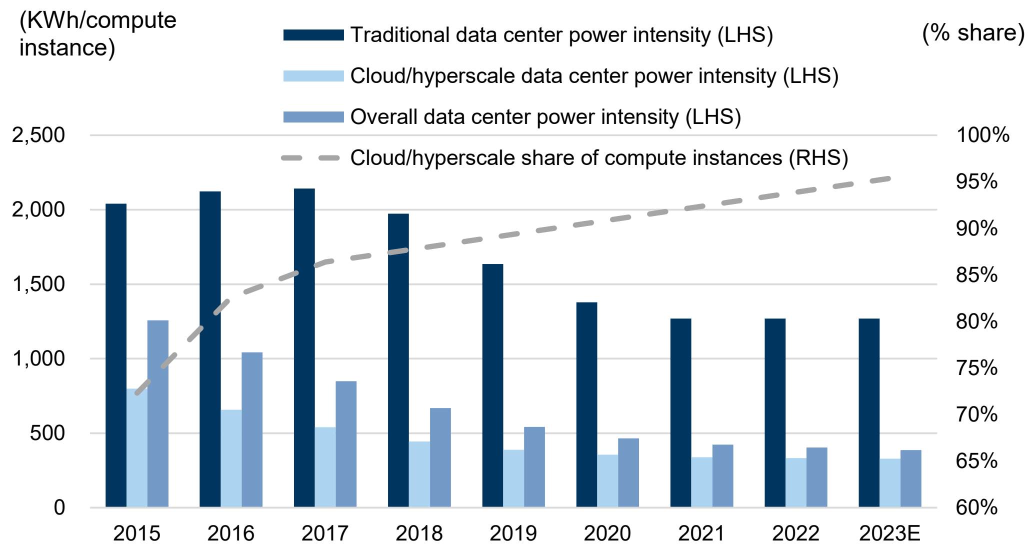


Source: Masanet et al. (2020), Cisco, IEA, Goldman Sachs Global Investment Research

However, in the last three years, power consumption from data centers has been on the rise. With much of the mix shift already done, the gains from the shift to cloud/hyperscale have narrowed. Additionally, we have seen efficiency gains appear to wane within cloud/hyperscale data centers (reported data to calculate efficiencies is not consistently available annually and as such for some historical years are estimated or implied). The IEA estimates 2022 data center power consumption was about 350 TWh, excluding contribution from cryptocurrency; all else equal this implies cloud/hyperscale annual efficiency gains decelerated to about 1%-2% in 2020-22.

Exhibit 10: Data center efficiency gains and the shift to cloud/hyperscale have been critical drivers of the moderate increase in data center power demand, but decelerating efficiency gains have helped to drive a pickup in power demand from data centers in recent years

Data center power intensity (LHS) in KWh per compute instance; share of cloud/hyperscale data centers (RHS) as % of workload



Source: Masanet et al. (2020), Cisco, IEA, Goldman Sachs Global Investment Research

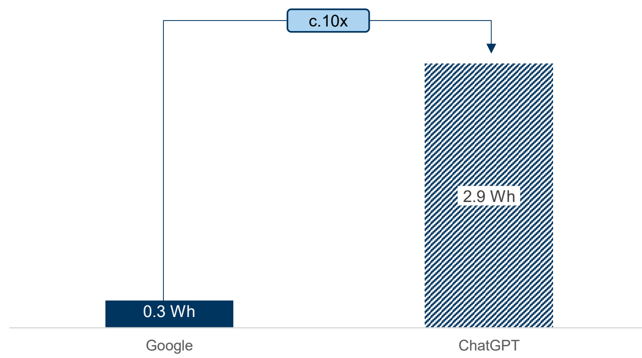
Three key assumptions will help drive data center power demand forecast.

- Data consumption outlook — both AI and non-AI
- Power efficiency gains
- Potential infrastructure constraints

AI to accelerate power demand growth

We assume power demand from AI rises about 200 TWh in 2024-30 (bear/bull case of 110-330 TWh), with AI representing about 20% of overall data center power demand by 2030 in our base case. We see a wide range in our bear/bull scenario driven by uncertainty over demand and power efficiency. As demand for AI training grows in the medium term and for inference longer term, we see demand growth well exceeding the efficiency improvements that are leading to meaningful reductions in high power AI server power intensity. We note that a ChatGPT search consumes around 6x-10x the power as a traditional Google search (see Exhibit 11).

Exhibit 11: ChatGPT queries are 6x-10x as power intensive as traditional Google searches
Power consumption per query/search (Wh)

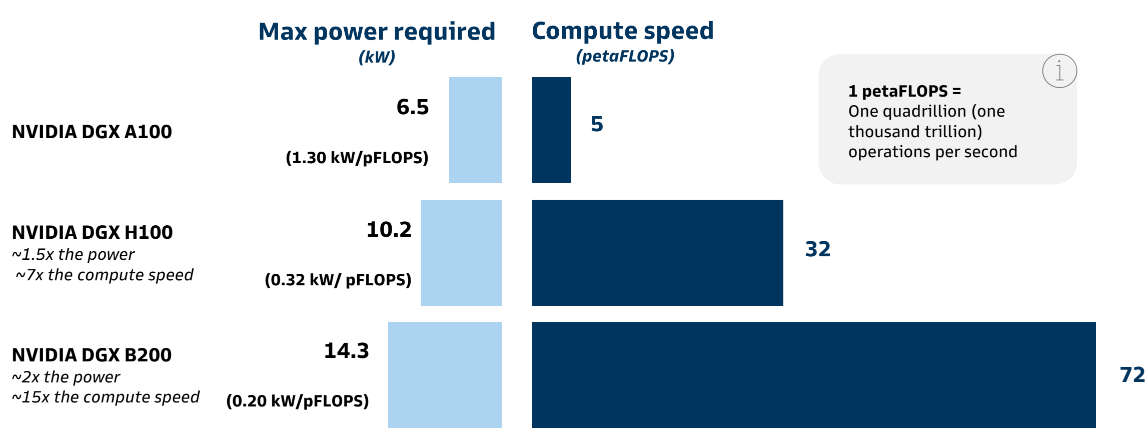


Source: Google, SemiAnalysis

We have seen new AI innovations increase computing speed and max power consumption per server, representing meaningful reduction in power intensity. As demand for GPUs grows, there is still notable company-projected intensity reductions. As an example of how innovations have reduced power intensity per server but increased overall power per server:

- The NVIDIA DGX A100 system is listed to net 5 petaFLOPS and consuming 6.5 kW max, or 1.30 kW per pFLOPS.
- The more recent NVIDIA DGX H100 system is listed at 32 petaFLOPS and consuming 10.2 kW max, or 0.32 kW per pFLOPS.
- The new generation NVIDIA DGX B200 system using the new Blackwell chips is listed to net 72 petaFLOPS (training) and consuming 14.3 kW max, or 0.20 kW per pFLOPS.

Exhibit 12: We have seen new AI innovations increase max power consumption per server but increase computing speed per server by an even greater level, representing meaningful reduction in power intensity
Recent evolution of NVIDIA server system specifications are indicative of increasing max power per server but with lower power intensity relative to computing speed (for training)



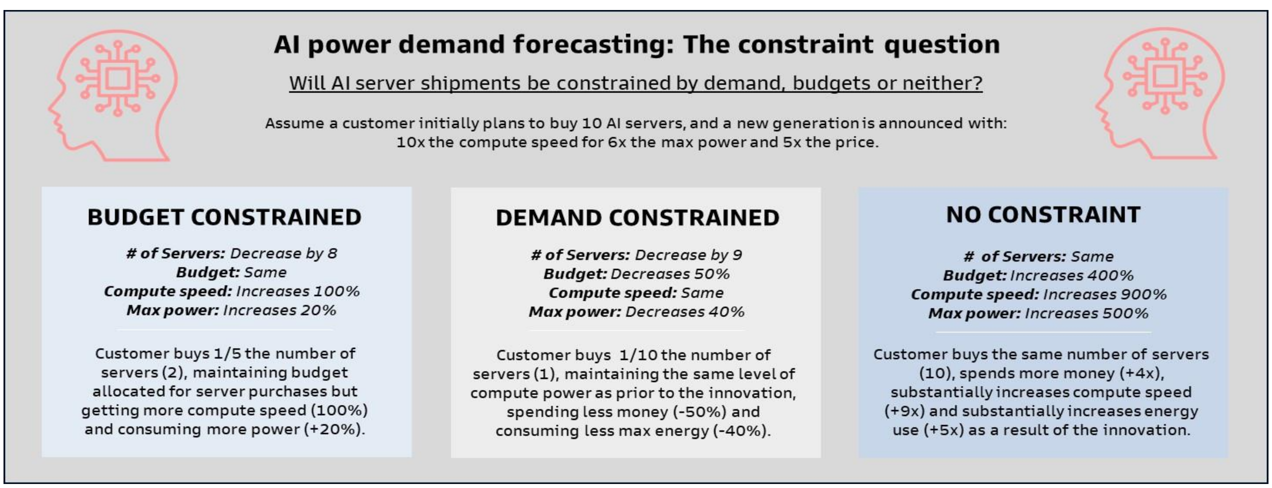
Source: NVIDIA, Goldman Sachs Global Investment Research

Our global TMT team expects AI server units shipped to grow at a 76% CAGR in

2024-26, representing a 50% CAGR in server revenues; whether demand, budgets or neither is the constraint to growth is critical for energy use forecasting. A key question impacting compute demand is whether that demand is pent-up (i.e., available new servers will be bought regardless of budget), not pent-up and constrained by demand itself, or constrained by customer budgets. In other words, will customers buy equal amounts of the more powerful servers as they would the less powerful ones? If in a scenario in which a customer initially desires to buy 10 AI servers, and a new generation is announced with 10x the compute speed for 5x the price, will the customer:

1. Buy the same number of servers (10), spend more money (5x) and substantially increase its compute speed as a result of the innovation (10x)? This would represent no constraints (i.e., unlimited budgets, so demand dictated by available supply).
2. Buy 1/10 the number of servers (1), maintaining the same level of compute power as prior to the innovation and spending less money (0.5x)? This would represent demand as the constraint.
3. Buy 1/5 the number of servers (2), thereby maintaining budget allocated for server purchases but getting a greater compute speed (2x)? This would represent budget as the constraint.

Exhibit 13: Extent of pent-up demand for AI server supply and voraciousness of technology capex budgets will be critical for pace of AI power consumption
Indicative scenario analysis of how demand vs. budget constraints could impact AI compute speed and power use



Assumes power generation, transmission and interconnection are not constraints for indicative purposes

Source: Goldman Sachs Global Investment Research

Confidence in the above question is key to whether forecasting methodology should be weighted towards server-based (requiring nuance given varied and dynamic power consumption intensity and compute intensity) vs. demand based (forecasting compute power and power intensity per unit of compute power).

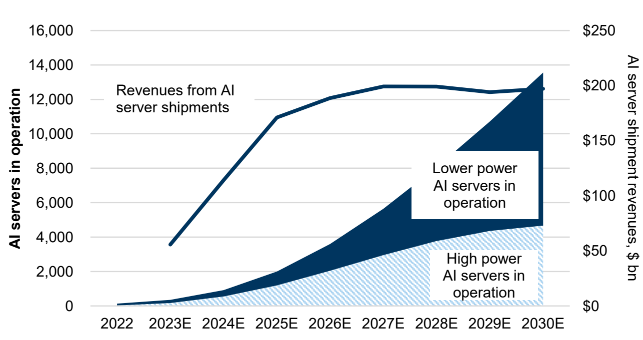
We have applied both a server supply driven forecast and a compute speed demand driven forecast, with a heavier weight applied towards the supply-driven methodology.

- On the **server supply-driven side**, we apply our global Technology team's forecast for server shipments per year mentioned above, divided among high energy vs. low energy servers. We assume server replacement every 5 years. Our TMT team sees a sharp increase in high power servers (greater electricity consumption per server, higher ASP) increasing sharply in the next few years to meet demand for AI training, while the team sees greater weighting of growth from lower power servers (lower electricity consumption per server, lower ASP) towards the back of the decade as AI demand weighting shifts more towards inference. We assume 5%-8% annual power efficiency gains per year to reflect expected future server innovation — relative to demand-based energy intensities where saw higher annual efficiencies early in life cycle, we assume slower pace in a supply-based approach to reflect timing of adoption. The result is falling power intensity per computing speed and sharp increases in overall power demand due to the growth in new servers with higher weighting within higher power servers towards the newer generation that as mentioned have lower power intensity but higher power consumption per server.
- On the **demand-driven side**, we use our China Media, Internet & Telecom team's AI compute power forecast to drive global AI compute demand outlook. We assume power efficiency gains of 8%-15% annually in our base case through the end of the decade — this reflects similar efficiency gains as seen ex-AI in 2015-20.

Together, this implies sharp increase in electricity use from AI, even as revenues from servers shipped are implied flattish in 2027-30. Our global TMT team's server shipment and ASP forecasts imply flattish revenues in 2027-30, driven by greater weighting towards lower power we see a greater mix shift towards lower cost lower power servers within the mix, in addition to expectations for ASP declines. However, with the mix shift and ASP reductions offset by increased volumes — and with the overall number of servers in operation continuing to grow, we see sharp demand growth from AI for electricity even despite expected efficiencies, owing to a combination of maturity and expected overlap with demand via AI. Based on the framework and assumptions described above, we see AI power demand moving up by around 200 TWh in 2030 vs. 2023.

Exhibit 14: AI servers in operation expected to grow sharply through 2030 even as revenues from AI server shipments flattens in 2027-30

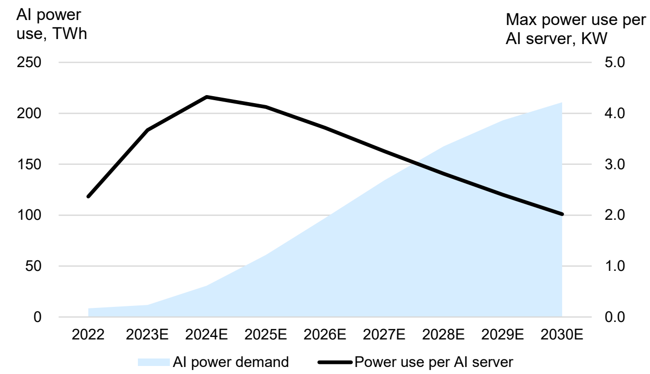
AI servers in operation and implied revenues from our global TMT team forecasts



Source: Goldman Sachs Global Investment Research

Exhibit 15: We see AI power demand growing rapidly even as power use per AI server falls later in the decade due to mix shift and expected efficiencies

AI power use, TWh (LHS); max power use per AI server, KW (RHS)



Source: Goldman Sachs Global Investment Research

Data center power demand ex-AI

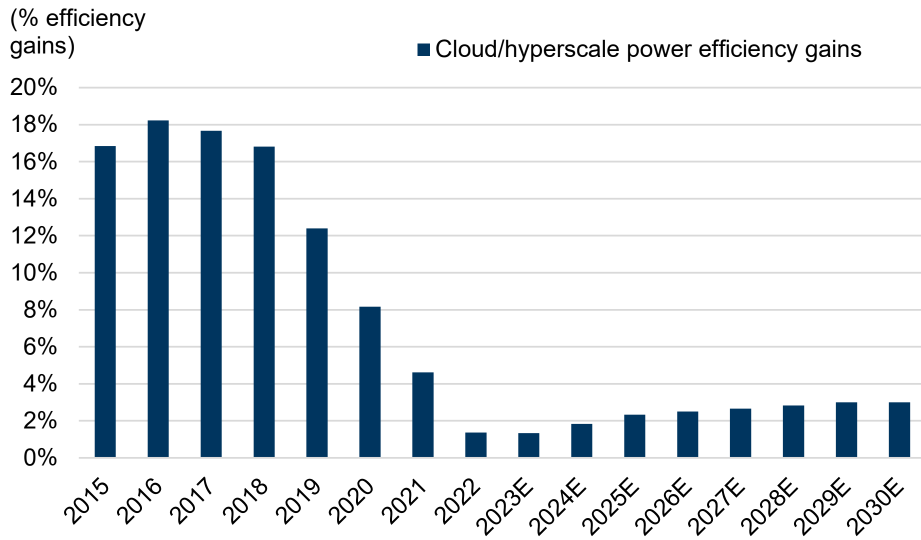
We expect continued strong growth in workload unrelated to AI. We assume double digit growth in workload compute instances with deceleration from the 20%-25% of compute instances growth seen since 2017 down to 12%-18% annual growth in 2026-30, owing to combination of maturity and expected overlap with demand via AI. A key question on ex-AI demand is whether AI modeling and user demand for AI will partially replace users' need for searches or other workload. We are broadly assuming minimal replacement — i.e., AI is largely incremental to the broader trend of data center workload demand.

Power intensity efficiency gains among cloud/hyperscale data centers have decelerated; we assume modest re-acceleration in our base case. We assume power efficiency gains — which as mentioned averaged around 15% annually in 2015-19 but decelerated to around low single digits in 2020-22 — will remain relatively low. However, we assume a slight re-acceleration to an average of 3% in our base case in 2024-30, as industry discussions suggest continued efforts towards innovation efficiencies, especially around the power intensity given the prospects for significant power needs ahead.

The implications of the efficiency gains assumption leads to a wide range between our bear and bull cases for ex-AI data center demand growth. Based on the above framework and assumptions, we see about 450 TWh of ex-AI power demand growth in 2030 vs 2023 in our base case vs. 225/650 TWh in our bear/bull cases. As we have highlighted earlier, we believe the efficiency assumption is a critical driver of power demand outlook ex-AI — our bear/bull cases assume 7%/0% annual intensity reductions on average in 2024-30.

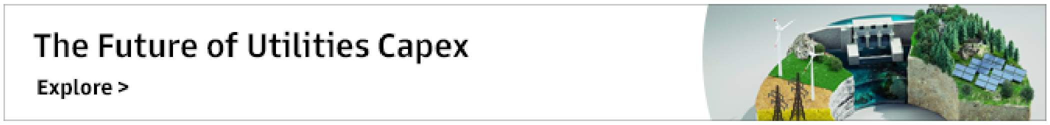
Exhibit 16: We expect power efficiency gains at cloud/hyperscale data centers to continue, but remain at a lower pace going forward relative to 2015-20

3-year rolling average % change in cloud/hyperscale KWh per compute instance



Source: Masanet et al. (2020), Cisco, IEA, Goldman Sachs Global Investment Research

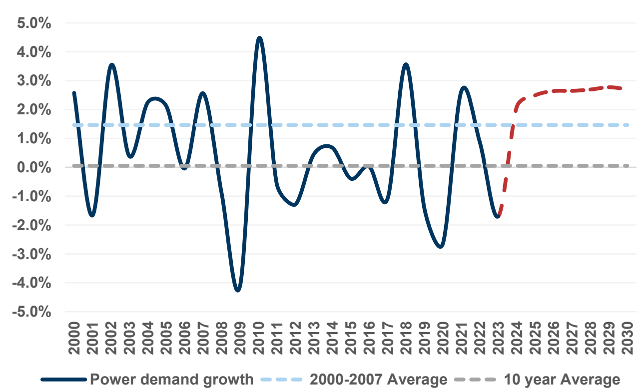
US power demand growth expanding to levels not seen in decades



Over the last ten years, power demand growth in the US has averaged ~0%. Despite economic and population growth over that time period, efficiencies have offset this, with advances like the penetration of LED lighting driving lower power usage. As mentioned above, power consumption efficiency of data centers and the mix shift to cloud and hyperscale data centers from traditional data centers have also contributed to these efficiencies. With that said, we expect power demand to accelerate to levels not seen in the US in many years.

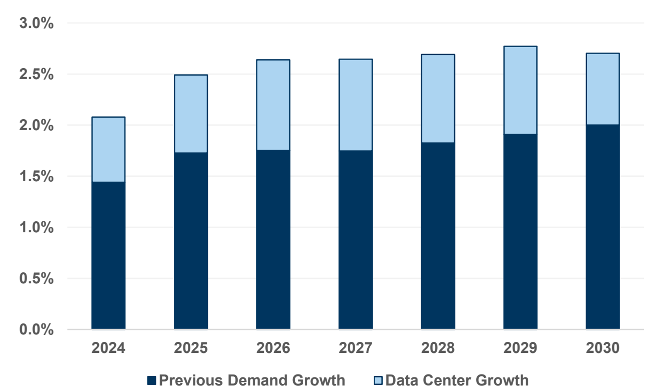
With this note, we raise our US power demand forecast to 5,036 TWh by 2030, which represents a 2.4% CAGR from 2022-2030. This compares to our prior estimates of 4,733 TWh demand by 2030 and a 1.7% CAGR from 2022-2030. The driver of this change is embedding explicit assumptions around data center and AI growth. We continue to forecast residential, commercial ex-data center, and industrial demand using historical relationships to macroeconomic factors, and embed a separate forecast for electric vehicles based on our colleagues' EV outlook.

Exhibit 17: US power demand growth has averaged 0% in the last 10 years, relative to early 2000s growth of ~1.5% on average, and our forecast for over 2% growth on average through 2030
US power demand growth, %



Source: EIA, Goldman Sachs Global Investment Research

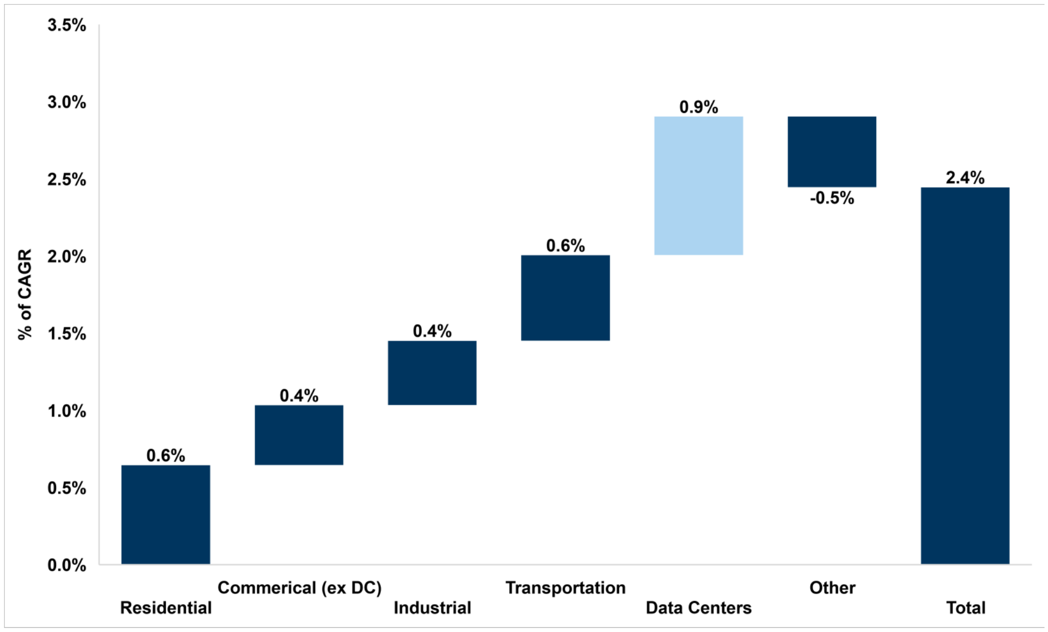
Exhibit 18: Data center/AI growth adds about 80 bps on average to our annual power demand growth rates from 2024-2030
US power demand growth, %



Source: Goldman Sachs Global Investment Research

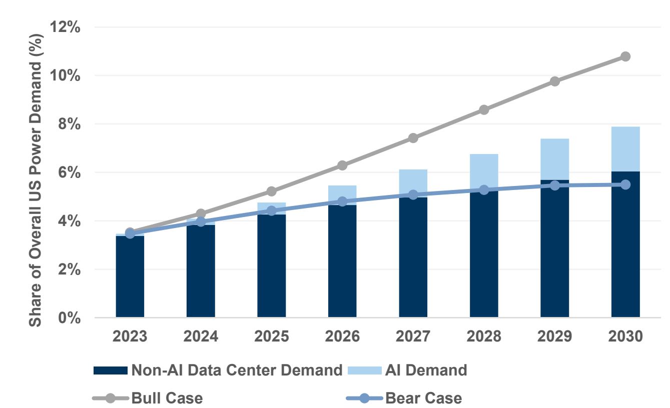
On our updated estimates, we expect data centers to contribute 8% to overall US power demand by 2030 in our base case, from current levels estimated at ~3%. This translates to a 16% CAGR for data centers in our base case from 2023-2030, and contributes about 90 bps to our overall power demand CAGR over the same time frame. We believe this will drive a need for incremental generation capacity to be built in the US, which we believe in part has been signaled by sizable IRP filings in recent years from several companies that have increased load growth forecasts/generation needs, as well as RTOs that have revised load growth assumptions higher.

Exhibit 19: Data centers contribute 90 bps to our 2.4% power demand CAGR over 2022-2030
Power demand CAGR composition, %



Source: EIA, Goldman Sachs Global Investment Research

Exhibit 20: We expect data centers to comprise ~8% of US power demand by 2030 in our base case, with potential for 11% in our bull case and 5% in our bear case
Data center demand as a share of total US power demand, %



Source: IEA, Goldman Sachs Global Investment Research, EIA

Exhibit 21: Several utilities in our coverage have filed meaningful resource plans on the back on increasing load growth
Integrated Resource Plan by utility

Resource Plans		
Company	**Plan name**	**Details**
DUK	NC & SC Resource Plan	8.9 GWs of natural gas, 6.5 GWs of solar, 2.7 GWs of storage, 1.2 GWs of wind
SO	Georgia Power IRP	Up to 10 GWs of renewables
XEL	Colorado Resource Plan - Alternative Portfolio	1.8 GWs of storage, 1.7 GWs of wind, 1.6 GWs of solar, ~700 MWs of natural gas
D	DESC IRP	5 GWs of solar and 1.6 GWs of battery storage
D	DEV IRP	10.8 GWs of solar, 5.9 GWs of natural gas, 3 GWs of wind, and 1 GW of storage
AEP	Various IRPs	8 GWs of wind, 6 GWs of solar, 5 GWs of natural gas, and 1 GW of storage
AEE	Missouri IRP	By 2030: 2.8 GWs of renewables, 800 MWs of natural gas, 400 MWs of storage

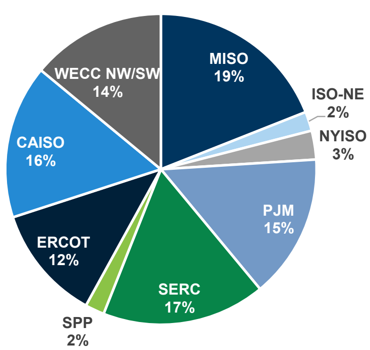
Source: Data compiled by Goldman Sachs Global Investment Research

In order to size the generation capacity potential, we have considered expected regional allocation of data centers, current and future states of reserve margins in different regions across the US according to NERC, and assumptions around natural gas vs. renewables and peakers vs. combined cycle gas plants based on recent IRP filings.

In order to support data center/AI driven load growth, we assume capacity is met with 60% gas (40% CCGT/20% peaking units) and 40% renewables (25% solar, 15% wind). This adds 47 GW of capacity cumulatively from 2024-2030, including 28 GW of gas and 19 GW of renewables. This embeds ~9 GW of combined cycle and ~19 GW of peakers, in addition to ~13 GW of solar and ~6 GW of wind. This points to average annual capacity additions through 2030 of ~1.3 GW for CCGT, ~2.7 GW for gas peaking units, 0.9 GW for wind, and ~1.9 GW for solar. Overall, our power supply/demand model now embeds ~45 GW annual net capacity additions on average through 2030, including non-data center driven adds.

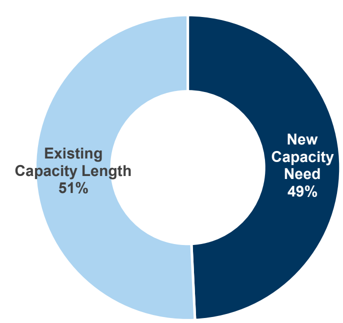
While we do not explicitly assume any nuclear capacity is added through the extent of our model (through 2030), we believe (1) we will see fewer nuclear plant closures going forward, which could present upside risk to nuclear generation as more plants receive license extensions, as well as uranium demand, (2) nuclear is an attractive generation source for data centers given it is zero carbon and reliable, but we view IPPs with nuclear capacity as best positioned to benefit versus regulated utilities, and (3) small modular reactors (SMRs) could have a more impactful role in the future, but we view that as beyond the life of our current model.

Exhibit 22: We assume the greatest share of data centers are built out in MISO, followed by SERC, CAISO, and PJM
Regional allocation of data center driven load



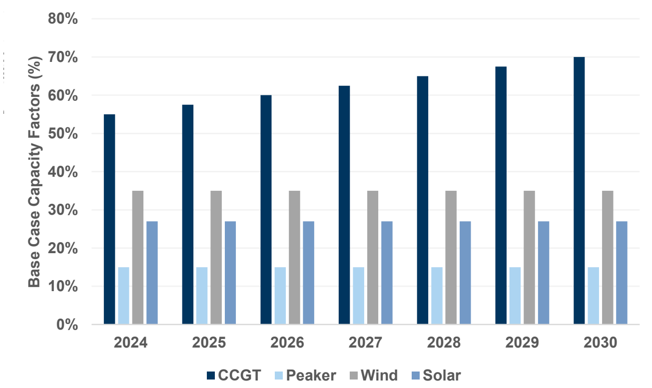
Source: BCG, Data compiled by Goldman Sachs Global Investment Research

Exhibit 23: Based on NERC forecasts for reserve margins across regions, we assume just under half of data center driven demand will need to be met with new generation capacity cumulatively through 2030
How to meet data center driven power demand, %



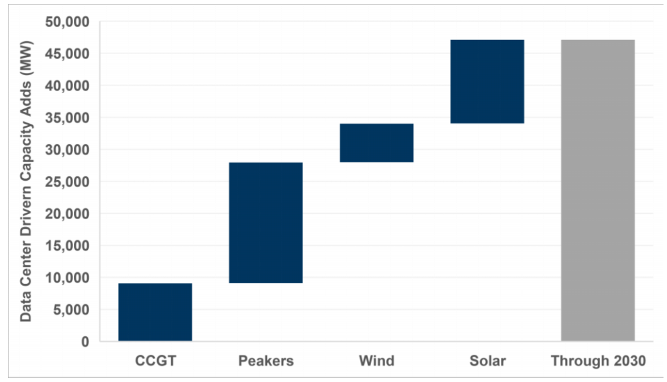
Source: Goldman Sachs Global Investment Research

Exhibit 24: We assume an average capacity factor of 63% on CCGT units, 15% on peakers, 35% on onshore wind, and 27% on utility scale solar to inform our capacity addition forecasts
Base case capacity factors, %



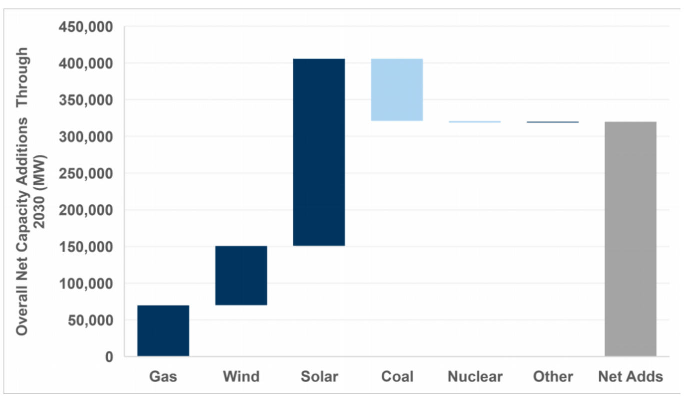
Source: Goldman Sachs Global Investment Research

Exhibit 25: We see about 47 GW of incremental capacity adds to serve data center driven load through 2030
Data center driven capacity adds, MW



Source: Goldman Sachs Global Investment Research

Exhibit 26: Capacity additions to support data centers on our numbers represent about 15% of our overall net capacity additions in the US through 2030
Overall net capacity additions through 2030 by source, MW

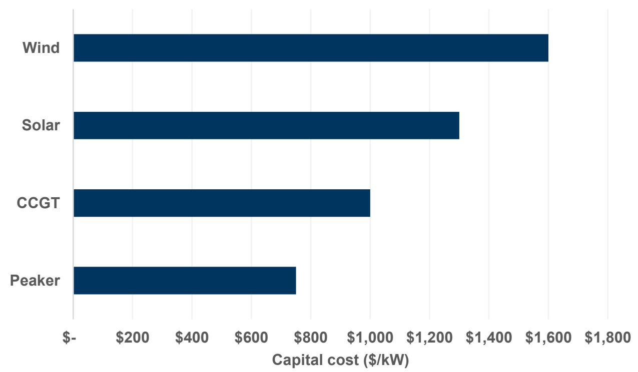


Source: Goldman Sachs Global Investment Research

Consistent with our LCOE model, we assume capital costs to build this generation capacity is $1,000/kW for CCGTs, $750/kW for gas peakers, $1,600/kW for onshore wind, and $1,300/kW for utility scale solar. This drives incremental capital investments of ~$50 bn cumulatively through 2030, or $7 bn on average per year to support data center growth. Combining data center related power generation capacity needs with our baseline capacity addition forecasts to support load growth in other areas as well as offset retirements of coal units drives total generation capex of $665 bn cumulatively through 2030, or ~$95 bn on average annually through 2030.

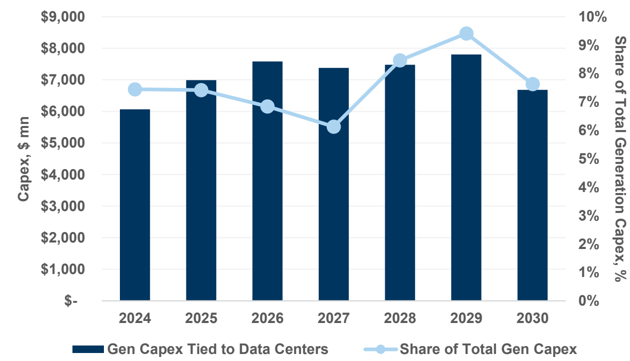
While we recognize that $50 bn industry wide spend through 2030 could be digestible, we believe spend will be regionally concentrated, particularly in MISO, which could be more meaningful for companies exposed to MISO. We also believe this is just one piece of the overall utilities capex opportunity pie. We see investment needed for further generation capex to support the energy transition, load growth outside of data centers, as well as needs to support grid reliability. We also note that assumptions around capacity mix/factor and share of demand that requires new capacity are key drivers of our capex forecast.

Exhibit 27: We see capital costs for different generation sources ranging from $750-$1600/kW, which informs our capex forecast for generation
Capital cost for different generation sources, $/kW



Source: EIA, Goldman Sachs Global Investment Research

Exhibit 28: We expect to see ~$50 bn of incremental capital investment in generation to support data centers through 2030, or about 8% of total generation capex
Capital investment in generation to support data center growth, $ mn/share of total generation spend, %



Source: Goldman Sachs Global Investment Research

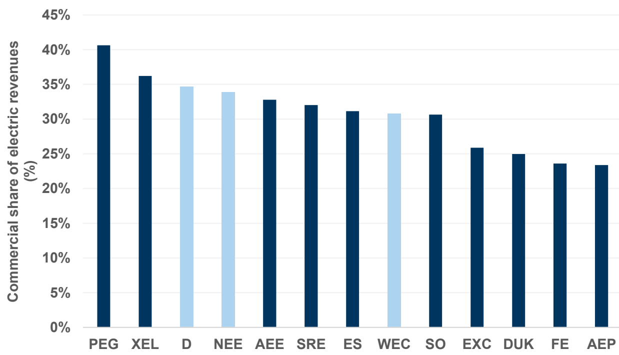
Exhibit 29: We outline three scenarios around US power demand/capacity adds/capex based on our SUSTAIN team's data center model
Data center/AI scenarios and key metrics

Data Center/AI Scenarios	Base Case	Bull Case	Bear Case
2024-30 Capacity Adds (MWs)	47,126	57,138	22,944
2024-30 Generation Capex ($ mn)	$49,979	$64,612	$24,326
2030 Data Center Demand (GWh)	397,979	533,026	276,251
2030 DC Share of Demand (%)	8%	11%	5%
2023-2030 DC Demand CAGR (%)	15%	20%	9%

Source: Goldman Sachs Global Investment Research

We have not seen significant stock price movement for regulated utilities on this theme, despite the fact that we have seen strong stock price performance for select independent power producers (IPPs) that are expected to benefit from increased demand for power and potentially higher power prices going forward. **We believe there are two potential avenues for regulated utilities to benefit from this data center driven load growth** (recognizing this is not the only driver of load growth). First, is the **volumetric benefits** from higher commercial load growth for companies that operate in regions tied to data center growth that are not decoupled. We recognize this is likely muted given the lower margin nature of commercial sales. Second, is **higher rate base growth via the increased capital investment** required to facilitate this growth. This could come in the form of generation capex, which we quantify for US demand tied to data centers above, or grid investment to support transmission/reliability needs.

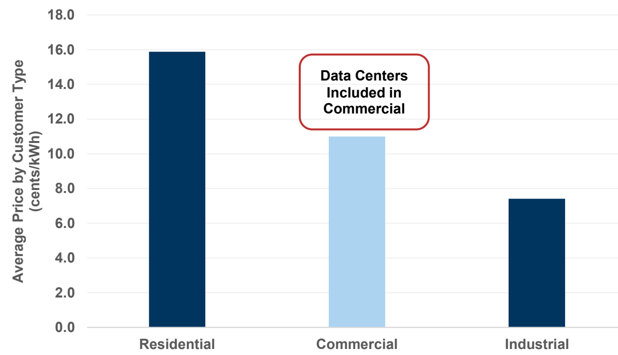
Exhibit 30: Within our coverage, D/NEE/WEC have higher than average commercial volumes and have no exposure to decoupling
Commercial share of electric revenue (%)



We exclude covered companies that are fully decoupled (CA, NY), and highlight those that have no exposures at subsidiaries to full or partial decoupling mechanisms

Source: S&P Global Market Intelligence, Goldman Sachs Global Investment Research

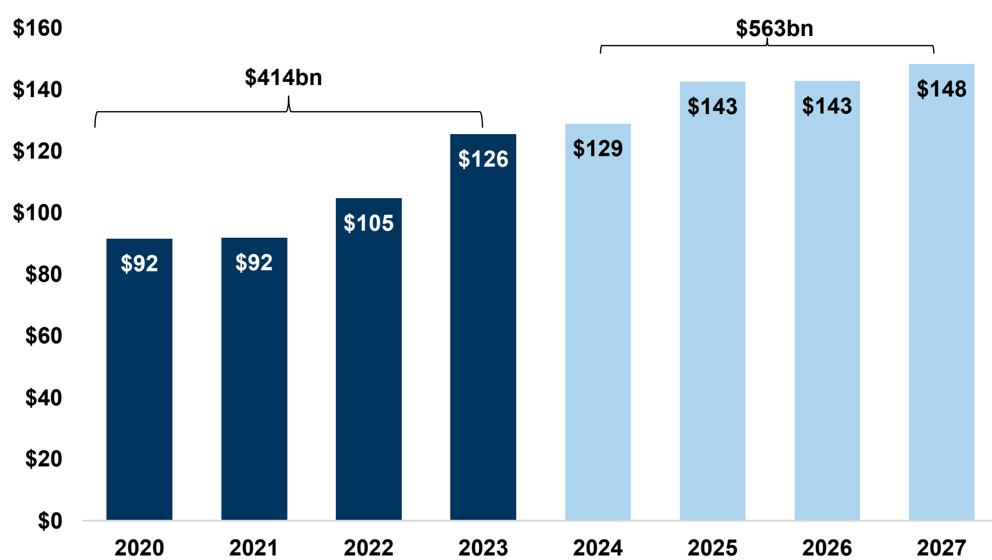
Exhibit 31: Across customer classes, residential sales are generally highest margin, followed by commercial and industrial
Average price by customer type (cents/kWh)



Source: S&P Global Market Intelligence, Goldman Sachs Global Investment Research

As mentioned above, in addition to incremental power generation needs to support data center/AI driven load growth, we also expect this load growth to support investment in grid reliability, in particular for transmission. While there is certainly existing capacity that can be utilized or enhanced, we continue to believe transmission is an area where incremental investment is needed. As we have written in our Future of Utilities Capex series, we expect to see a significant step up in capital investment across our coverage going forward (+36% cumulatively from 2024-2027 vs. prior 4 year period), supporting ~7% earnings growth across our coverage.

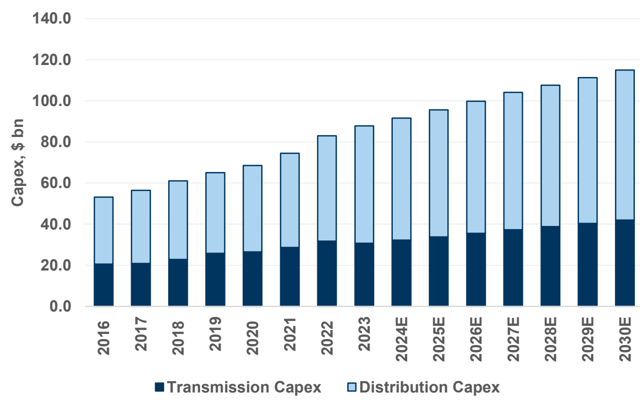
Exhibit 32: We forecast 2024-2027 capex across our coverage to increase ~36% versus than the previous four year period
Capex by year, $ bn



Source: Company data, Goldman Sachs Global Investment Research, SNL

On grid spending specifically, we introduce an industry spend estimate of ~$720 bn cumulatively through 2030, including ~$260 bn on transmission and ~$465 bn on distribution. The historical baseline is driven by EEI industry capex estimates, and the forecast is based on the growth in grid spend we expect for our coverage. We assume transmission grows at a slight premium to the average, offsetting areas of spend decline (e.g. regulatory compliance/other), and that distribution grows more in line with the average. This points to average annual spend through 2030 of ~$66 bn on distribution and ~$37 bn on transmission. Including the generation spend noted above, the total capital investment across transmission, distribution, and generation is up ~38% across 2024-2027 relative to the prior four year period, broadly in line with the step up in our coverage capex outlined above.

Exhibit 33: We see $720 bn of grid spend across the industry required through 2030, based on the capex growth outlook for our coverage
Grid capex, $ bn



Source: EEI, Goldman Sachs Global Investment Research

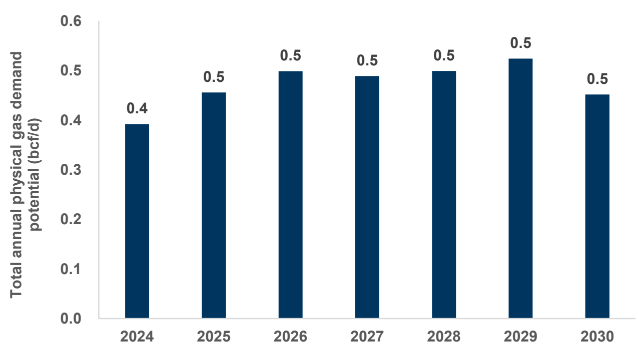
Capacity Additions - Gas Demand Growth from Data Centers

We see incremental data center power demand driving ~3.3 bcf/d of new natural gas demand by 2030 - creating strong infrastructure development opportunities for Kinder Morgan (KMI, Buy) and Williams (WMB, Neutral), among others. This estimate assumes gas provides ~60% of the ~28.7 GW of total data center power demand expected through the rest of the decade, and implies roughly a ~10% increase in the amount of gas consumed in the power market vs. today. More notably, this represents a ~50% increase vs. our prior growth expectations for power demand for gas - and adds to the broader constructive backdrop for gas demand growth alongside new LNG export capacity, coal plant retirements, and renewables backstopping.

We expect this growth to be relatively ratable (~0.47 bcf/d on average) through the decade, though this can swing based on price, regional build-out, and infrastructure delays (we discuss these below). While natural gas currently serves 40% of power demand, and we expect that overall share to hold relatively firm through the rest of the decade, we assume a higher share (60% as mentioned above) serving data center demand growth specifically given gas's relatively low cost and high reliability. For this estimate, we assume ~40% of this demand is met through CCGTs with heat rates of 7,000 kWh/btu and ~20% of this demand is met through peakers with heat rates of 10,000 kWh/btu - a swing more towards the former could reduce incremental gas demand all else equal. On timing, we would expect the existing fleet to pull more gas in nearer years and then new plants - via new pipelines (see below) - would serve new demand in later years. .

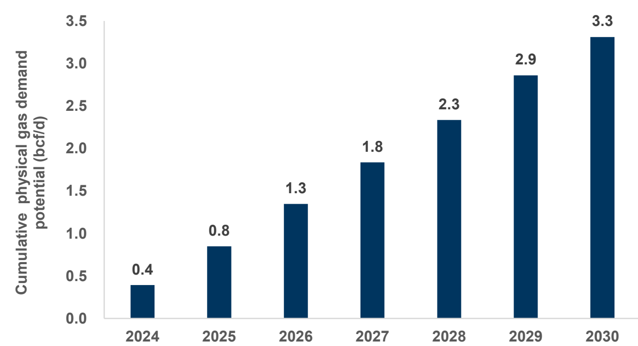
For context, the US gas market for power sits at roughly ~35 bcf/d and makes up roughly a third of the total gas market of ~100 bcf/d - making this a notable, but not yet revolutionary, change in the outlook. Looking forward, we expect natural gas for power demand to grow ~3% annually, of which, data centers make up a meaningful portion of that growth (~40%). Versus the market size today, our estimate of an incremental ~3.3 bcf/d of gas demand growth from data centers represents a ~10% increase in the amount of gas consumed in the power market. For context, this compares to the gas market for LNG exports which currently sits at ~12 bcf/d and is set to nearly double to ~25 bcf/d by the end of the decade based on currently FID'ed projects - and the ResComm and industrial demand of 21 bcf/d and 23 bcf/d, respectively. All else equal, while we see the potential for data center driven power demand to accelerate gas demand for power growth generally, and it could represent a meaningful slice of the pie by the end of the decade, we see the potential magnitude for growth on a smaller scale than the ramp of LNG set for the second half of the decade.

Exhibit 34: We expect gas demand growth to be relatively ratable (~0.47 bcf/d on average) through the end of the decade
Potential incremental annual physical gas demand (2024E-2030E)



Source: Goldman Sachs Global Investment Research

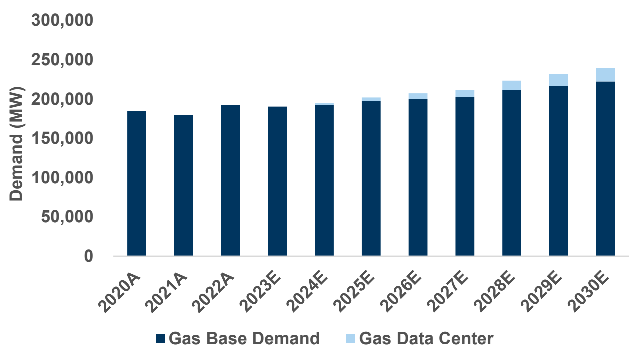
Exhibit 35: We see incremental data center power demand driving ~3.3 bcf/d of new natural gas demand by 2030
Potential incremental physical gas demand, cumulative (2024E-2030E)



Source: Goldman Sachs Global Investment Research

Exhibit 36: We expect data center power demand to result in a ~10% increase in the amount of gas consumed in the power market vs. today

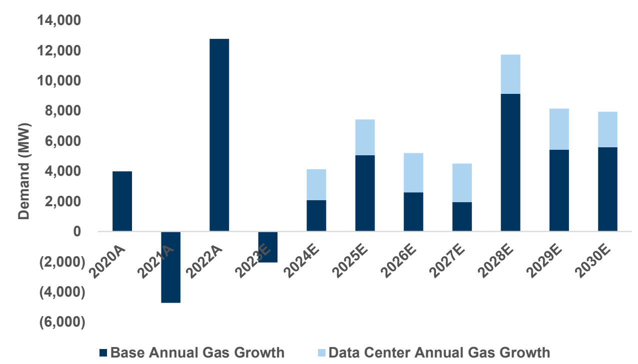
Gas demand for power generation base plus data center power demand (2020-2030E)



Source: Goldman Sachs Global Investment Research

Exhibit 37: We expect natural gas for power demand to grow ~3% annually, of which, data centers make up a meaningful portion of that growth (~40%)

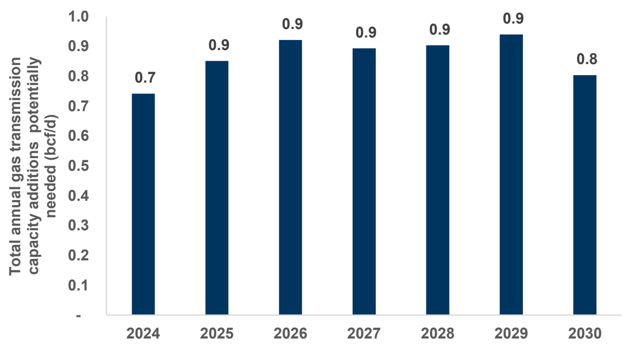
Gas demand growth - base vs data centers (2020-2030E)



Source: Goldman Sachs Global Investment Research

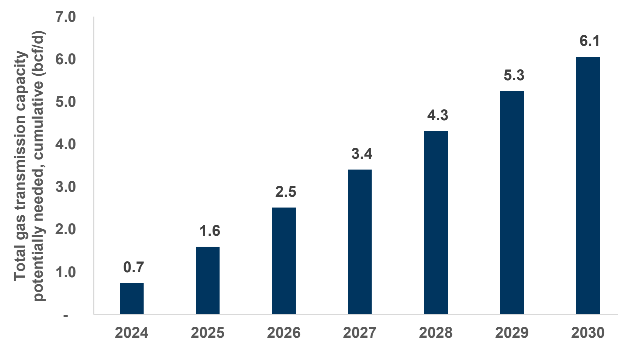
We believe this growth could require the construction of ~6.1 bcf/d of new pipeline capacity. Taking the Utilities team's forecast that roughly half of overall new data center demand requires new powergen capacity (~14.2 GW out of the 28.7 total) with the balance being able to be served by existing facilities, we assume that only the former needs incremental pipeline build-out. Given our assumed capacity factors for CCGT and peakers ~60% and 15%, respectively on average, the required pipeline capacity to generate the ~3.3 bcf/d of physical demand by 2030 could be ~6.1 bcf/d if contracted out to 100%. While this may not be required in all cases, contracts for new capacity are now often sized to be able to accommodate peak load - this has been a consistent message from management teams in the sector, most notably by WMB at their 2024 Analyst Day. A qualifier to this view includes the potential for data centers to connect directly to gas transmission systems as discussed recently by KMI on its 1Q24 call and WMB at its Analyst Day. Direct connectivity could result in lower pipeline capacity requirements given likely higher average utilizations at data centers vs average gas-fired power plants – though, these types of projects could be lower capex and/or higher return, mostly offsetting this impact in our view. As mentioned, our estimate assumes roughly an equal mix between higher flows on existing assets and new pipeline construction to accommodate new flows; tighter than expected utilization on the former could drive the investment requirements for the latter higher. We discuss upside scenarios below.

Exhibit 38: We believe data center power demand growth could require the construction of ~0.9 bcf/d of new pipeline capacity annually, on average
Total annual gas capacity additions potentially needed (2024E-2030E)



Source: Goldman Sachs Global Investment Research

Exhibit 39: We believe this data center power demand growth could require the construction of ~6.1 bcf/d of new pipeline capacity
Total gas capacity potentially needed, cumulative (2024E-2030E)



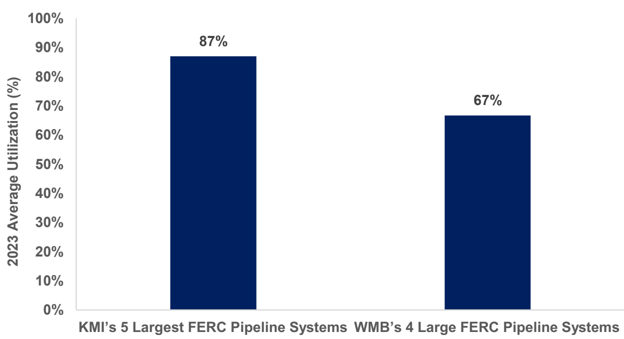
Source: Goldman Sachs Global Investment Research

This incremental gas demand should be a solid incremental tailwind for energy infrastructure companies. The growth in power demand should drive both incremental flows on existing pipelines and the need for new pipeline development; we estimate roughly ~$7.4b of gas transmission investment could be needed to provide the ~6.1 bcf/d of capacity by the end of the decade. Our capex estimate is based on the historical average pipeline capex requirement per 1 mmcf/d of pipeline capacity additions of $1.21m - thus, it would take approximately ~$7.4b to construct ~6.1 bcf/d of capacity. Returns for these types of projects can vary based on size, scope, and location, but typically range between 6-9x build multiples. Taking our $7.4b capex estimate, this investment could result in incremental annual EBITDA of $800m-$1.2b by 2030 for the midstream sector.

We see Kinder Morgan (KMI, Buy) and Williams (WMB, Neutral) as two of the best positioned natural gas infrastructure operators to benefit from this growth in data center power demand. Within our midstream coverage, the two largest natural gas transportation players, KMI and WMB, are well positioned in terms of scale and geography to benefit from potential data center driven power demand growth. For context, the two incumbents handle ~40%/~33% of the natural gas consumed in the US, respectively, and between the two companies, there is connectivity from each major associated and dry gas basin to growing East Coast, Midwest, and West Coast demand markets. Despite current utilization ranges of ~70-85%+ on KMI and WMB's transmission assets, new power gen demand would need to be supported by incremental pipeline capacity, meaning KMI and WMB could provide a meaningful percentage of our new pipeline capacity addition estimate of 6.1 bcf/d by 2030 – likely through brownfield expansions and laterals off of existing footprints.

Pipeline capacity additions related to data center demand growth could provide ~2% upside for our estimates for KMI and WMB by 2027 – and continued growth beyond our model forecasts. Given the scale of and connectivity of each KMI's and WMB's footprints, specifically KMI's large position in Texas and WMB's large position in the Southeast, we expect KMI and WMB to be well positioned to capture potential growth opportunities to supply new power gen capacity - which could imply upside to outer year estimates. On EBITDA impacts, if we assume KMI and WMB maintain their current gas transportation market share of 40%/33% respectively (out of simplicity), this could imply incremental annual EBITDA of ~$330-490m for KMI and $270-410m for WMB by 2030. The relative market shares can swing materially however, as can realized margin on these projects.

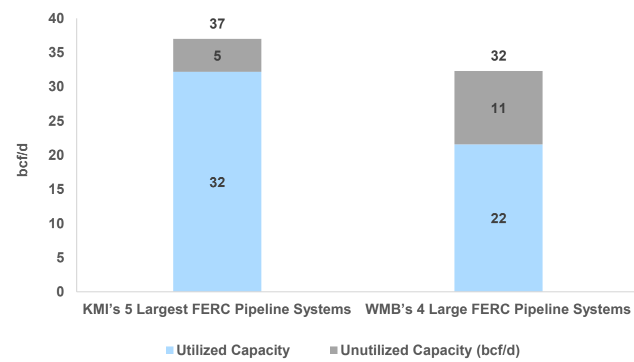
Exhibit 40: While average utilization ranges from ~70-85%+ on KMI and WMB's transmission assets, these assets are contracted to peak power plant capacity, implying new demand would need to be supported by incremental pipeline capacity
2023 average pipeline utilization



Includes 100% of NGPL and Gulfstream Capacity

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 41: Despite current utilization ranges of ~70-85%+ on KMI and WMB's transmission assets, new powergen capacity would need to be supported by incremental pipeline capacity
2023 average pipeline utilization vs capacity (bcf/d)

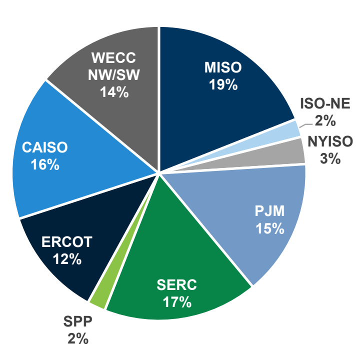


Includes 100% of NGPL and Gulfstream Capacity

Source: Goldman Sachs Global Investment Research, Company data

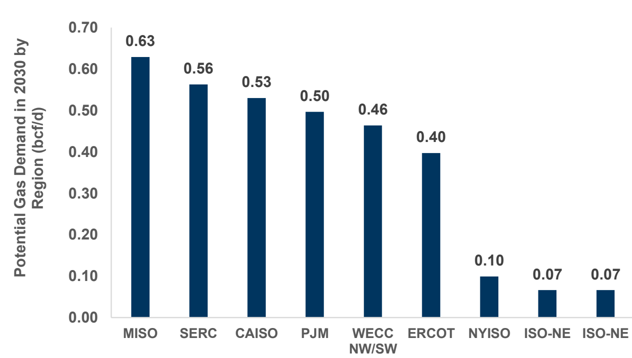
We acknowledge the regional nature of data center build out and incremental power demand will likely vary by region. On market connectivity, we note that across the US, the MISO, PJM, SERC, Texas ERCOT, and WECC-CA/MX markets are set to realize a majority of the data center driven power demand growth, representing ~2.6 bcf/d of gas demand (of 3.3 bcf/d total gas demand). Other names in our coverage that could benefit include Energy Transfer (ET, Neutral) given its exposure to Texas ERCOT market and TC Energy (TRP, Sell) given its exposure to the PJM/MISO markets through its Columbia/ANR pipelines, respectively.

Exhibit 42: We assume the greatest share of data centers are built out in MISO, followed by SERC, CAISO, and PJM
Regional allocation of data center driven load



Source: Goldman Sachs Global Investment Research

Exhibit 43: We assume MISO, SERC, CAISO, and PJM will call for most of the incremental gas demand
Regional allocation of data center driven gas demand for new capacity in 2030, bcf/d



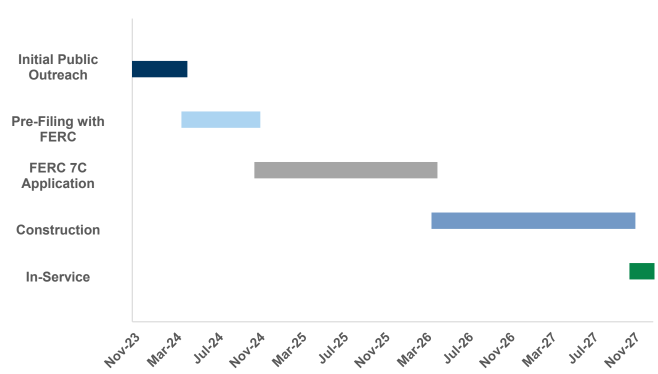
Source: Goldman Sachs Global Investment Research

Long timelines for infrastructure permitting and construction could be a constraint on growth. Despite the potential for incremental demand growth, there are logistical constraints in building natural gas transmission infrastructure including long-dated timelines, permitting challenges, and project costs. On timelines, we see an average of ~4 years from the project announcement date to in-service which includes roughly a year for pre-filing and filing activities, 1-1.5 years for permitting and 1.5-2 years for construction, based on historical precedent. We highlight several projects as context:

- WMB's Southeast Supply Enhancement is a fully-subscribed ~1.6 bcf/d project designed to meet growing power demand in mid-Atlantic and Southeast markets, though will take 4 years from the project's announcement in 3Q23 before entering service by late 2027.
- Similarly, WMB's Commonwealth Energy Connector, a 105 mmcf/d lateral project off of Transco to service growing power demand in Virginia, will also have taken nearly 4 years from initial public outreach to in service in 2Q25.
- We estimate similar 3-4 year project permitting and construction timelines for KMI's Cumberland project designed to provide 245 mmcf/d of capacity to support coal to gas switching in Tennessee by 3Q25.
- We see the same timeline for KMI's Permian North I project, designed to provide 80 mmcf/d of incremental capacity on its NGPL system to meet growing power demand in Midwest markets by 4Q24.

Other infrastructure constraints include ongoing permitting challenges, where we expect future growth in the Northeast to be limited to brownfield expansions given persistent delays and cost increases from permitting and litigation challenges in the region. Lastly on project returns, the bar for project returns remains high, particularly given the midstream energy sector pivot towards capital discipline and higher capital returns for shareholders in recent years.

Exhibit 44: We expect WMB's SSE project to take ~4 years from the project announcement date to in-service
Southeast Supply Enhancement Timeline (2023-2027)



Source: Company data, Goldman Sachs Global Investment Research

We acknowledge the range of outcomes is wide and potential gas and pipeline capacity demand growth is still being determined - and we highlight potential upside cases below. While we see recent commentary from both midstream and E&P

companies on the prospect for natural gas to serve significant data center power demand growth as positive for the gas macro backdrop generally, the magnitude of demand and how that can manifest on a micro level for each company is still being determined. In recent weeks, looking to incremental data center gas demand, we have seen EQT cite high-single-digit bcf/d growth and an upside case in the double-digits, KMI cite 7-10 bcf/d, AR cite ~3 bcf/d, and RRC cite ~1 bcf/d (though acknowledged the embedded conservatism in their guide). In our view, this wide range points to the ongoing debate, with the market likely focused from here on data center efficiency gains, targeted renewable mixes, gas prices, and regional differentiation.

We provide two bull case scenarios to illustrate potential upside to our physical gas and gas pipeline capacity demand estimates - there could be up to ~5.5 bcf/d of natural gas demand and up to 20.5 bcf/d of gas pipeline capacity demand by 2030:

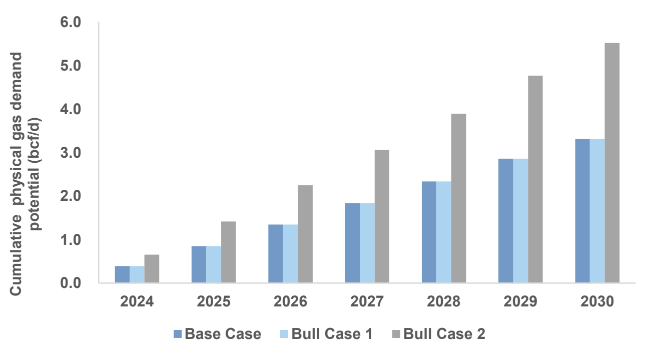
- **Base Case:** As described above, our base case assumes that by 2030, 3.3 bcf/d of gas could be needed to serve ~60% of the ~28.7 GW of total data center power demand, with the remaining 40% served by renewables. Our incremental pipeline capacity estimate of ~6.1 bcf/d assumes roughly half of overall new data center demand requires new powergen capacity (~14.2 GW out of the 28.7 total) with the balance being able to be served by existing facilities - we assume that only the former needs incremental pipeline build-out. Given our assumed capacity factors for CCGT and peakers ~60% and 15%, respectively on average, the required pipeline capacity to generate the ~3.3 bcf/d of physical demand by 2030 could be ~6.1 bcf/d if contracted out to 100%.
- **Bull Case 1:** Our first bull case assumes that incremental pipeline capacity could be required for all incremental gas-fired powergen demand (i.e. 60% of total 28.7 GW, not just new powergen capacity as we assume in our base case). Assuming pipeline capacity is contracted to peak plant capacity, this could result in pipeline capacity needs of ~12.3 bcf/d and ~$15b of transmission capex. By 2030, this scenario could add up to ~$1.7b-$2.5b of annual incremental EBITDA to the midstream sector.
- **Bull Case 2:** Our second bull case assumes that instead of gas/renewables serving 60%/40% of incremental data center powergen demand, gas will serve 100%. We maintain our heat rate and capacity factor assumptions embedded in our base case as well as the proportion of new powergen capacity that will be supplied by CCGT (~67%) and peakers (~33%). Our second bull case assumes that 100% of data center power demand requires new pipeline capacity (~28.7 GW total). This could result in ~5.5 bcf/d of incremental physical gas demand, and assuming pipeline capacity is contracted to peak plant capacity, this could result in ~20.5 bcf/d of gas pipeline capacity needs. On capex, 20.5 bcf/d of pipeline capacity could require $24.9b of transmission capex by 2030 - this could add ~$2.8b-$4.1b of annual incremental EBITDA for the midstream sector.

Exhibit 45: We see a wide range of potential pipeline capacity needs and therefore capex requirements and EBITDA additions through 2030
Base Case vs Bull Case - Gas Demand, Pipeline Capacity Demand, Capex, and EBITDA Implications

Data Center Physical Gas and Transmission Capacity Scenarios	Base Case: - Gas share of power demand: 60% - Share of new gas demand requiring new pipeline capacity: 50%	Bull Case 1: - Gas share of power demand: 60% - Share of new gas demand requiring new pipeline capacity: 100%	Bull Case 2: - Gas share of power demand: 100% - Share of new gas demand requiring new pipeline capacity: 100%
Physical Gas Demand Adds (bcf/d)	3.3	3.3	5.5
Gas Pipeline Demand Adds Assuming Pipes are Contracted to Peak Capacity (bcf/d)	6.1	12.3	20.5
Gas Pipeline Capex by 2030 ($m)	$7,353	$14,930	$24,884
Potential Annual Midstream EBITDA Adds by 2030 ($m)	$817-$1,226	$1,659-$2,488	$2,765-$4,147

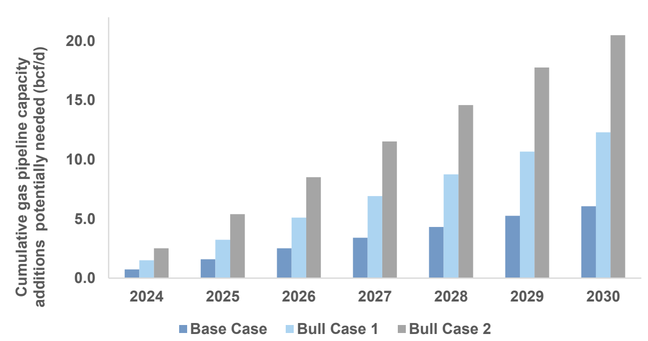
Source: Goldman Sachs Global Investment Research

Exhibit 46: Our Base case call for up to 3.3 bcf/d of gas demand through 2030, but our bull case call for up to ~5.5bcf/d through 2030
Base Case vs Bull Cases - Cumulative Natural Gas Demand Potential (bcf/d)



Source: Goldman Sachs Global Investment Research

Exhibit 47: Our base case calls for ~6.1 bcf/d of pipeline capacity additions, but our bull cases call for up to ~12.3-20.5 bcf/d of pipeline capacity additions
Base case and Bull Cases - Cumulative gas pipeline capacity additions potentially needed (bcf/d)



Source: Goldman Sachs Global Investment Research

Appendix

Price Target Methodologies and Key Risks					
Ticker	Methodology	Rating	Price Target (12 mo.)	4/26/2024 Price	Key Risks
FLNC	DCF + EV/Sales	Buy	$26	$16.85	**Key downside risks:** slower than expected energy storage adoption, slower enegy storage revenue recognition, worse supply chain impacts and/or logistical issues, litigation outcomes, timing of the mix shift from hardware to software revenue
XEL	P/E (19x 2025 EPS)	Buy	$72	$53.96	**Key downside risks:** negative rate case outcomes, slower than expected renewable transition, unfavorable commission decision on IRPs, and cost management
FSLR	12.5x P/E on Q5-Q8 EPS + Cash	Buy	$265	$178.73	**Key downside risks:** module oversupply, higher than expected module costs, trade policy and changes to US manufacturing credits.
GEV	14.0x EV/EBITDA on Q5-Q8 EBITDA	Buy	$172	$153.07	**Key downside risks:** slower than expected demand growth, lower than expected margins, and worse than expected policy.
SO	P/E (18x 2025 EPS)	Buy	$82	$73.21	**Key downside risks:** execution risk around Vogtle, balance sheet strength, slower than anticipated rate base/earnings growth
ETN	Q5-Q8 EBITDA multiple of 22.5x	Buy	$331	$324.30	**Key downside risks:** backlog deteriorates faster than expected; slowdown in Electrical Americas, price/cost headwinds worsen; limited capital deployment.
NVT	Q5-Q8 EBITDA multiple of 15.5x	Buy	$77	$75.69	**Key downside risks:** de-stock lasts longer than expected; pricing headwinds in a deflationary environment; non-res sentiment worsens; limited capital deployment.
CAT	24x P/E on mid-cycle EPS	Buy	$408	$343.38	**Key downside risks:** broader economic slowdown, supply disruptions, and higher price/cost headwinds.
PWR	15.5x STM (second 12 month) EV/EBITDA	Buy	$259	$261.66	**Key downside risks:** pace and volume of projects, quantum of capex spent by customers
MYRG	11.5x STM (second 12 month) EV/EBITDA	Buy	$188	$168.16	**Key downside risks:** project executon, M&A risks, lower infrastructure spending
SRE	SOTP	Buy	$88	$71.32	**Key downside risks:** delays with the LNG projects, Texas customer growth slowing or the regulatory environment becoming less favorable in Texas, and unfavorable rate case outcomes at the California utilities or challenging regulatory constructs
KMI	9.5x multiple on 2025 EBITDA	Buy	$21	$18.68	**Key downside risks:** Slower-than-expected ramp in natural gas demand, new unexpected recontracting headwinds, worse-than-expected rate gas headwinds for TGP, lower-than-expected returns on new projects, execution on RNG strategy, lower commodity prices, especially for oil given the impact on the EOR business, high-multiple acquisitions, and over extension of balance sheet capacity for buybacks or new projects.
CCJ	30.0x through-cycle P/E	Buy	$55	$49.35	**Key downside risks:** operational execution, timing of deliveries/sales, commodity prices, nuclear reactor startup/construction timing
EQT	DCF	Buy	$43	$40.61	**Key downside risks:** costs, well results, commodity price volatility and government pronouncements.
VRT	23x multiple on Q5-Q8 EBITDA	Buy	$103	$93.49	**Key downside risks:** revenue growth, margins, leverage
NEE	SOTP	Buy	$74	$65.99	**Key downside risks:** a slowdown in renewables demand or deterioration in economics for these projects, and the impact of higher interest rates on financing costs, particularly as interest hedges roll off.
WMB	10.0x multiple on 2025 EBITDA	Neutral	$37	$39.26	**Key downside risks:** faster-than-expected recovery in natural gas prices and production growth, better-than-expected execution on capital projects, lower run-rate capex needs, high-multiple sale of E&P assets, slower-than-expected recovery for gas, worse-than-expected rate case headwinds for Transco, higher regulatory hurdles for natural gas pipeline projects, and high-multiple bolt-on M&A

SO and FSLR are on Americas Conviction List. WMB risks stated include both upside and downside risks

Source: Goldman Sachs Global Investment Research, Factset

Disclosure Appendix

Reg AC

We, Carly Davenport, Brian Singer, CFA, Neil Mehta, Brian Lee, CFA, John Mackay, Ati Modak, Brendan Corbett, John Miller, Toshiya Hari, Joe Ritchie, Mark Delaney, CFA, Jerry Revich, CFA, Jaskaran Jaiya, Varsha Venugopal, Nick Cash and Olivia Halferty, hereby certify that all of the views expressed in this report accurately reflect our personal views about the subject company or companies and its or their securities. We also certify that no part of our compensation was, is or will be, directly or indirectly, related to the specific recommendations or views expressed in this report.

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The rating(s) for Kinder Morgan Inc. and Williams Cos. is/are relative to the other companies in its/their coverage universe: Antero Midstream Corp., Aris Water Solutions Inc., Cheniere Energy Inc., Cheniere Energy Partners, DT Midstream Inc., Energy Transfer LP, Enterprise Products Partners LP, Enviva Inc., Kinder Morgan Inc., Kinetik Holdings, Kodiak Gas Services Inc., MPLX LP, Plains All American Pipeline LP, Plains GP Holdings, TC Energy Corp., Targa Resources Corp., Williams Cos.

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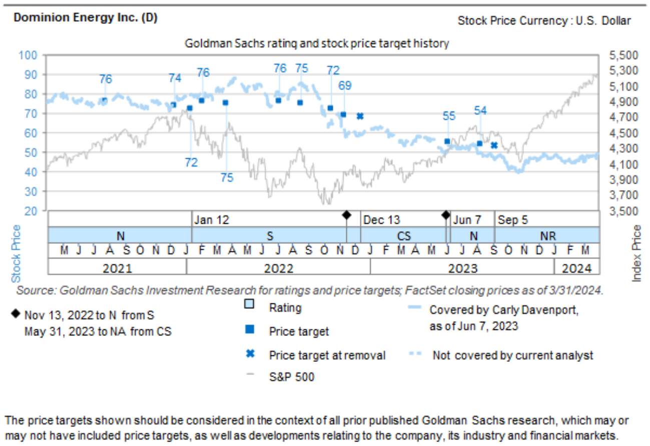
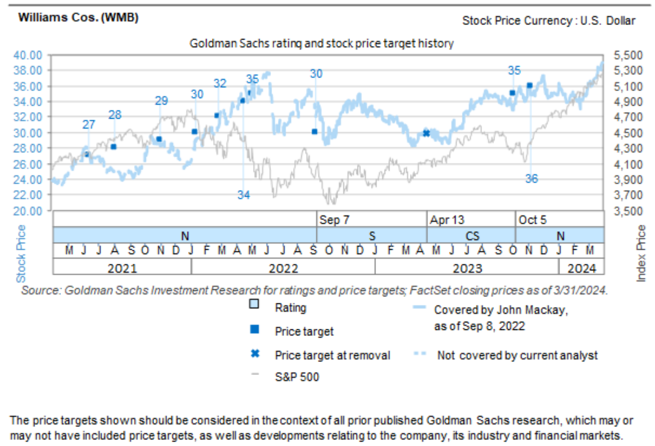
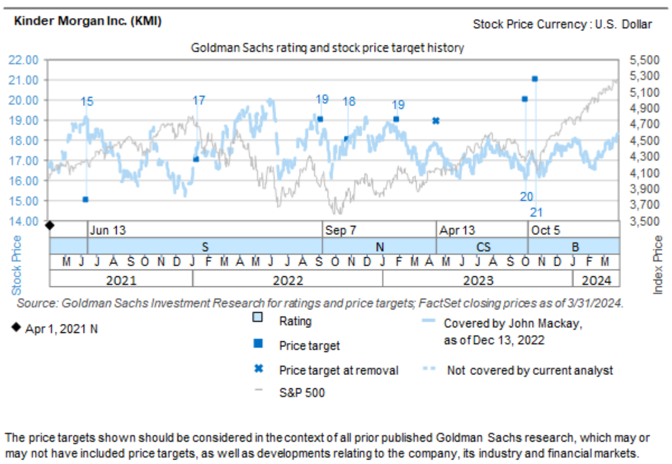
Price target and rating history chart(s)







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