

Look Forward

Data Center Frontiers



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S&P Global



The promise of generative AI depends on many factors, none more critical than the proliferation of data centers powering AI computation and the corresponding surge in energy required to fuel the world's digital infrastructure.

This data center revolution isn't just about building digital infrastructure; it is also about laying the foundation for sustained economic transformation. Data center and AI-related investments have become a dominant contributor to growth in the US — the leader in global data center capacity — accounting for 80% of private domestic demand growth in the first half of 2026.

Data centers are reshaping the dynamics of economies, capital investment, productivity, and national competitiveness. While the US and China are leading the data center charge, collectively commanding over 60% of global capacity, players across Europe, the Middle East and Asia-Pacific are racing to establish their own digital sovereignty.

This growth story also comes with profound challenges. How should investors and other market participants think about the risks of overbuilding, if AI promises don't materialize as expected? How will stakeholders manage the water required to cool data centers in areas where water sources face pressure? Can supply chains effectively stretch to meet the insatiable appetite for specialized equipment? As AI drives productivity gains concentrated in specific sectors, how could labor markets be reshaped?

In Look Forward: Data Center Frontiers, sponsored by the S&P Global Look Forward Council, we show how data centers are the defining infrastructure of the 21st-century economy. We bring together the best thinking from across S&P Global to examine the data center story from every angle — from our economists tracking the macro impacts to our infrastructure analysts modeling power demand, from our ratings teams assessing credit risks to our sustainability experts examining environmental implications.

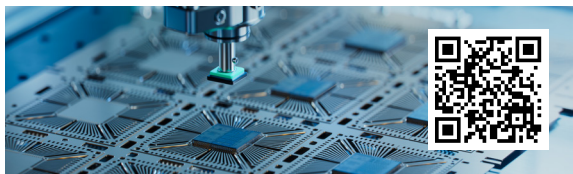
Every day, we bring together our data and insights from across S&P Global, Advancing Essential Intelligence and helping you stay a step ahead.

Martina Cheung
President and CEO

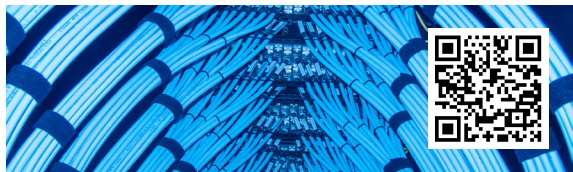
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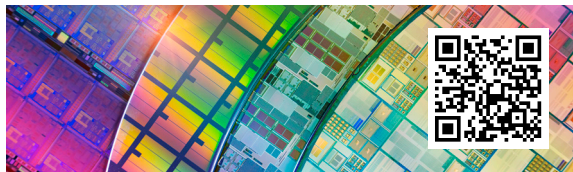
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Data center investments are increasingly moving the macro needle



Navigating the US data center power crunch: On-site solutions offer a faster path to power



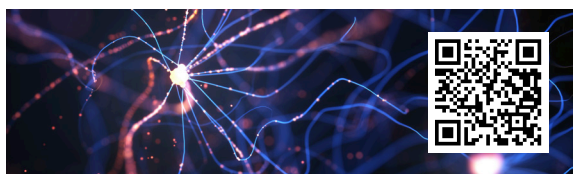
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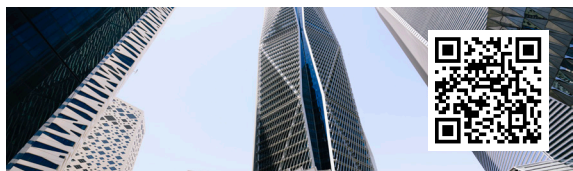
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AI's global resource race: Challenges and opportunities

Data centers are the factories of the digital economy and are essential for AI, but growth in the industry faces limits due to AI energy consumption challenges and AI power demand constraints.

By Kelly Morgan and Brian Partridge

Highlights

GenAI players are competing to create the “best” AI models and capture market share. Access to AI infrastructure and the energy to operate the data centers could determine winners and losers, with AI energy management also becoming a competitive factor.

Supply chain constraints, data center expansion headwinds and energy shortages could arrest AI development. Companies and countries that can address these issues will have an advantage.

Building infrastructure to support AI is expensive, and if demand turns out to be lower than planned, assets and capital could be stranded in under-utilized data centers and power plants.

Data centers are becoming the defining infrastructure of the 21st-century economy, underpinning AI-driven digital transformation. Yet expansion faces headwinds, including challenges around power availability, critical material costs and supply, environmental resource constraints and financial risks. Players that can innovate across design, location, energy sources, financing and supply chains will control the digital infrastructure, enabling a modern industrial revolution.



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Data center investments are increasingly moving the macro needle

Investments related to data centers have become the largest contributor to US growth, countering the effects of policy unpredictability on expenditures more generally.

By Satyam Panday and Paul Gruenwald

Highlights

The data center boom powering the AI revolution is clearly moving the macro needle, especially in the US. This goes well beyond the physical construction of data centers.

Preliminary data suggest that investments in data centers and related high-tech activities led to US GDP being about 0.5 percentage point larger in the second quarter of 2026 than it would have been if businesses' spending on data center and power construction, information processing equipment, software, and research and development had grown in line with the 2011–2022 trend. 2022 marked an inflection point for data center investment due to multiple factors, including the public release of ChatGPT and the passage of the CHIPS and Science Act.

Looking ahead, the key question is the payoff. Will the surge in data center investment generate productivity gains and fulfill the promise of a multiyear boost in growth?

Any boom in AI-driven growth will likely create a windfall and raise distributional issues. Will labor be augmented or replaced? Tensions are inevitable.

Data center construction has exploded in the past few years. This is a global story, with the US in the lead. Data centers are part of a worldwide AI race turbocharged by the launch of technologies such as ChatGPT. This race has multiple dimensions, spanning economics, geopolitics, energy and technology. In a macro context, data center and related high-tech business investment has implications for growth and labor demand, and ultimately productivity.



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Navigating the US data center power crunch: On-site solutions offer a faster path to power

Surging electricity loads from data centers, electrification and manufacturing are outpacing grid capacity, prompting a shift toward customer-sited energy resources and capabilities to address data center energy demand.

By Ben Levitt and Doug Giuffre

Highlights

Although pockets of excess generating capacity exist across the US, data centers' impact on load growth is expected to exceed grid-based power generation and transmission capacity.

Limits to grid-based power generation and transmission capacity do not mean data center power demand will go unmet. Instead, technology, market, and policy approaches that deliver power supply for the grid's most constrained hours and locations will command a premium, as will strategies that quickly provide power independent of the grid.

Gas-based power-generating resources, such as gas turbines, are well positioned to meet current needs and have seen renewed demand amid the data center boom. Battery energy storage solutions also offer scalable near-term capacity but depend on evolving market rules and requirements.

With concerns rising over the slow pace of grid-connected capacity expansion, customer-sited energy resources and capabilities offer a faster path to power. Expansion of these resources may continue long term, especially as data center campuses grow.

US electricity demand is set to surge, driven by data centers, electrification, and the reshoring of manufacturing. These factors are expected to lift US grid-based electricity consumption by 17% by 2030 compared to 2025 levels, and potentially by 23% to 25% if data center operators achieve their goals. Grid resources alone are unlikely to meet this pace or maintain the reliability consumers expect. For the first time in decades, the expansion of large-scale electricity consumers will be limited by grid power availability and deliverability. Stakeholders are working to stretch existing grid assets, but these efforts are not matching the speed and scale of AI-driven data center energy demand. In this tight market, companies, states, and grid operators have an opportunity to meet the needs of large energy users and regional grids. With grid-connected capacity slow to expand, customer-sited energy resources and capabilities are positioned to accelerate power delivery.



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Optimism grows as capital flows, but what if AI promises fade?

Data center and AI infrastructure investment are expected to continue growing at pace. Market fundamentals are healthy, but high capital intensity and investor appetite also bring risks for data center financing, owners/operators, and technology companies' ambitions.

By James Manzi, Pierre Georges, Satyam Panday, and Alexandra Dimitrijevic

Highlights

Data center and AI infrastructure investment has grown rapidly, with its contribution to economic growth already evident. Sector market fundamentals are healthy, and digital infrastructure has become a central theme for investors and lenders. With the AI transformation still in its early stages, we expect this will remain the case for several years, supported by robust demand, limited supply, strong earnings, high prices and narrow corporate spreads.

However, with such capital intensity and investor appetite, competition is also increasing fast. This could lead to higher leverage, unsustainable asset valuations, reduced spread differentiation across the asset-quality spectrum and more aggressive financing structures. These are all typical ingredients for busts and highlight the importance of data center risk management.

Other longer-term risks for data centers include overbuilding, lower residual values, obsolescence, tenant credit quality and regulatory requirements. We believe these risks will not be uniform among market participants should AI revenue promises fade.

Over the past five years, transactions in data centers reached about \$450 billion, financed with over \$300 billion of debt, according to Infralogic data. Two-thirds of this aggregate amount was effectively spent over the past two years, making data centers the most invested infrastructure asset class over the period, above solar technology. Some forecasts project total sector financing needs in the trillions over the next five years. The repayment of these sizable borrowings may depend on the future revenue that AI can create on a sustainable and long-term basis, especially for companies that invested heavily but have yet to generate profit, and as structures evolve and new (smaller and riskier) borrowers emerge. This introduces risks for investors as well as data center real estate. We do not believe these risks will be uniform, however, nor likely to surface in the near term, given the seemingly insatiable demand driven by the AI transformation and limited supply. We will be watching for signs that a riskier environment is emerging, including more speculative construction, notably increasing valuation levels, more aggressive financing structures and more tolerance for operating risks. These factors underscore the need for comprehensive data center risk management strategies.



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Geopolitics of data centers: An AI showdown that will reshape the world

The policies of the latest chapter of the fourth industrial revolution will impact the global geopolitical landscape, with data center security and data sovereignty emerging as critical themes.

By Dan Thompson, Tony Lenoir, and Perkins Liu

Highlights

Technological advances historically have led to commercial empowerment and enhanced military capabilities, resulting in greater influence within the spheres of ideas, culture and economics. The stakes around global AI leadership could not be higher.

Accordingly, governments around the world are supporting the data center infrastructure build-out and trade in AI chips needed to secure at least a degree of independence and, for the top players, dominance. The US and China are in the driver's seat, respectively hosting 39% and 22% of global data center power available to IT equipment.

Established geopolitical dynamics and national security are in the balance. Under a prevailing AI umbrella, globalization likely would stay the course, while the coexistence of competing systems might reverse the trend, raising new questions about data sovereignty and cross-border implications for data center security.

Nations worldwide are engaged in an AI race, determining the future of economic competitiveness, national security and societal paradigms. This race requires a massive infrastructure build-out, supported by some public policies and potentially hindered by others. The US has established an early lead in developing data centers to support AI, but China is not far behind. Analyzing the strengths and weaknesses of the two markets suggests a potentially close finish in the home stretch for AI advantage.



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Rapid data center growth faces sustainability challenges: Increasing emissions and water stress

Even if data center operators reduce their own environmental footprint, the exponential growth of the industry could still lead to higher emissions and water stress in regions where data centers are located.

By Dan Thompson, Matt Macfarland, Terry Ellis, and Victor Hazell Laudio

Highlights

Global data center power demand is projected to nearly double between 2024 and 2030. Data center companies are leading clean power procurement efforts to meet their power needs and climate ambitions. But fast growth points to challenges ahead, with broader impacts — in the US, we expect emission reductions in the power grid to slow, and emissions could ultimately grow compared to previous forecasts due to rapid data center expansion.

We also estimate that 43% of data centers globally are exposed to high water stress in the 2020s. While adaptation and resilience measures are being incorporated into data center designs for areas most affected by water stress, water management programs are not yet widespread across the industry in North America and Europe, according to 2024 S&P Global Corporate Sustainability Assessment (CSA) data.

Data center operators' plans must carefully balance high growth expectations and power demand, with site-specific solutions required, such as using recycled water or treated wastewater to reduce potable water use. Reputational risks could be heightened if stakeholders feel spillover impacts.

S &P Global Market Intelligence 451 Research projects that global data center power demand will nearly double between 2024 and 2030. In addition, research from S&P Global Ratings and S&P Global Energy shows that many existing data centers will be in water-stressed regions. Addressing these intertwined challenges — escalating energy needs, rising emissions and water scarcity — requires a broader ecosystem-level analysis. Can the industry navigate this complex interplay of factors while sustaining rapid growth?



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Disrupting the future: Quantum in data centers?

While quantum computing has the potential to transform the world of compute, quantum computing integration into existing data center environments is rife with complexity — and brimming with opportunity.

By Ellie Brown and Kelly Morgan

Highlights

The emergence of fault-tolerant quantum computing, able to detect and correct quantum errors in real time, is only a few years away. Yet significant gaps in industry knowledge and system design stand between today's data center blueprints and quantum computing integration.

For the foreseeable future, key differences inherent to quantum modality types will necessitate uniquely customized quantum data center environments.

Quantum system deployments remain primarily lab-based, although a shift is taking place as hyperscalers, telcos and governments begin to acquire and prioritize quantum computing infrastructure, with quantum hubs emerging in high-value, high-expertise locales.

Quantum is no longer confined to the realm of science fiction. There has been a surge in quantum computing power and reliability in the last few years, with intermediate-scale systems already in use and fault-tolerant, universal machines anticipated as early as 2028. While the scientific progress behind these advancements is laudable, the next steps of the quantum journey will require a focus on engineering and product expertise. Quantum computers remain bulky, finicky and non-standard — a challenge as they look to evolve out of laboratory contexts and into the existing data center market. Quantum architectures that play nicely with classical compute infrastructure will have an advantage in quantum computing data center deployment — and may even dictate the future trajectory of quantum technology.



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The Saudi Arabia data center market: A catalyst for economic innovation

Saudi Arabia is experiencing a digital transformation as it seeks to diversify its economy.

By Mai Barakat

Highlights

The Saudi Arabia data center market is poised for significant expansion as the kingdom transforms its economy. This growth stems from both market forces and targeted government policy. The kingdom's Vision 2030 plan seeks investment to diversify the economy beyond oil dependence.

Increases in operations by hyperscale providers like AWS, Microsoft and Oracle are driving cloud computing in Saudi Arabia. As these organizations build their market presence, they require scale and efficiency, encouraging a trend toward wholesale data centers.

Aiming to emerge as a global technology hub, the kingdom is investing in AI and developing Arabic large language models. Government initiatives seek to develop expertise in AI and cloud computing, supporting Saudi Arabia's digital transformation.

Dammam, Riyadh and Jeddah are becoming the country's data center sites of choice. Each of the three cities has unique advantages, such as location, access to resources, and well-established infrastructure, making them desirable sites for digital and cloud services investment.

The Saudi Arabia data center market is rapidly becoming central to the kingdom's digital economy. The data center sector's megawatt load is projected to expand at a 29% growth rate from 2024 through 2030, driven by Vision 2030 initiatives, ambitious AI investments, and the country's abundant energy resources. As global hyperscalers commit billions of dollars to increase capacity and regulatory reforms attract unprecedented foreign investment, data centers are positioning the kingdom for regional and global competitiveness while accelerating economic diversification beyond oil dependence.



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