UNIVERSITY OF OXFORD

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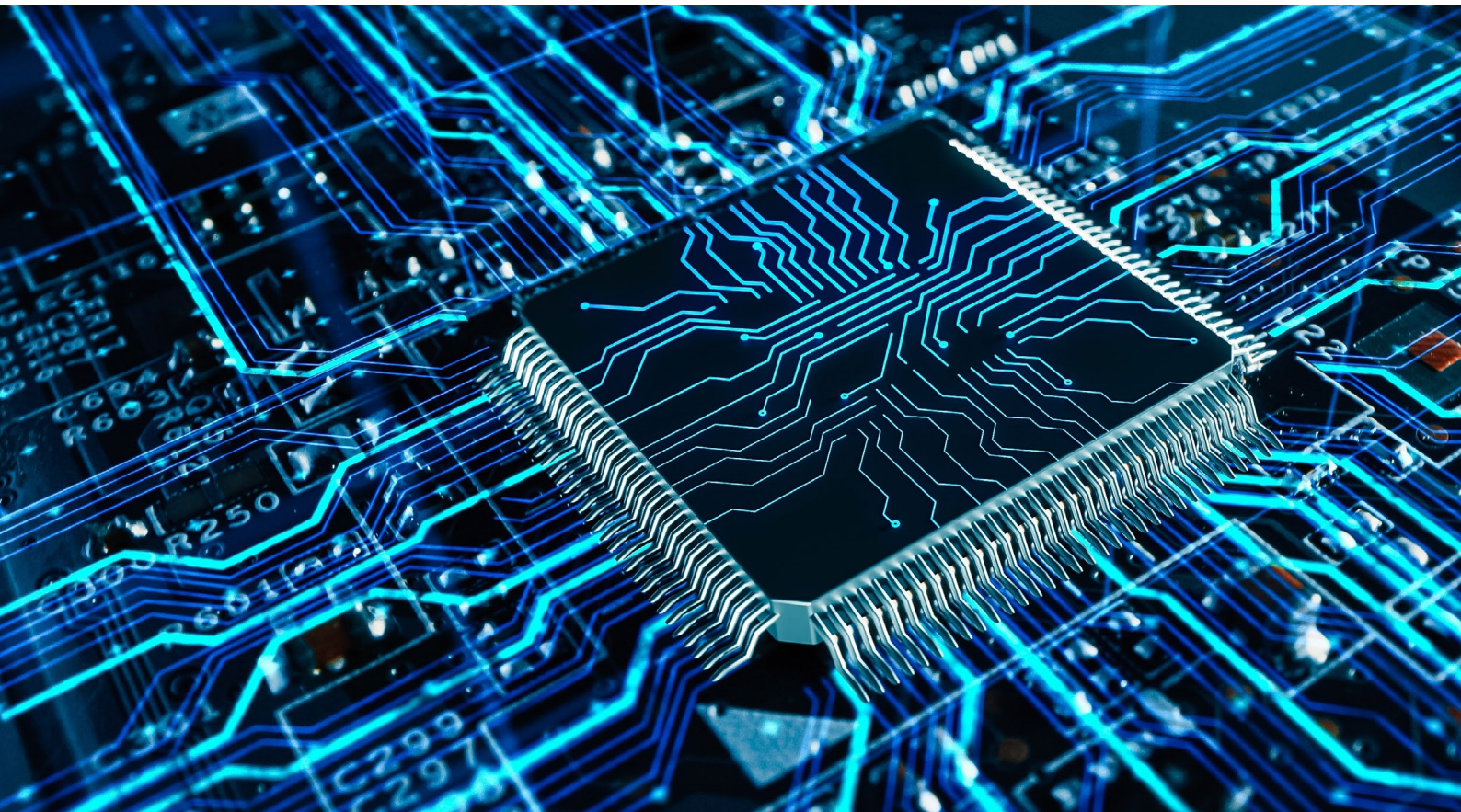
MAREX

The Great AI Infrastructure Buildout:

Impact on Power and Commodity Markets

This white paper discusses the halting buildout of AI infrastructure – its constraints, delays, and why the predicted boom in new construction may be over-hyped and behind schedule.



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Date of publication: 22 April 2026

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Executive Summary

The race to build AI-ready cloud computing infrastructure is in full swing, but a stark disconnect is emerging between announced data centre capacity and “steel in the ground.” Media and markets are expecting a rapid, exponential ramp-up of AI infrastructure. The evidence tells a different story: a rollout that is delayed, lumpy, and constrained by physical realities.

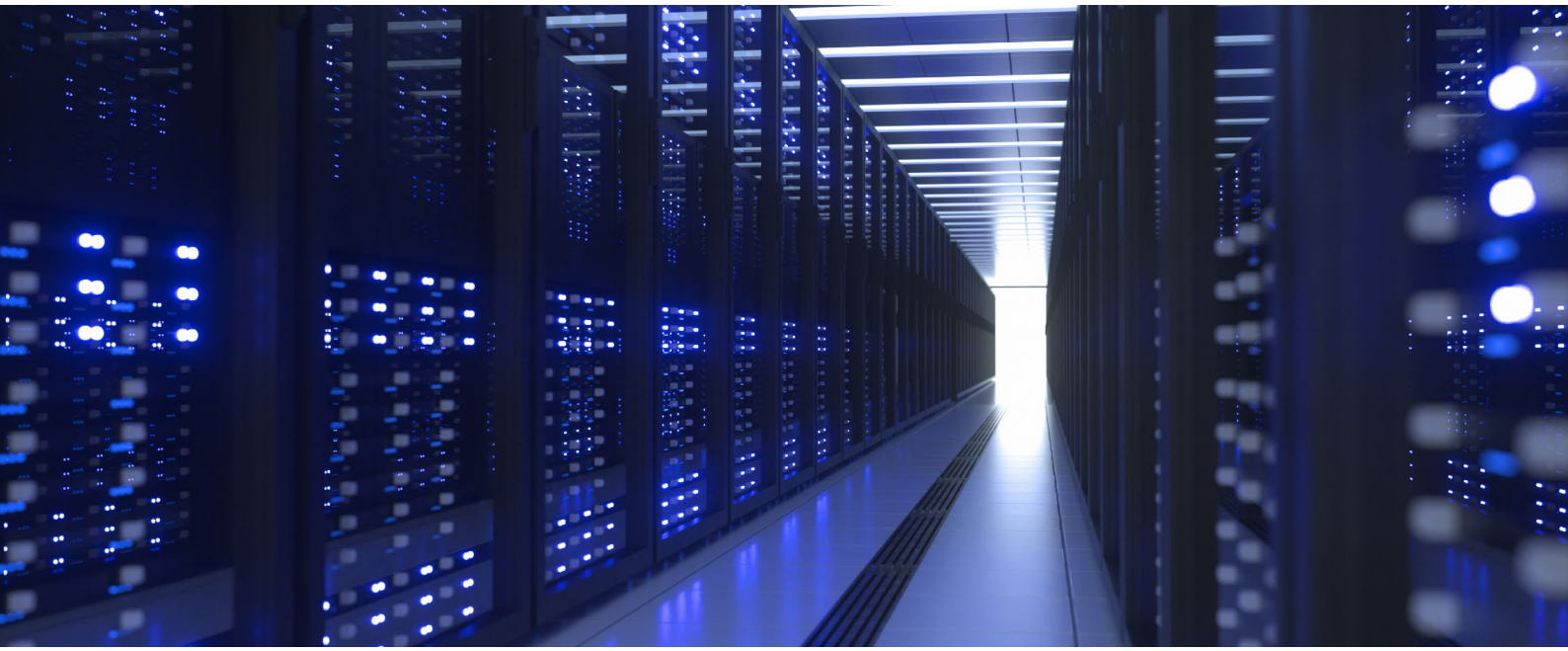
Hyperscale campuses face multi-year setbacks due to slow permitting, lengthy grid interconnection queues, equipment shortages, and labour bottlenecks. A significant share of announced capacity is inflated or postponed —"bragawatts,” not real assets.

These execution challenges are reshaping energy markets. In some regions, large data centres are straining grids and raising local power costs and volatility (although average wholesale prices remain mostly driven by traditional factors like fuel costs and weather).[1] To cope, operators are increasingly turning to BYOG (‘Bring Your Own Generation’) — on-site gas turbines, fuel cells, and battery systems. By 2028, off-grid generation for data centres could account for a substantial uptick in natural gas usage not captured in official power sector statistics.[2]

Commodity markets have responded to lofty announcements with rising prices and investments. But the timing of demand is misaligned, raising the risk that the “announcement curve” diverges from a much slower “delivery curve.”

Economic fundamentals are also under scrutiny. At the corporate level, individual hyperscalers are planning $100-$200 billion each in annual data centre spending.[3] If enterprise AI adoption does not scale as expected, the result could be stranded assets or sharply lower utilization.

Our research confirms the core thesis: a multi-year “delivery gap” exists between plans and reality, along with an energy system responding with volatility and ad-hoc solutions rather than a steady ramp. This gap will have significant consequences for energy markets, climate progress, and AI development.



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2. Natural Gas Intelligence (2025), "Data Centers Going Off-Grid With Natural Gas to 'Find Any Way to Get Power'." Natural Gas Intelligence, June 19.
3. CIO.com (2026), “What hyperscalers’ hyper-spending on data centers tells CIOs.”

In the following six sections, we document the delivery gap between announced and executable data centre capacity, before turning to the energy and power market effects of the buildout, the commodity supply chain implications, and the demand-side economics facing hyperscalers. Section V presents some counterarguments to our thesis, and Section VI draws together the findings and their strategic implications. Our analysis draws on primary data from grid operators, auction reports, and earnings disclosures, alongside industry research from CBRE, JLL, the IEA, and the IMF, covering the period 2023–2028.

I. The Delivery Gap: Announced vs. Executable Buildout

The Scale of the Disconnect

A large gap exists between data centre announcements and delivered, powered megawatts. The announced pipeline is inflated by a combination of genuine execution bottlenecks, optimism bias, and strategic overstatement. Many of the megawatts touted by companies are "bragawatts" — impressive on press releases and policy briefs but far slower to materialize as live capacity.

Table 1 provides a simple snapshot of this gap across four markets.

There is ample precedent for major industries retreating on widespread capital announcements. For example, in 2025, US energy developers cancelled roughly 266 GW of announced developments, partly in response to US policy changes, totalling tens of billions of dollars in planned but uncommitted capital.[4]

One estimate tallied over 100 GW of announced data centre power demand in the U.S. from 2024 to 2035[5]. U.S. data centre supply is currently roughly 25 GW.[6] These numbers imply a potential 400% increase in data centre capacity by 2035. But real estate services firm CBRE reports that primary markets have just 6.4 GW under construction as of the end of 2024[7] — a sliver of what is notionally required in the next decade.

Other regions follow a similar pattern. Ireland became a cautionary tale: by 2021, data centres reached the limits of what the grid could support, prompting regulators to halt new connections in the Dublin area despite a long queue of proposals.[8] Singapore imposed a moratorium from 2019–2022.[9] No region is immune to the announcement-execution gap — though the causes vary.

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Table 1: Announced / Expected vs Actually Delivered Data Center Capacity

Illustrative snapshots showing divergence between forecast/expected additions and realized delivered capacity. All figures in MW.

Market / Region	Expected / Announced (MW)	Delivered (MW)	Delivered ÷ Expected	Snapshot Window
North America (CBRE primary markets)[10, 11, 12]	>3,000 (construction activity)	1,748.5	~58%	2024
Europe core (FLAP D)[13, 14]	467 (forecast new supply)	244 (YTD Q3)	~52% (YTD)	2024
Europe (CBRE)[15, 16]	937 (expected new supply)	655 (delivered)	~70% (cross year)	2024–2025
Asia Pacific (annualized from APAC capacity projection)[17, 18]	~4,200 (annualized implied additions)	1,600	~38%	2024 vs 2024–2030 projection

Notes:

North America delivered MW is calculated as the year-end supply change (6,922.6 – 5,174.1 = 1,748.5 MW) using CBRE's primary-market inventory series. Asia Pacific expected MW is an annualized implied addition from JLL's APAC capacity projection (32 GW to 57 GW by 2030 ≈ 25 GW over ~6 years ≈ 4.2 GW/year), compared to Cushman & Wakefield's reported 1.6 GW of new capacity coming online in 2024.

Are delays structural?

Delivery rates of actual capacity trail far behind announcements, with the gap being deferred to later dates or remaining unbuilt. This is likely to be an ongoing and repeated theme.

This announcement inflation is driven by several reinforcing dynamics:

Speculative and duplicative requests. Data centre developers often file multiple grid interconnection requests for the same project or for tentative projects, effectively "calling dibs" on future power supply. Because queue entry is cheap, many requests never convert to actual builds, creating phantom capacity in planning data.[19]

Strategic signalling. In an ultra-competitive race for AI compute, companies may announce large capex plans partly to intimidate rivals, reassure investors, or secure government incentives — a "game-theory capex" dynamic. Some announced capacity was never fully intended to be built on the initial timeline.

Optimistic timelines. Even for earnest projects, initial schedules often prove too aggressive. One tally estimated that half of the world's data centre projects scheduled to come online in 2026 may face delays.[20]

The result: capital is available and announcements abound, but physical execution is slower. The binding constraint is not money — it is the real-world build rate.

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Where Are the Bottlenecks?

The delivery gap traces to several choke points, each of which can cascade into the others:

Grid interconnection. Perhaps the most acute bottleneck. In the U.S. the average timeline from initial connection request to a fully built and operational station exceeded four years in the period between 2018-2023.[21] Grid operators allocate capacity on a first-come basis, and data centre operators frequently reserve more power than they use, blocking others from connecting.[22]
A data centre can be physically built in 18–24 months but then sit idle waiting for grid connection — some data halls are fully constructed yet idle for months awaiting delayed substation transformers and upgrades.[23]

Permitting and local approvals. Community opposition in Virginia and Ireland has slowed or stopped projects.[24,25] Even in business-friendly jurisdictions, processing permits takes many months due to bureaucratic load and legal challenges.

Electricity supply. Even once connected, there remains the question of available generation. Ireland's EirGrid warned in 2021 that Dublin's existing generation was insufficient for surging data centre load, raising blackout risks.[26] In response, the Irish government spent roughly €1 billion on emergency gas generators.[27]

In Northern Virginia, data centre demand is projected to exceed 11 GW by 2030, a dramatic rise from just a few gigawatts earlier in the decade — potentially accounting for more than 40% of the state's current peak demand.[28]

Equipment supply chains. Power transformers that once took weeks to procure now have lead times of 2–3 years.[29] Switchgear, backup generators, and cooling units are similarly constrained. One report found power constraints were extending data centre construction timelines by 24 to 72 months.[30]

Construction labour. The boom in simultaneously building dozens of mega-data centres has stretched specialized contractor availability — electricians, HVAC technicians, and other skilled trades — in concentrated markets.

Outright cancellations. The Stargate project, heralded in January 2025 as a $500 billion initiative through to 2029, had by mid-2025 scaled back to "a more modest goal of building a small data center at year-end."[31] Such cases should technically remove announced capacity from the pipeline entirely although unfulfilled intentions are often left to wither on the vine rather than be explicitly announced.

These constraints reinforce each other: a transformer shortage worsens grid interconnection delays, which require emergency generators, which require new permitting. The slowest link — often power infrastructure — dictates the project timeline.

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Can the Bottlenecks Relax in 1–3 Years?

Most constraints will take several years to materially improve, though incremental progress is underway.

Interconnection reforms are in progress. The U.S. FERC issued Order 2023 to speed up grid interconnections, and the DOE has proposed rules to cap review times at 60 days for certain decisions.[32] In recent years, the U.S. Congress has come close to agreeing on permitting reform with bipartisan support, but remains stymied over whether to favour fossil energy over renewable sources. The UK has announced "AI Growth Zones" to fast-track grid delivery.[33] These measures should shorten wait times by 2027–2028, but the backlog is large.

Equipment manufacturing is scaling up. The U.S. Defence Production Act was invoked in 2022 to boost distribution transformer output.[34] Large equipment firms (Hitachi Energy, Siemens) have announced new factory lines.[35] Experts predict continued pain through at least 2026 on transformer availability,[36] with meaningful relief by 2027–2028.

Standardization could help at the margins. Industry groups are exploring standardized transformer designs to replace the current landscape of bespoke designs, and data centre designs are evolving toward modularity and prefabrication.[37]

Labor constraints are tougher to fix quickly — training skilled trades takes years. Some moderation may occur by 2026 as certain overbooked markets slow new starts, but an adequate supply of available skilled labour is unlikely.

In summary, the constraints will not vanish in the next 1–3 years, but incremental improvements are on the horizon. For the 2023–2026 window, the data indicates we are still in the thick of delayed and lumpier-than-expected delivery.

Demand response could reduce grid strain during peak periods. This includes dispatchable load reductions from large users such as data centres, as well as the expansion of virtual power plants (VPPs). VPPs aggregate distributed energy resources—smart appliances, EV charging load, thermostats, and behind-the-meter batteries—through coordination with utilities. VPPs could shave peak demand and provide dispatchable capacity from distributed storage. While progress has been made in recent years—particularly with bidirectional EV charging—VPP deployment remains constrained by regulatory barriers and consumer interest.

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Regional Divergence: Winners and Losers

Not all regions navigate the delivery gap equally. Certain areas are structurally advantaged by their permitting regimes, grid infrastructure, and energy resources.

United States. Northern Virginia remains the largest market but also among the most bottlenecked, with interconnect waits up to seven years[38] and rising local opposition. Atlanta has emerged as a winner — delivering 706 MW of net absorption in 2024, surpassing Northern Virginia for the first time[39] — benefiting from available land, state incentives, and greater power accessibility. Phoenix, Dallas, and Chicago are also seeing faster growth, while California and the New York City area lag due to strict reviews and constrained grids.

Europe. Dublin experienced a de facto halt from 2021–2025.[40] Parts of London's grid were so maxed that no new large connections could be accommodated until 2035 in West London.[41] The UK is responding with a £35 billion transmission upgrade plan.[42] Nordic countries (Sweden, Norway) have ample renewable power and proactive permitting, which may attract hyperscale facilities with surplus hydro or wind.

Asia-Pacific. Singapore carefully controls permits after its 2019–2022 moratorium, effectively matching approvals to what the grid can handle. China can expedite state-backed projects but faces internal relocation policies ("East-to-West") and massive power infrastructure dependencies.

Middle East. Qatar, Saudi Arabia, and the UAE have abundant solar and fossil energy and top-down governance enabling swift permitting. Some capacity may come online ahead of full utilization — the opposite of Silicon Valley's constraint.

These divergences mean metals demand and power price impacts will also diverge by region. Regions enabling faster buildout will see sooner-than-expected spikes in local resource usage, while bottlenecked regions spread the impact over a longer time.

India has seen rapid growth in data centre capacity, with installed capacity reaching approximately 950 MW in early 2024 and projected to more than double to 2–2.3 GW by fiscal year 2027,[43] driven by rising cloud adoption and AI workloads. Financial services remain the dominant end user, though this is expected to give way to the growing tech and consumer demand sectors. Nearly half of all capacity is concentrated in the Mumbai region, with around 90% located across India's top seven cities. Government reforms under Modi have streamlined approval processes and land acquisition to enable faster development. India has also aggressively expanded power generation capacity: solar installations reached a record 36–40 GW in 2025, up over 40% year-on-year, though coal still accounts for over half of total generation.[44] As in most countries, grid expansion is lagging behind generation additions, though equipment manufacturers across the sector are rapidly expanding capacity to address this.

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II. Energy & Power Market Effects

Structural Power Price Impact

At a high level, one might expect that adding significant constant load would raise wholesale power prices. The reality so far is nuanced: data center loads have not yet caused a broad sustained rise in average wholesale prices in most markets — other factors like fuel prices and weather still dominate.[45] An IMF analysis found that even under constrained infrastructure scenarios, U.S. electricity prices might increase on the order of 8.6% between 2025 and 2030 due to the AI boom[46] — noticeable but not a regime change.

However, localized structural impacts are already visible:

Capacity market signals. In PJM's Dominion (Virginia) zone, the capacity auction clearing price in the Dominion zone hit $444/MW-day — roughly 15 times the prior year's price of $29/MW-day.[47] Without major new investment, retail rates in Virginia might have to rise as much as 70% over the decade to fund reliability.[48]

Locational price elevation. Mamkhezri et al. (2025) found that new data centre connections significantly increase locational marginal prices (LMPs) — the real-time cost of electricity at a specific point on the grid — by driving up transmission congestion.[49] This is a different mechanism from capacity market pricing: rather than raising costs system-wide, it creates persistent price hotspots at the nodes nearest to large data centres. Businesses, industrial users, and ultimately households in those localities bear the higher cost, even if regional average prices remain stable.

Pass-through costs. Irish households saw an average €100 increase in 2024 electric bills specifically to fund grid upgrades largely needed for data centres.[50] The UK's £35 billion upgrade plan implies higher network charges eventually. Even where wholesale prices remain stable, the cost of accommodating data centres flows through to ratepayers.

In regions with abundant cheap power — the U.S. Pacific Northwest, the Nordics — data center growth has not yet caused noticeable price increases. The effect is concentrated where capacity is tight.

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Volatility and Peak Strain

While average prices have not skyrocketed, price volatility and peak stress events are on the rise in grids with large data centre loads. Data centres draw power in a relatively steady manner, which shrinks the cushion for peaks. When a peak occurs — driven by a heat wave or supply outage — prices escalate faster and further than they would without the constant background drain.

The Virginia LMP study found data centre growth increased not just the level but the volatility of local prices.[51] Oregon's utility commission approved special penalties for high-load users contributing to peak strain without coordination.[52] Deloitte's survey of power executives cites harmonic distortion and load relief warnings in data centre regions.[53]

In short: the peaks are sharper even if the average is only modestly higher. Data centres inject more volatility rather than uniformly lifting prices.

Alternate power sources

Three previously shuttered nuclear facilities in the US (Michigan, Pennsylvania and Iowa) are to be repowered between 2026-29 according to reports.[54] That is in addition to recent advances in Small Modular Reactors (SMRs) which have the potential to fill the BYOG requirements for data centres at faster timeframes than traditional nuclear capacity.[55] Other technologies such as solid oxide fuel cells are also being adopted.[56]

Self-Supply: Data Centers as Energy Producers

Faced with grid delays and cost volatility, many operators are becoming energy producers. This trend is crucial: it changes how data centers interact with the grid and introduces consumption that is not fully visible in traditional market data.

Companies are loath to wait years for grid connections. As a result many are starting to improvise new solutions—particularly self-supplying or self-generating power.

Examples of self-supply at utility scale include the Homer City (Pennsylvania) site, where a 4.5 GW former coal plant is being redeveloped into a natural gas-powered data center campus.[57] ExxonMobil announced in December 2024 that it would build a natural gas combined-cycle plant of more than 1.5 GW dedicated exclusively to powering data centers, to be sited off-grid to bypass interconnection queues entirely.[58] Proximity to natural gas pipelines is now a site selection factor for developers.[59]

In the medium term, self-supply acts as a pressure relief valve on wholesale markets: if data centres self-supply, they can reduce peak demand and cap extreme prices. Over a longer horizon, these on-site assets could be offered to the grid as distributed generation. Some jurisdictions (Ireland notably) now require any new data centre to have on-site generation or demand flexibility.[60]

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Hidden Gas Demand

One consequence of self-supply is a surge in off-grid fuel consumption — particularly natural gas — not captured in traditional power sector data. Data centers are spawning a new category of behind-the-meter electricity producers, whose fuel use is structurally invisible to standard electric utility reporting.

A rough quantification illustrates the scale. One MW of continuous data center load running on a modern natural gas combined-cycle generator consumes approximately 57–60 million cubic feet of gas per year — derived from standard EIA heat rate and conversion factors.[61] If 3,000 MW of new data center capacity ends up served by on-site gas by late decade, that equates to roughly 0.5 Bcf/day. Broader industry estimates suggest that if the full projected growth in data center power demand through 2030 were met entirely by gas-fired generation, incremental demand could reach on the order of 2 Bcf/day.[62] For context, total U.S. natural gas consumption currently runs approximately 90–100 Bcf/day — meaning even 2 Bcf/day represents a meaningful regional increment even if modest at the national level.[63]

This demand does not appear in traditional electric sector reporting. Under EIA sectoral classification, a data center that purchases natural gas to run its own turbine is recorded as industrial sector consumption rather than electric power sector consumption, and therefore falls outside the fuel-use statistics compiled for utilities and independent power producers.[64] The IEA notes that natural gas already comprised the largest source of electricity for U.S. data centers — at over 40% of supply as of the mid-2020s, ahead of renewables at approximately 24%[65] — and gas is the single largest source of additional supply through 2030.[66] Whether on-grid or off-grid, gas is the de facto bridging fuel enabling rapid AI infrastructure expansion.

This opacity matters for forecasting. If grid electricity demand growth appears slower than expected because a growing share of generation is behind-the-meter, analysts relying solely on utility load data may systematically underestimate AI's true energy footprint. Energy market stakeholders — from gas producers to grid operators — will need to account for these "shadow" loads in their capacity planning and supply projections.

61. EIA combined-cycle heat rate (~6,800 Btu/kWh at ~50% efficiency) at 1,038 Btu/cf yields ~57–60 MMcf/MW-year of continuous load. EIA, "How Much Coal, Natural Gas, or Petroleum Is Used to Generate a Kilowatthour of Electricity?," eia.gov/tools/faqs; EIA, "What Are Ccf, Mcf, Btu, and Therms?," eia.gov/tools/faqs. The 3,000 MW scenario and 0.5 Bcf/day figure are the authors' illustrative calculations.
62. Enverus Intelligence Research, cited in Woodway Energy Infrastructure, "Fueling the Future: Natural Gas and the Rise of Data Center Power Demand," woodwayenergy.com (2025); see also NRF Project Finance News, "Data Centers and Natural Gas," projectfinance.law, Aug. 25, 2025.
63. EIA, Natural Gas Monthly, Table 2 (total U.S. consumption), eia.gov/naturalgas/monthly.
64. EIA sector definitions: natural gas consumed by an entity operating its own generation equipment is classified as industrial (or commercial) consumption, not electric power sector consumption. EIA, Annual Energy Review, Glossary, eia.gov.
65. IEA, Energy and AI (Paris: IEA, April 2025), "Energy Supply for AI," iea.org/reports/energy-and-ai/energy-supply-for-ai.
66. Ibid.

III. Physical Supply Chain & Commodity Mispricing

Are Markets Getting Ahead of Reality?

A critical question is whether commodity producers and markets are pricing in the full announced buildout rather than the executable buildout. If so, prices and investments may overshoot in the short term, expecting demand that materializes years later, if at all.

Every AI data center is a mini-infrastructure project. Each megawatt of capacity embeds 60–75 tonnes of minerals in construction and equipment.[67] Key materials include:

Copper. Data centers are extremely copper-intensive — a large Microsoft facility (80 MW in Chicago) used 2,100 tonnes of copper, roughly 26 tonnes per MW.[68] The World Economic Forum estimates 4.3 million tonnes of copper could be associated with data centres and their power infrastructure globally by 2035.[69] The IEA projects a 30% copper supply deficit by 2035.[70] Copper prices have remained elevated partly on the AI and electrification narrative, with industry outlooks warning of a 25–30% shortfall by 2035.[71] The clear risk is that if commodity producers gear up for demand that arrives years late, we will get a boom-bust cycle akin to 2007-2016. Relatedly, the time for new mine capacity to come online can stretch to years or decades between initial investment and first production.

Electrical steel (GOES). Grain-oriented electrical steel, essential for transformer cores, has limited producers globally and remains expensive and constrained.[72] If transformer orders are rescheduled as projects slip, the market could flip from shortage to surplus unexpectedly.

Hardware shortages. The clearest example of front-running. Current transformer prices are 2–3× pre-2020 levels. Utilities and developers are locking in equipment speculatively, exacerbating scarcity for others.[73]

Table 2: Commodity Demand Expectations vs. Delivery Reality

Commodity / Equipment	Expected Demand (Announcement-Based)	Actual or Deliverable Demand (2023–2025)	Market Condition
Copper	~4.3 Mt linked to DCs by 2035 (implied ~300k t/yr by late-2020s)[74]	Est. ~100k–150k t used in DC builds 2023–2025	Tight but volatile; risk of near-term surplus if builds lag [75]
Electrical Steel (GOES)	Massive expansion needed for all planned transformers[76]	Orders booming but many projects delayed; lead times 2–3 years[77]	Extreme shortage; potential relief by 2026 as production scales
Transformers (HV/MV)	Thousands of new large units implied by interconnection queues	Actual installations limited by lead times[78]	Record backlogs and pricing; likely moderation after 2026[79]
AI Semiconductors	Implied demand from all announced DCs would require ~90% of world chip output[80]	Constrained production; lead times 6–12 months	Severe shortage 2023; overcapacity risk by 2026 if fabs over-invest

Sources: WEF, NREL, Utility Dive, WRI, company reports. Estimates illustrative.

67. WEF (2025).
68. Ibid.
69. World Economic Forum (2025), “Scaling metals to secure the data centre materials backbone.”
70. IEA, Global Critical Minerals Outlook 2025.
71. WEF (2025).
72. Utility Dive (2025).
73. Wood Mackenzie, cited in "Transformers in 2026: Shortage, Scramble, or Self-Inflicted Crisis?," POWER Magazine, January 2, 2026 (estimating 30% power transformer shortfall in 2025; lead times averaging 128 weeks for power transformers, 144 weeks for GSUs); see also Trabish, "Transformer Supply Bottleneck," Utility Dive, Feb. 12, 2025.
74. World Economic Forum (2025), “Scaling metals to secure the data centre materials backbone.”
75. WEF (2025).
76. Utility Dive (2025), citing NREL.
77. Utility Dive (2025), “Transformer supply bottleneck threatens power system stability as load grows.”
78. Wood Mackenzie, cited in "Transformers in 2026: Shortage, Scramble, or Self-Inflicted Crisis?," POWER Magazine, January 2, 2026 (estimating 30% power transformer shortfall in 2025; lead times averaging 128 weeks for power transformers, 144 weeks for GSUs); see also Trabish, "Transformer Supply Bottleneck," Utility Dive, Feb. 12, 2025.
79. Utility Dive (2025), “Transformer supply bottleneck threatens power system stability as load grows.”
80. WRI (2025).

The evidence suggests that materials markets have, to an extent, been pricing lofty announcement-driven expectations. There is a near-term overpricing risk: the market sees an exponential growth curve, but actual uptake is a stair-step with plateaus and delays. Some commodities may experience periods of unexpected softness amid an overall strong trend — confounding those who assumed a smooth exponential. Just as energy markets may misread the smooth rollout, commodity markets risk making the same linear-rollout error.

IV. The Economic & Demand Logic

Revenue Reality Check

The major cloud providers have signalled a paradigm shift in capital commitment (Table 3). As of late 2025: AWS indicated plans to spend $200 billion in 2026 on AI-related infrastructure; Google pointed to $180 billion for data centres and server replacements; Microsoft's capex was trending toward ~$100 billion annually. Collectively, the big three are committing on the order of half a trillion dollars in a single year.

The question is whether revenue justifies this.

Table 3: Hyperscaler Capex vs. Cloud Revenue (2025–2026)[81]

Company	Annualized Cloud Revenue (Q4 2025 × 4)	Announced 2026 Capex	Capex-to-Revenue Ratio
AWS	~$142 billion	~$200 billion	~1.4×
Google Cloud	~$71 billion	~$180 billion	~2.5×
Microsoft (Azure est.)	~$55–60 billion	~$100 billion	~1.7–1.8×

Note: Google and Microsoft capex covers the full company, not just cloud; Azure revenue is estimated from segment reporting. Even with conservative adjustments, ratios are historically unprecedented.

These companies are building for future demand that far exceeds current demand. Cloud revenue growth has been robust but decelerating — AWS slowed from ~30% year-over-year to low teens in 2022–2023 before reaccelerating modestly. Whether AI services can sustain >30% annual growth to justify these outlays is uncertain. If cloud revenue only grows 15% annually while capex doubles, a capacity glut is plausible.

The dot-com/telecom parallel is instructive: companies laid enormous fiber optic networks under the assumption of ever-growing traffic. When growth paused, much fiber was "dark" for years and bandwidth prices collapsed. Investors in the first wave lost out, although traffic eventually caught up.

Several indicators suggest a similar dynamic may be forming in AI infrastructure:

Utilization uncertainty. AI model training is spiky — a large model may be trained, then those GPUs sit idle or perform smaller tasks. If every major player builds its own AI supercomputer, aggregate utilization could be low until demand matures.

Revenue-per-workload compression. Many AI applications (ChatGPT's free tier, cheap image generators) have been offered at low cost to gain market share. If revenue per GPU-hour remains low, the economics of GPU-heavy data centers are unsound until pricing improves.

Emerging corrections. The Stargate project illustrates how even the most high-profile plans face execution friction: the $500 billion, 10-GW consortium stalled for months in mid-2025 amid partner disputes and financing gaps before recovering momentum.[82] Some analysts see "signs of a bubble emerging in AI applications and associated data center construction."[83]

81. CIO.com (2026) "What hyperscalers' hyper-spending on data centers tells CIOs ." https://www.cio.com/article/4128931/what-hyperscalers-hyper-spending-on-data-centers-tells-cios.html
82. Reuters (2025), "OpenAI, Oracle deepen AI data center push with 4.5 gigawatt Stargate expansion."
83. WRI (2025).

Obsolescence Risk: 24-Month Hardware Cycles vs. 20-Year Infrastructure

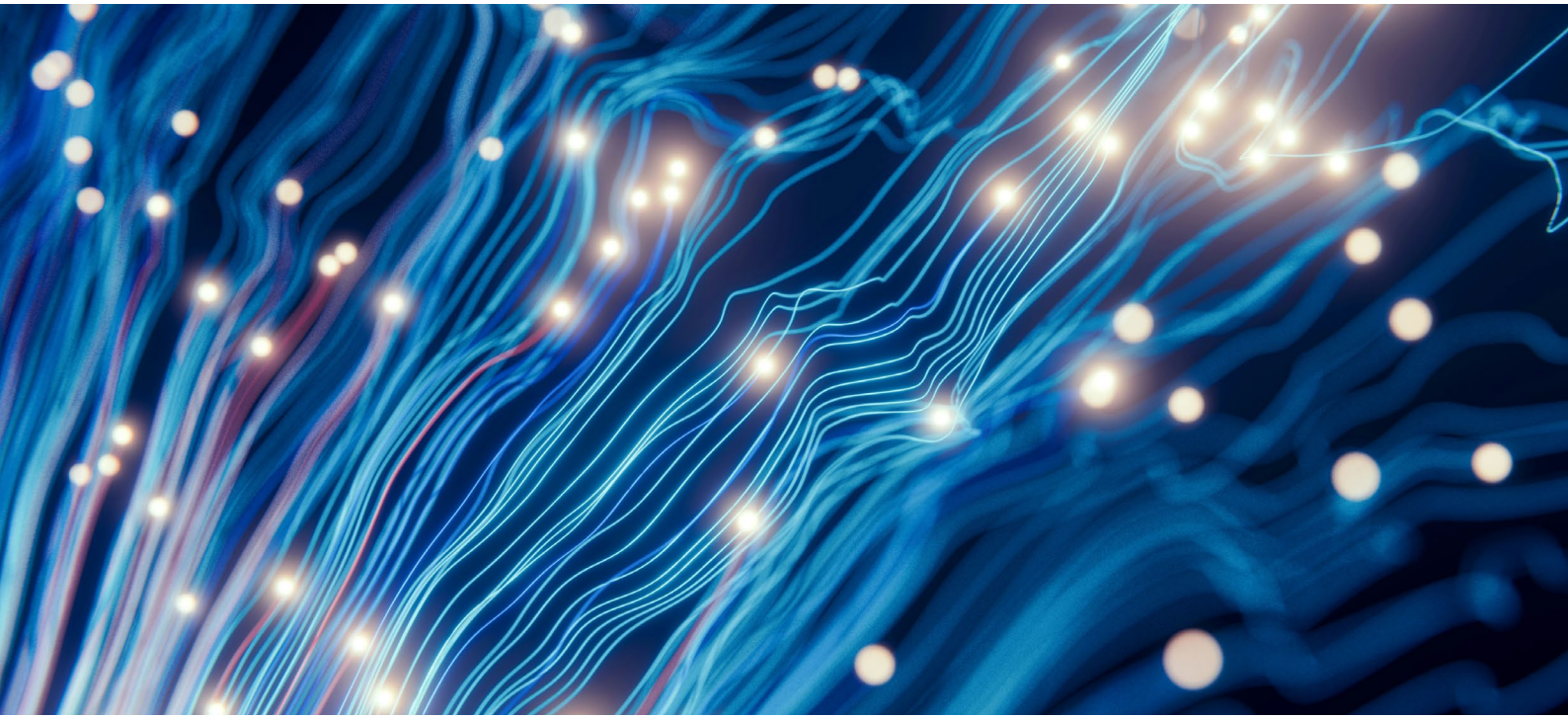
The pace of innovation in compute hardware poses a structural challenge to long-horizon infrastructure investments. NVIDIA went from the A100 GPU to the H100 in approximately two years, nearly tripling performance on some workloads. By 2026, even more advanced chips will be available. This rapid refresh cycle creates several tensions:

Stranded power capacity. If new GPUs offer the same compute at half the power draw — a data center designed for 30 MW may only need 15 MW for the same workload — leaving expensive power infrastructure underutilized. The Uptime Institute noted that data centers can lose 10% or more of UPS capacity as "stranded power."[84]

Retrofit costs. A data center built in 2023 for air-cooled GPUs at 30 kW/rack may by 2026 need to support 100 kW/rack with liquid cooling. If it cannot adapt, the owner must invest in major upgrades — raising total cost beyond projections — or accept lower-tier workloads.

Compressed return periods. If a facility has only 3 high-value years before newer technology outclasses it, the effective ROI window is far shorter than the 10–15 year depreciation schedule for physical plant. This favors shorter payback expectations and higher per-unit pricing — which may limit demand.

Microsoft's capex plans explicitly include replacing aging servers with a large portion of spend,[85] acknowledging that hardware turnover may outpace the life of the facilities housing it. The 24-month compute cycle does not render data centers worthless, but it raises investment risk and compresses the window for earning returns.



84. Rawlinson, K. (2025), "Datacenters Accused of Hoarding Grid Capacity," The Register, December 8, reporting on: Uptime Institute (2025), Are Data Centers Reserving Too Much Grid Power? Uptime Intelligence. https://www.theregister.com/2025/12/08/uptime_institute_datacenter_grid/
85. Microsoft Corporation, Q1 FY2026 Earnings Call Transcript, October 2025 (CFO Amy Hood).

V. The Bull Case: Why the Buildout May Succeed

There is a critical distinction to be made between possible excessive short-term expectations or exuberance and the potentially positive long-term outcomes. Both scenarios can exist simultaneously.

Demand may be systematically underestimated. Every prior wave of computing infrastructure — mainframes, PCs, mobile, cloud — saw demand forecasts revised upward, not downward, over a 5–10 year horizon. If generative AI becomes as foundational as the internet itself, the 100 GW pipeline may prove conservative. Some AI boosters argue that future AI capabilities (agents, scientific research, code generation at scale) will unlock demand that does not yet exist in any forecast. If even a portion of these use cases materialize, today's capacity could be absorbed and then some.

Hyperscalers can afford patience. Unlike the telecom companies of the dot-com era — many of which were leveraged and dependent on revenue to service debt — today's hyperscalers are among the most cash-rich companies in history. Apple, Microsoft, Google, and Amazon collectively hold hundreds of billions in cash and equivalents. They can sustain low utilization for several years without existential financial risk. This is not 2001-era WorldCom building on borrowed money; it is Google building on retained earnings.

Bottlenecks are a feature, not a bug. The very delivery gap we document could prevent overbuilding. If only 35–50% of announced capacity arrives on time, the risk of a massive capacity glut is moderated by the physical constraints themselves. Demand has several years to catch up to whatever supply does come online. The transformer shortage, paradoxically, may be protecting the industry from its own exuberance.

Self-correction mechanisms exist. Hyperscalers have already demonstrated willingness to moderate spend: in April 2025, both Microsoft and AWS paused or slowed early-stage data center projects in response to demand signals.[86] Unlike long-cycle industries (mining, power generation), tech firms can adjust quarterly. If utilization drops, they simply slow new construction — the sunk cost of planned but unbuilt facilities is relatively low.

Historical delivery gaps close. The shale revolution, LNG buildout, and renewable energy deployment all featured multi-year gaps between announcement and execution, followed by dramatic catch-up phases as permitting, supply chains, and financing aligned. The U.S. solar industry, for example, had years of underdelivery against forecasts before installations accelerated sharply once interconnection and supply chain issues were resolved. The AI infrastructure buildout could follow a similar trajectory.

Sovereign urgency adds a tailwind. Governments worldwide — the U.S., EU, China, UAE, India — are treating AI infrastructure as a matter of national security and economic competitiveness. This political will translates to permitting shortcuts, subsidies, and dedicated power allocations that may accelerate the buildout beyond what pure market dynamics would suggest.

These counterarguments are real and material. The bear case is not that the AI buildout will fail — it is that markets are pricing as if it will succeed on a smooth and exponential timeline, when the actual path will be irregular and halting. The bull case requires sustained exponential demand growth to meet the capacity being built. Our assessment is that the bull case is plausible but priced as certainty, and the balance of evidence favors a more cautious posture over the 2025–2028 window.

86. PYMNTS (2025), "AWS, Microsoft Slow Down Data Center Deployments." https://www.pymnts.com/technology/2025/aws-microsoft-slow-down-data-center-deployments/

VI. Conclusion: Navigating a Lumpy, Volatile, Self-Supplied Expansion

The evidence compiled here strongly indicates that markets have been pricing an idealized AI infrastructure rollout when reality is characterized by delivery gaps, regional disparities, energy volatility, off-grid generation, and uncertain demand.

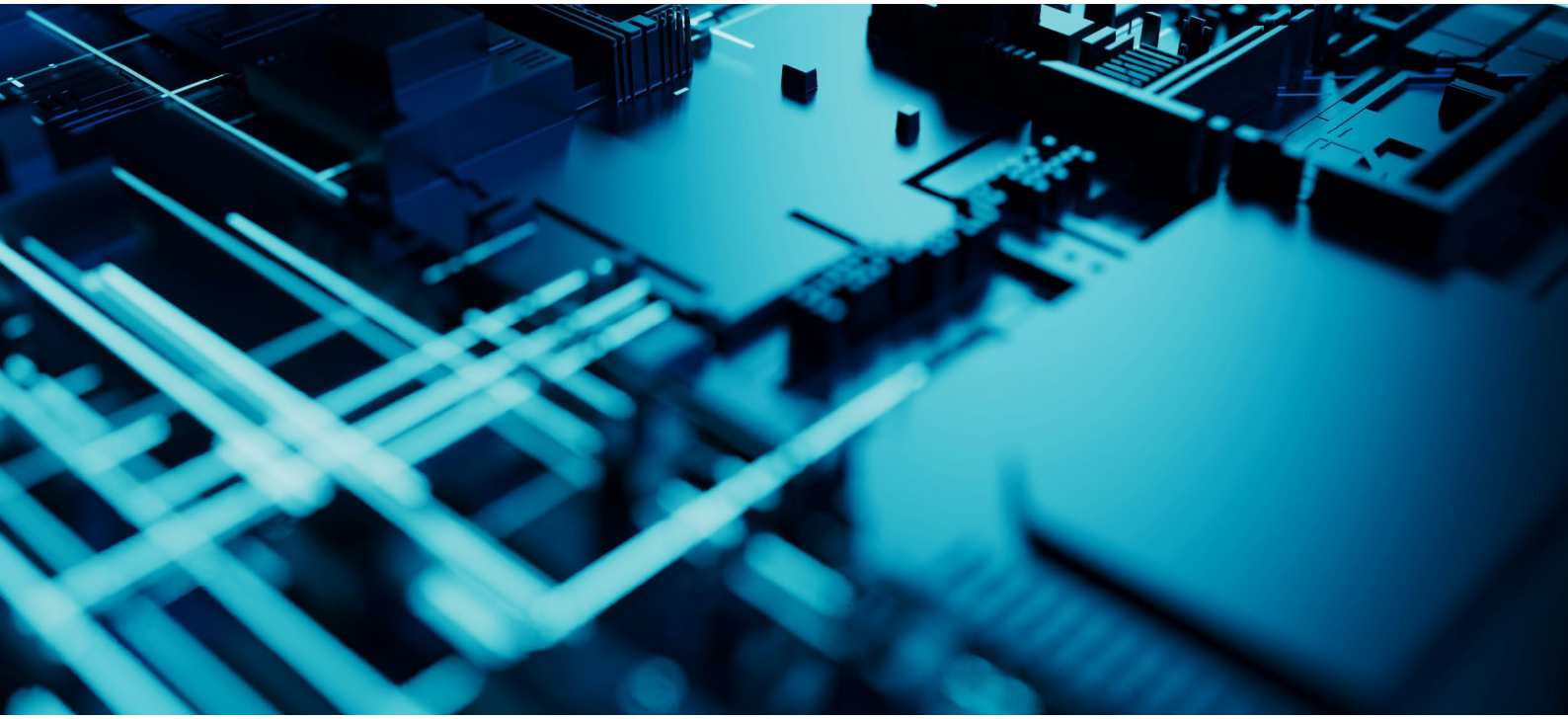
The delivery gap is real and material. Only 35–50% of announced capacity is translating into powered megawatts on original timelines. The binding constraint is physical execution, not capital. Wait times range from 2–3 years in favourable regions to 7years or more in constrained ones.

Energy effects are concentrated, not uniform. Average wholesale prices have not surged, but volatility, localized scarcity, and capacity market stress are pronounced. Self-supplied power is emerging as a defining feature, introducing shadow gas demand that traditional market data may not capture.

Commodity markets risk front-running demand. Transformer, copper, and electrical steel markets show signs of pricing the announcement curve rather than the delivery curve. Near-term overpricing may give way to long-term oversupply if planning does not adjust for the actual pace of buildout.

The economic case is not yet proven. Capex-to-revenue ratios are at historic highs for the major hyperscalers. If AI-driven revenue does not accelerate sharply, some facilities will be underutilized. The 24-month hardware cycle compresses return windows and increases investment risk.

Disruptors are also at risk of disruption. Historical examples abound of first-movers being supplanted (MySpace by Facebook, Yahoo by Google). The DeepSeek-R1 model offers comparable reasoning capabilities to OpenAI's o1 at 90-95% lower training costs.[87] Other approaches such as on-site SLMs may prove more commercially viable than LLMs in the long-run.



87. Venture Beat (2025), "Open-source DeepSeek-R1 uses pure reinforcement learning to match OpenAI o1 — at 95% less cost." https://venturebeat.com/ai/open-source-deepseek-r1-uses-pure-reinforcement-learning-to-match-openai-o1-at-95-less-cost

Strategic Implications

Build delay scenarios into all planning. Any model projecting AI-driven demand — for power, gas, metals, or equipment — should include scenarios where 40–60% of announced capacity arrives 2–3 years late. This affects commodity hedging, power purchase agreements, and infrastructure investment timing.

Exploit regional divergence. The buildout is not a homogeneous global story. Energy and commodity exposure should be weighted toward regions where data centres are actually connecting (Georgia, Arizona, the Nordics) and underweighted in regions mired in constraint (Northern Virginia queue, Ireland). Power pricing models should incorporate nodal congestion from data center clustering.

Price the "shadow" gas demand. Midstream companies and gas traders should model incremental demand from behind-the-meter data center generation. This demand — potentially 0.5–2.0 Bcf/day in North America by late decade — will not appear in utility-scale data but will tighten regional balances, particularly in the Northeast U.S. and specific European markets.

Watch the capex-to-revenue ratio. The single most important leading indicator for whether the buildout is overbuilt is the trajectory of cloud revenue relative to capital expenditure. If by 2027 the hyperscaler capex-to-revenue ratios shown in Table 3 have not compressed meaningfully, expect pullbacks in construction pace — with downstream effects on equipment orders, metals demand, and power off-take.

Maintain commodity flexibility. Avoid long-term commitments that assume a linear demand ramp. The supply chain is likely to experience alternating periods of tightness (when delayed projects all ramp simultaneously) and softness (when project slippage creates order lulls). Shorter-term contracts, rental arrangements for equipment, and diversified sourcing are prudent.

Monitor the bull case signals. The strongest indicator that our cautious thesis is wrong would be a sustained acceleration in enterprise AI adoption — specifically, measurable productivity gains translating to corporate willingness to pay premium prices for AI compute. If this occurs at scale by 2026, the buildout may be justified. We do not see this yet, but we remain open to the evidence.

The coming 2025–2028 period will be marked by exuberance and correction, by regional booms and bottlenecks, by innovation solving some problems and creating new ones. The winners will be those who balance ambition with realism — investing in the future of AI without losing sight of the practical constraints of the present.

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