Data Centers
2023 Global Outlook

Rapidly expanding data needs accelerate growth and drive investor interest, even as headwinds persist

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Executive summary

Data centers are the hidden infrastructure underpinning all digital activities. Internet usage is almost universal, reaching 91% in North America, 87% in Europe and 73% in Asia Pacific, and mobile phone subscription and use rates are even higher at above 90% in most markets. The demand from smartphone-based applications has driven an appetite for more digital infrastructure from cloud service providers, hyperscalers and over-the-top media companies in all regions. The global colocation data center market size is forecast to grow with a five-year CAGR of 11.3% from 2021 to 2026, and the hyperscale market is expected to grow even faster, at approximately a 20% CAGR.[1]

In this market perspective, we explore the global dynamics and outlook for the data center industry in 2023 and beyond.

Challenges

While demand is high, current challenges limit industry growth. Supply chain delays have limited new construction, altering market dynamics toward preleasing. Skills shortages in technical fields limit new construction and make it more difficult to own and operate a data center.

Opportunities

Sustainability and energy efficiency are top priorities for data center users, operators and investors. Legislation and self-regulatory initiatives are setting standards to improve the industry's climate impact. Those who react the fastest and improve efficiency with both energy and water usage stand to benefit, as environmental impacts are top of mind for most leading companies.

Demand

The fastest-growing segments of the data center space are hyperscalers and edge data centers. Hyperscalers cater to the increasing demand, while edge allows diversification and improves latency. The rise of artificial intelligence (AI) will both bolster demand, with increased data usage, and improve computing efficiency.

Investor impact

Capital markets pricing challenges are causing decreasing volumes across all sectors, but data centers still have high interest from investors. Opportunities exist for development plays in key markets, especially for value-add opportunities such as redevelopments. Supply chain limitations have also limited development activity, opening the door to increased opportunity to purchase existing assets or sale-leasebacks.

[1] Structure Research, 2022: Global Data Centre Colocation & Interconnection Report
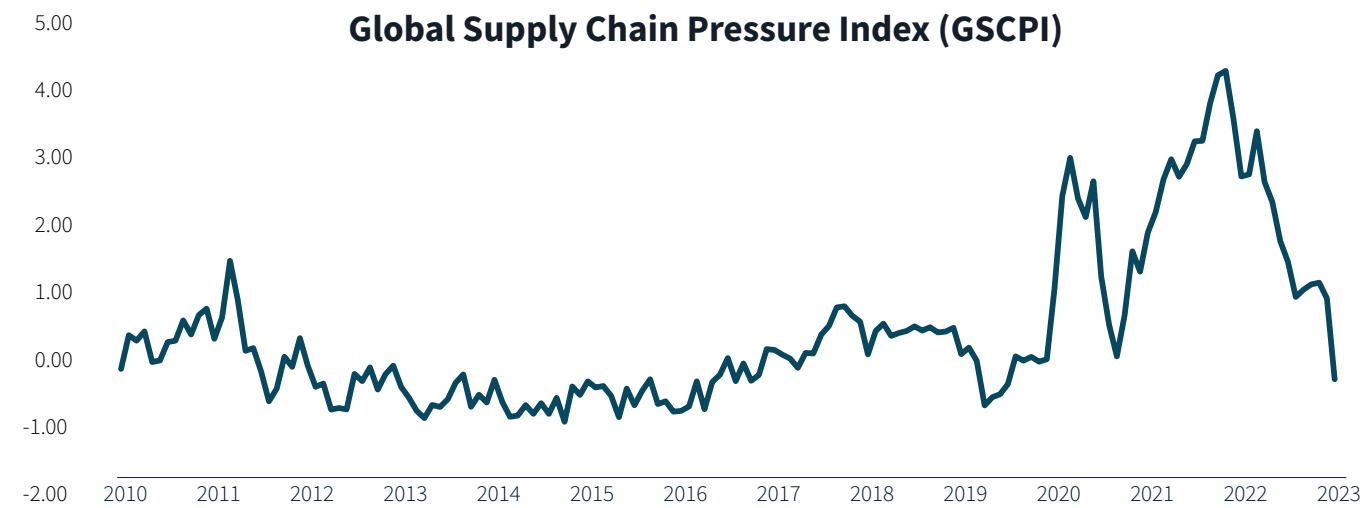
Challenges

Supply chain issues cause lead times to increase, making supply unable to keep up with demand

Due to supply chain challenges during the pandemic and geopolitical tensions, components required to build and operate data centers have been delayed. This has pushed back construction timelines, but with demand remaining strong, users have turned to preleasing. In all regions, a large portion of the new supply pipeline is preleased, with most of the vacant new supply not expected to deliver until late 2023 or 2024. Absorption in 2023 is expected to be lower than in 2022 because developers have pushed back lead times from the norm of 12–16 months to more than 24 months.[2] Deals for new spaces signed now will not be delivered until at least mid-2024 due to the time it takes to acquire components.

While pandemic-related lockdowns are abating, given China's repealing of the Zero Covid policy, new challenges have emerged including geopolitical tensions in Europe and Asia Pacific. Key natural resources, such as neon for semiconductor manufacturing, have been limited due to the war in Ukraine. Labor availability remains an issue for manufacturers, and increasing wages contribute to increasing prices.

Supply chain delays will continue to be an issue throughout 2023 but should moderate in 2024 as operators and users adjust to newer, slower timelines and manufacturers find additional suppliers and make processes more efficient. The Federal Reserve's Global Supply Chain Pressure Index declined significantly in February 2023, showing that on average supply chains have returned to normal despite some challenges for select materials.

To mitigate supply chain challenges, developers and operators need to plan for greater lead time and address critical path issues and bottlenecks. Operators are using multi-sourcing to reduce the risk of relying on a single supplier. Nearshoring and friend-shoring to avoid delays due to political tensions has increased, and protectionist measures such as the CHIPS Act in the U.S. and a comparable legislation under discussion in the EU seek to address supply chain issues but will not have a substantial impact in the short term as new factories will take several years to bring online. Users are extending the life of their hardware and refreshing servers less often, extending the use of servers for up to seven years.

Global Supply Chain Pressure Index (GSCPI)

Source: Federal Reserve Bank of New York, Global Supply Chain Pressure Index, https://www.newyorkfed.org/research/gscpi.html

[2] Credit Suisse, 2023 Outlook: The cloud has four walls, January 18, 2023

Most vendors delay deliveries to customers

Which of the following options best describes the timeliness of your product supply to your data center customers? (n=467)

Our prioritized customers receive a timely supply (others may be exposed to delays) 29%

All customers may be exposed to delays 48%

All customers receive a timely supply 23%
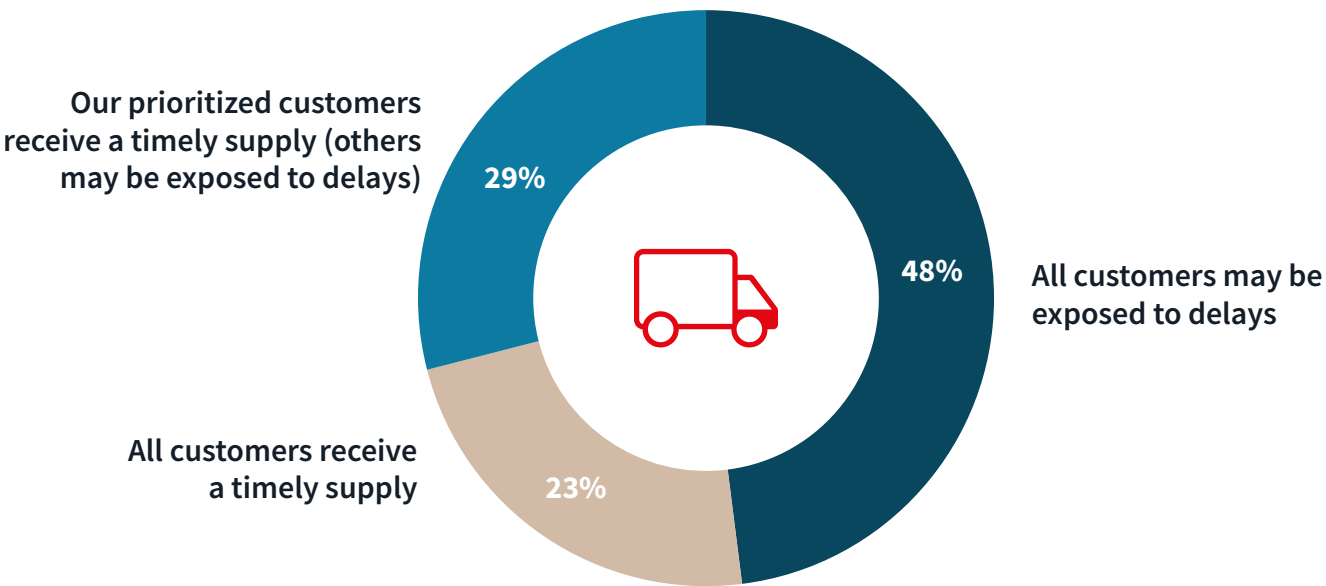
Source: Uptime Institute

Skills shortage a challenge for continued growth of data center market, and tech cannot help yet
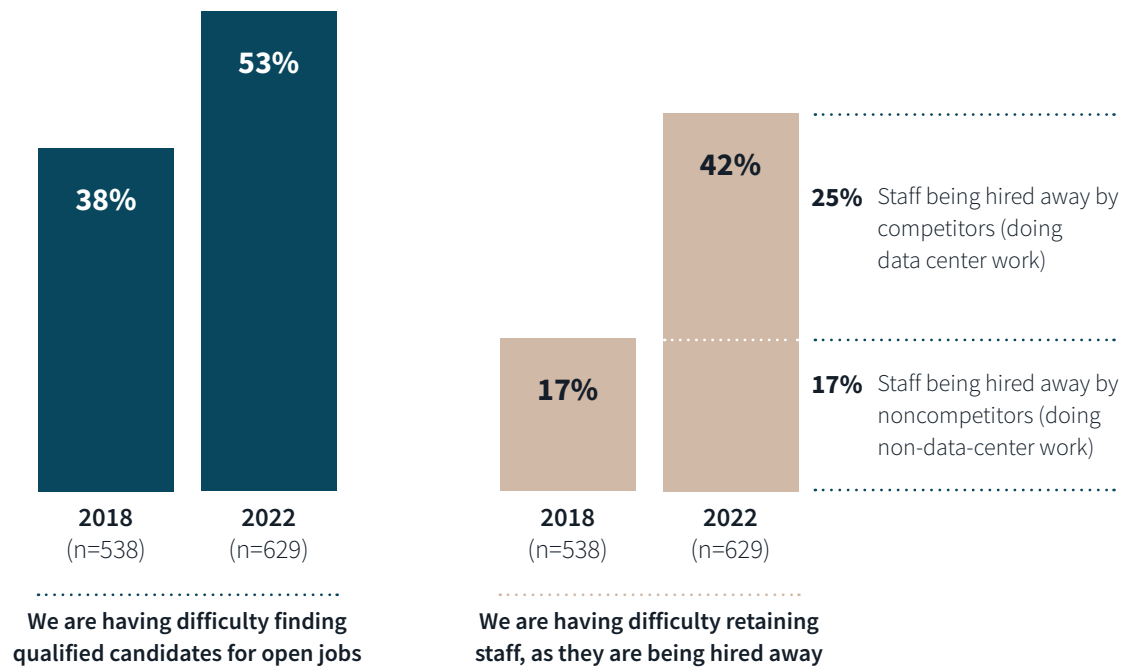
The high-tech data center industry requires specific skill sets to both build and staff, and employment requirements have boomed in the rapidly expanding industry. Uptime Institute forecasted that the data center industry would grow from about 2 million FTE employees in 2019 to 2.3 million in 2025, a 15% increase.

The mature data center markets in the U.S., Western Europe and Asia Pacific are faced with demographic challenges. According to Uptime Institute's annual data center survey, nearly half of the workforce has more than 20 years of working experience in the sector, and therefore may be approaching retirement age within the next decade. An aging workforce is compounded by limited entrants into the data center space due to poor visibility into the types of jobs and skills needed. Lack of available talent is the biggest challenge facing the technology sector as a whole in EMEA, according to the global tech trends and strategies report from Equinix. Additionally, women remain underrepresented, with only 4% of operators surveyed by Uptime Institute responding that half of their workforce was women.

More operators struggle with attracting, retaining staff

Please select any of the following statements that apply.

We are having difficulty finding qualified candidates for open jobs

- 2018 (n=538): 38%
- 2022 (n=629): 53%

We are having difficulty retaining staff, as they are being hired away

- 2018 (n=538): 17%
- 2022 (n=629): 42%
  - 25% Staff being hired away by competitors (doing data center work)
  - 17% Staff being hired away by noncompetitors (doing non-data-center work)

Source: Uptime Institute

To counter labor shortages, governments have instituted training programs or requirements for high-tech jobs.

- In the U.S. as part of the CHIPS for America Act, grants and loans will help boost the education pipeline, which will indirectly impact the whole technology ecosystem, including data centers.

- In APAC, data center and cloud companies are opening educational institutions to address the data center skills shortage and demonstrate contribution to the local economy. Microsoft announced its first Data Center Academy in Singapore to advance applied data center skills. Amazon launched a program in New Zealand to allow small and medium businesses access to over 200 cloud services. Oracle has started a free training program in Singapore that will help to expand Singapore's IT talent pool required for growth and innovation.

- In Europe, the Digital Europe Programme, a new funding program from the European Commission armed with a €7.5 billion overall budget will be focused on shaping the digital transformation and infrastructure of Europe, including master courses to help boost digital skills.

- In January 2023, the European Commission announced the launch of the Artificial Intelligence Skills Alliance (ARISA), aimed at upskilling and reskilling prospective employees in the field of AI technology. This will be funded under the Erasmus+ program, the EU's support for education and training.

For data center users, outsourcing all data center operations or even just outsourcing staffing can alleviate issues by having a specialist to train and deploy operators. A third party can often do this more efficiently and cost-effectively than in-house, since specialists can work on multiple facilities.

Technology can also help counter the need for more labor, eventually. AI is increasingly being used in data centers for efficient operations and power and cooling systems. However, the technology is not advanced enough yet to replace staff, and most operators believe it will be more than five years before AI will allow data centers to reduce staffing levels.[3] Currently, AI is creating more jobs than it is replacing, according to a recent study from Lightcast.[4]

[3] Uptime Institute, 2022 Data Center Industry Survey
[4] Lightcast, Talent Playbook, 2023

Opportunities

Sustainability: Regulation and independent initiatives incentivize sustainability improvements

Sustainability is a top priority for all data center operators as demand for data centers is rapidly growing. This includes the need to address energy use and emissions. Legislation and self-regulatory initiatives aim to set standards to improve the climate impact of the industry.

Region/ Country	Initiative	Details	How to prepare
Europe	Corporate Sustainability Reporting Directive (CSRD)	• Law that will apply to over 50,000 EU companies • Requires sustainability disclosures on environmental, governance and social factors • Increase transparency around emissions to inform investors on sustainability impact of companies' operations, to aid in achieving the goals of the Paris Agreement • Reporting in line with Sustainable Finance Disclosure Regulation (SFDR)	• Perform a gap analysis to understand where the company stands in relation to CSRD requirements and the information necessary to collect to understand the impact on people and the environment • Define a transition plan to sustainable energy • First reporting period will be for FY24, so companies must start identifying how to collect information on carbon impacts and climate risks
Europe	Climate Neutral Data Center Pact (CNDCP)	• Self-regulatory initiative formed by 25 European cloud and colocation providers • Since expanded to 81 operators and 27 associations, covering over 90% of the data center industry in Europe • Goal is to make all data centers climate neutral by 2030 • The CNDCP sets specific targets for energy efficiency, clean energy, water conservation and circular economies	• Participating data centers must certify adherence by July 2023 • New data centers in the EU must have a PUE of 1.3 in cool climates and 1.4 in warm climates
Singapore	Data Center Moratorium	• As part of lifting the data center moratorium, which stood from 2019 to 2022, data center developers were invited to apply for new construction if they met the objectives of decarbonization and efficiency • Potential projects also evaluated on economic impact and ability to support Singapore as the regional interconnectivity hub • Incorporates best-in-class PUE, IT energy-efficiency measures and Green Mark for DC Platinum Certification for data center buildings	• Over 50 developers applied to build under the first phase of the pilot program • PUE of 1.3 required

Region	Initiative	Details	How to prepare
U.S.	Inflation Reduction Act of 2022	• Extended tax credits for sustainable energy sources • Created a new technology-neutral tax credit starting in 2025 • Expanded incentives through IRC Section 179D for immediate tax deductions for energy-efficient system installations	• Tax credits make sustainability improvements more cost-effective. Operators can elect for direct-pay for carbon capture credits or sell carbon credits. This allows data center operators to receive a benefit directly after investing in equipment that reduces and/or sequesters carbon
U.S.	SEC rule on climate disclosures	• Expected to take effect in 2024 applying to 2023 reporting years • Will be based on the Taskforce on Climate-Related Financial Disclosures (TCFD) • Likely to include disclosures on climate governance, climate-related risks and impacts and Scope 1, 2 and 3 greenhouse gas emissions	• Starting to track climate-related data can help operators and users prepare for disclosures • Renewable energy certificates and PPAs can help meet emissions targets
Canada	Canadian Net-Zero Emissions Accountability Act and 2030 Emissions Reduction Plan	• Committed to zero emissions by 2050 • Targeting a 40%–45% reduction in greenhouse gas emissions by 2030 • Each province has implemented a carbon-pricing policy and charges industrial companies and power generators with emissions over a baseline	• Identify sources of renewable energy • Reduce emissions by improving PUE

Climate legislation and initiatives are driving technology improvements and new sources of power. Companies are exploring micro-nuclear power sources, first as backup power, but it has the potential to be a primary power source as well. Liquid cooling innovations allow hot servers to run more efficiently. As the increase in carbon regulations grows, interest in retrofitting will grow, since the carbon impact of a new build will be greater than reusing unused real estate.
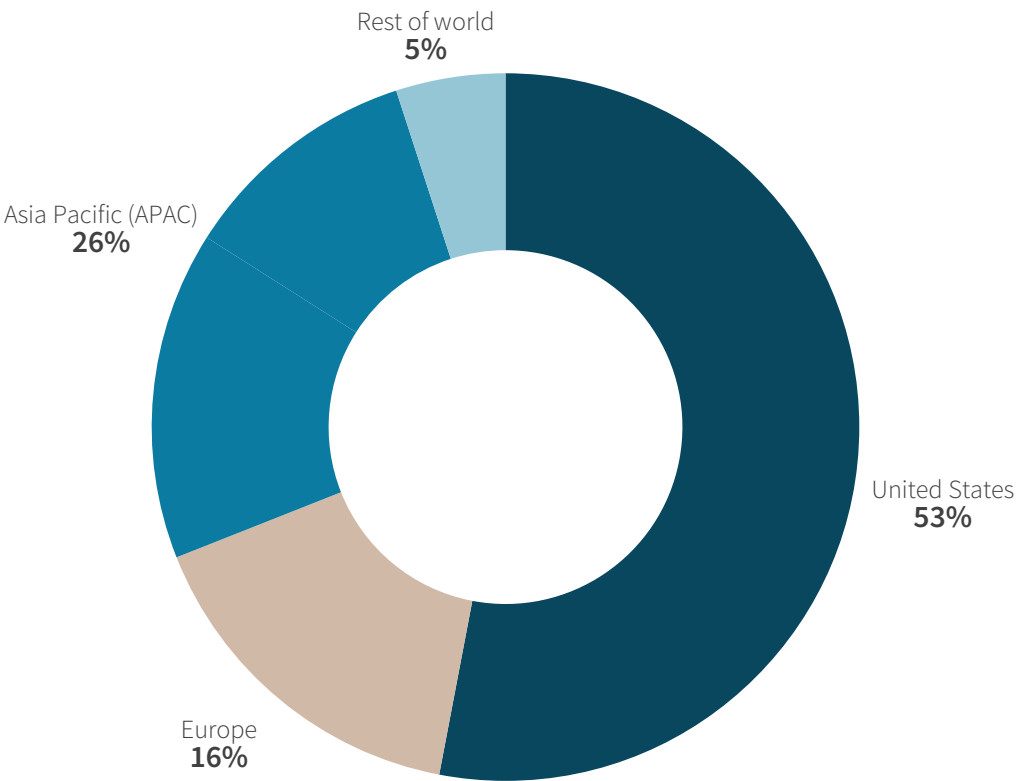
Hyperscale: scaling up on size and efficiency

The Data Center industry witnessed exponential growth during the last decade as cloud computing took center stage. Ten to fifteen cloud service providers, over-the-top media services and hyperscalers dominate the market and lead global demand. The global public cloud market grew from US$9 billion in 2009 to US$208 billion by 2019[5]—a 37% CAGR growth. The pandemic propelled higher growth of cloud services, which led to the number of hyperscale data centers increasing from 259 in 2015 to 700 in 2021.[6] The capex trends of leading cloud service providers like Amazon, Google, Meta, Microsoft, Apple, Alibaba and ByteDance led to a sharp rise in the number of hyperscale data centers globally.

[5] Forrester Research
[6] Synergy Research Group

Demand

Continued growth in developed and frontier markets

In the next five years, the fastest-growing segments of the data center market will be large data centers in key markets and edge data centers providing greater connectivity.

Developed regional hub markets such as Northern Virginia, Hong Kong and Frankfurt will continue to grow even in the face of unfavorable conditions such as higher land and utility costs because these markets offer low risk and stability. It is difficult for other markets to build up the dense enterprise ecosystems, network connectivity infrastructure and service provider capabilities of these hubs. Enterprises and hyperscalers will plan to centralize or consolidate low-latency workloads from throughout the region into these hubs to enjoy economies of scale, minimize excess capacity and centralize governance. However, power is constrained in many of these hub markets—Amsterdam has imposed stricter rules for data centers due to energy consumption, and Loudon County in Northern Virginia has limited available power. This is driving growth out into secondary markets such as Atlanta, Berlin and Chennai.

The proliferation of mobile devices globally and the Internet of Things has pushed applications closer to the end user and the edge. The bandwidth and latency demands of next-generation applications based on AI, machine learning and augmented reality are now driving growth in secondary and frontier markets. For future developments, the closer to core regional hubs, the larger the data center will be. The further away to the edge the development, the smaller the data center will be.

Share of hyperscale data center capacity by region

- Rest of world: 5%
- Asia Pacific (APAC): 26%
- United States: 53%
- Europe: 16%

Source: Synergy Research Group

Top 10 Hyperscalers by self-build capacity
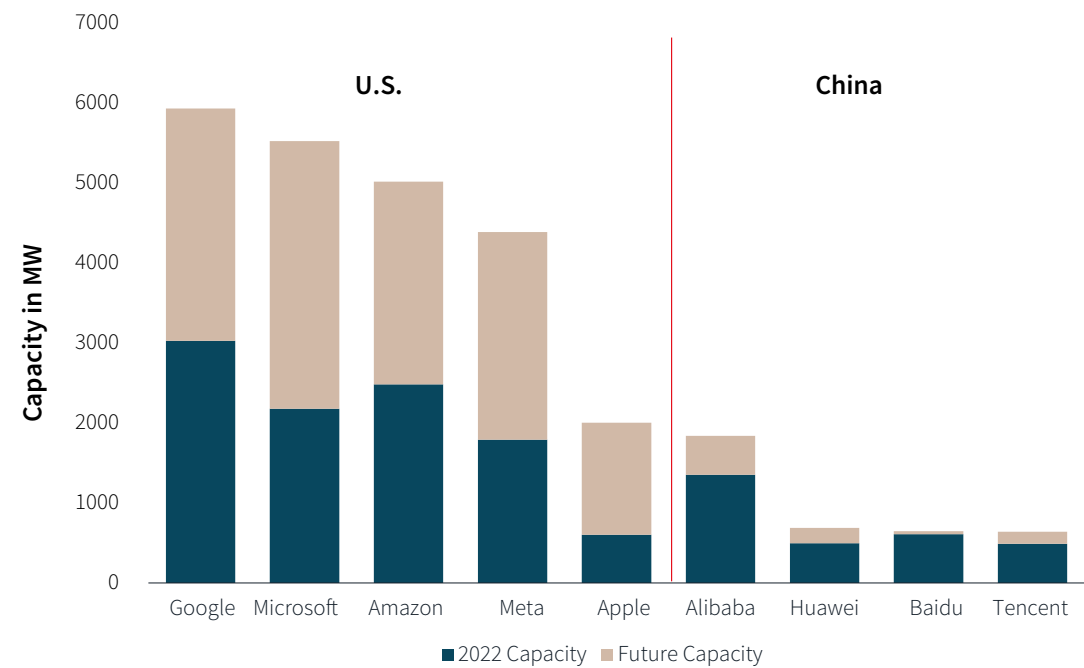
Source: Data Center Knowledge

In 2023, data center builds announcements of over 100 MW are not uncommon, whereas a decade ago 10 MW was a large requirement. When hyperscalers are unable to build in a select market due to land, power or supply chain constraints, they may lease a whole data center from a colocation provider, making it difficult for smaller requirements to find adequate space.

Globally, 314 new hyperscale sites are in development, and at the end of 2024, the number of hyperscale sites will pass 1,000, up from around 500 sites just five years ago. The U.S. is expected to remain the center of hyperscale developments over the next few years, while other regions like China,

Ireland, India, Spain, Israel, Canada, Italy, Australia and the UK are also witnessing hyperscale growths. The public cloud services market revenues[7] are expected to grow at a CAGR of 19.8% from 2022 to 2026, which is going to increase the demand for hyperscale data centers.

Hyperscale data centers continue to make their operations smarter and more efficient by using software-driven systems. Increasing cloud usage led to the emergence of software-defined data centers where all the infrastructure elements—networking, storage, CPU and security—were virtualized and delivered as a service.

[7] IDC Worldwide Whole Cloud Revenue forecast, 2022

Software-defined infrastructure is managed by software with minimal human intervention and enables policy-based automation of IT operations such as monitoring, provisioning and configuration, greatly improving efficiency. The digital transformation has led to the adoption of next-generation applications like artificial intelligence, machine learning and augmented reality. These applications require high-density computing including high-performance computing, converged, hyper-converged and composable softwares. This allows cloud providers to use the computing power efficiently, potentially reducing operational costs for users through their scale.

Artificial intelligence: The rise of machine learning chatbots

The AI goldrush is firmly on the way, and we are still at the beginning. OpenAI's ChatGPT, with an investment from Microsoft, has led to Google reallocating resources to work on a rival "Bard." Generative AI uses advanced machine learning algorithms combined with incorporating human feedback into the model to answer questions and write code, essays or even songs. The current iteration of the ChatGPT model has 175 billion parameters, over 100 times bigger than its predecessor.

As uses become more prevalent, this will cause significant demand for computing power in data centers. It takes a huge amount of computing power and massive resources to run and train these models, limiting the number of companies that can make breakthroughs. The server computer density

required by AI also creates a tremendous amount of heat, and to counter this, innovations in liquid cooling are developing.

In addition to increasing data center use, AI will be used to support AI's high density and performance requirements. Gartner estimates that half of all cloud data centers will use AI by 2025. Data center operations will use machine learning and AI to help improve performance and efficiency. AI will help react to how the data center is performing in real time. AI can also facilitate operation-based technology such as liquid cooling. This can help data centers become more efficient, cost effective in the long term and sustainable, as liquid cooling is estimated to be up to 3,000 times more effective than air.
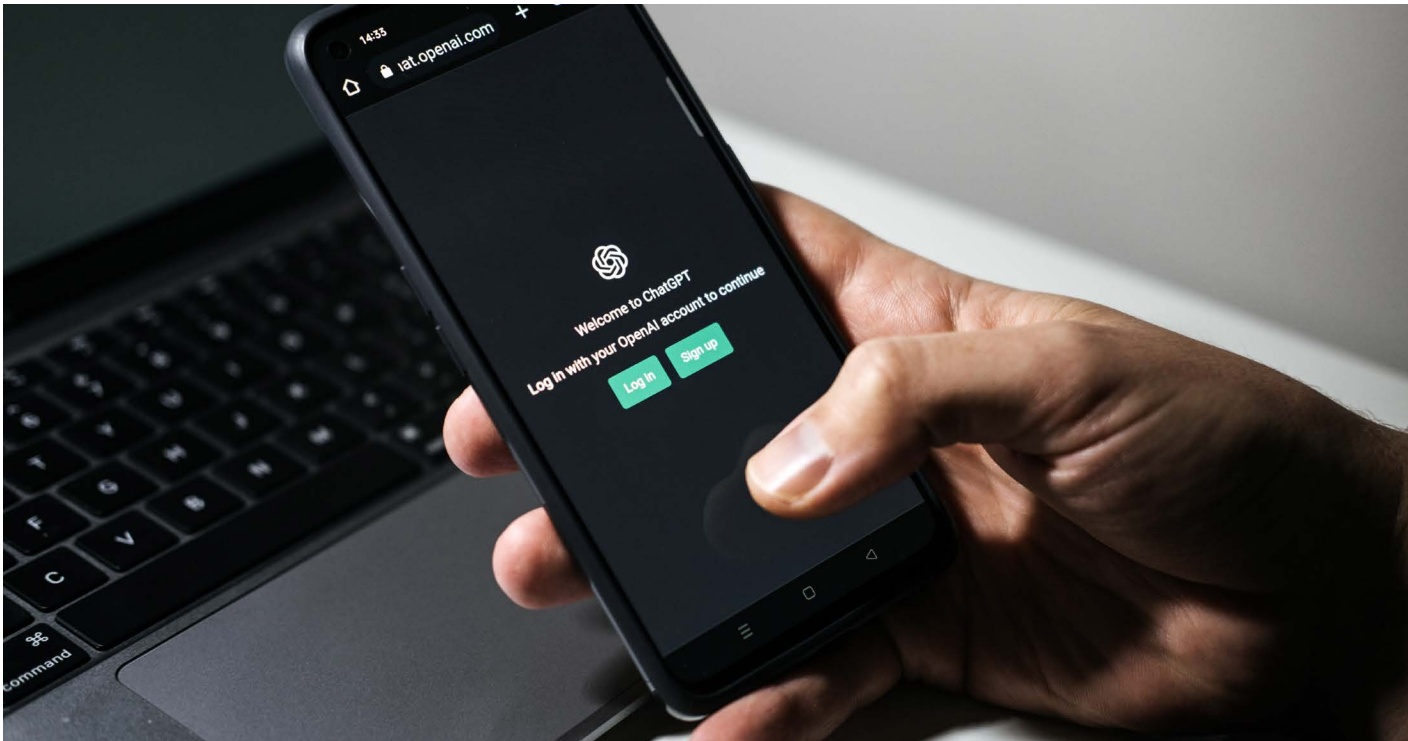
Investor impact

Global uncertainty results in slower transaction volumes in 2022

Data centers are in high demand among investors. Due to high development costs and strong demand, supply continues to closely track absorption, keeping vacancy at record lows and allowing operators to keep strong pricing. Private equity has increased its appetite for data centers and, in 2022, accounted for 91% of the US$48 billion of data center M&A. In the last four years, KKR, Blackstone and Berkshire Partners all acquired major data center operators in the U.S. In Asia Pacific, the Macquarie Group acquired an AirTrunk Data Center portfolio and Bain Capital acquired Xiamen Qinhuai Data Center. Data centers are among the top three

asset classes anticipated to see the largest net increase in loan exposure over the next 12 to 24 months, according to JLL's Annual Lender Survey.[8]

Transaction volumes for almost all asset types slowed in 2022, including for data centers, due to global economic uncertainty. Rising interest rates strained the global capital markets with debt costs rising. This, combined with past industry consolidation, has made it more difficult to complete larger transactions. The U.S. comprises an outsized share of data center transactions, accounting for 52% of all transactions from 2018 to 2022.

[8] JLL Lender Survey, December 2022

Global data center annual transaction volume
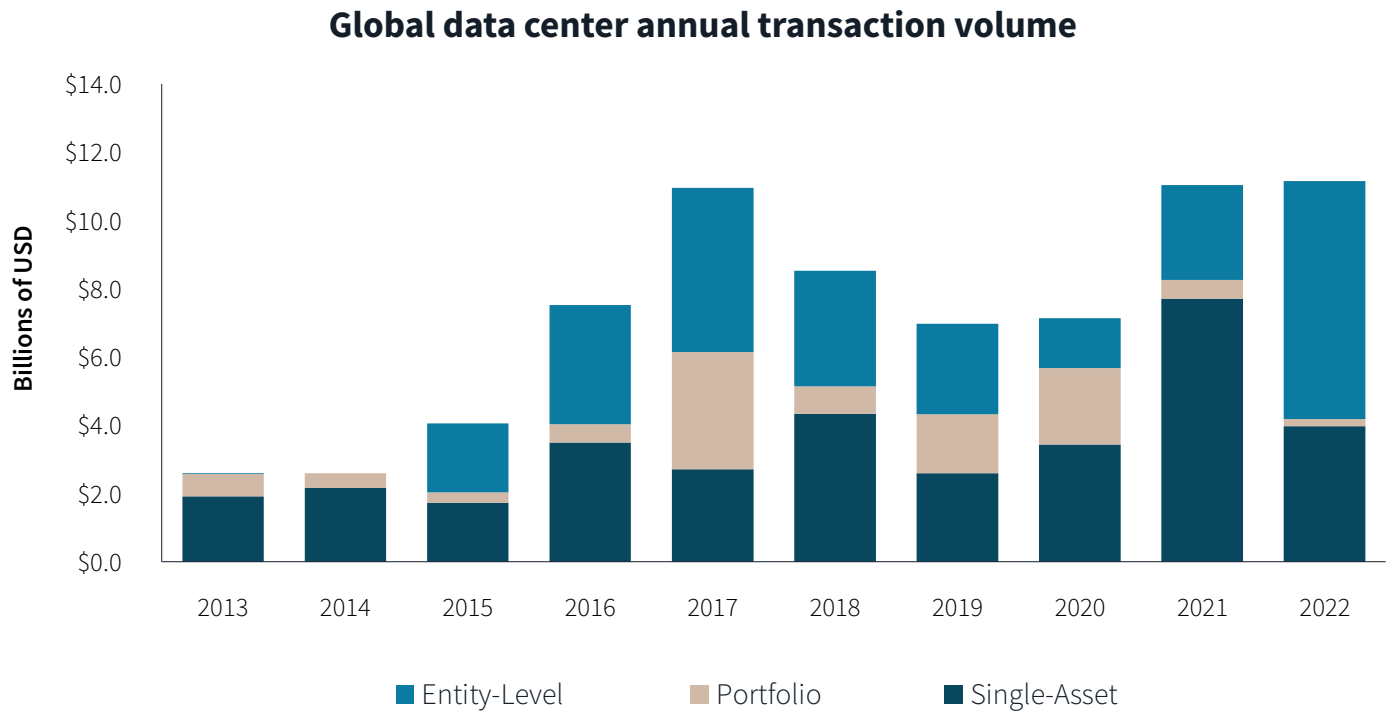
Source: JLL Research; deals US$5MM and above

For data centers, this has resulted in core fund buyers shifting to value-add opportunities. The risk-free rate of U.S. Treasuries has gone up over 150 bps since January 2022, driving borrowing rates up for investors and expanding cap rates. Nominal cap rates for data center assets have risen to 5.5% on average from a valley of 4.7% in Q1 2022. This remains significantly lower than average cap rates in 2019 and 2020, and rates likely will rise further in 2023. As investors search to maximize yields and obtain higher returns, fundraising for core assets has decreased and value-add and opportunistic has increased. This shift is likely to continue throughout 2023.

Infrastructure capital raised ($B) by type

Source: Pitchbook | Geography Global

North America Data Center Cap Rates

Source: Greenstreet

Share of infrastructure capital raised by type

Source: Pitchbook | Geography Global
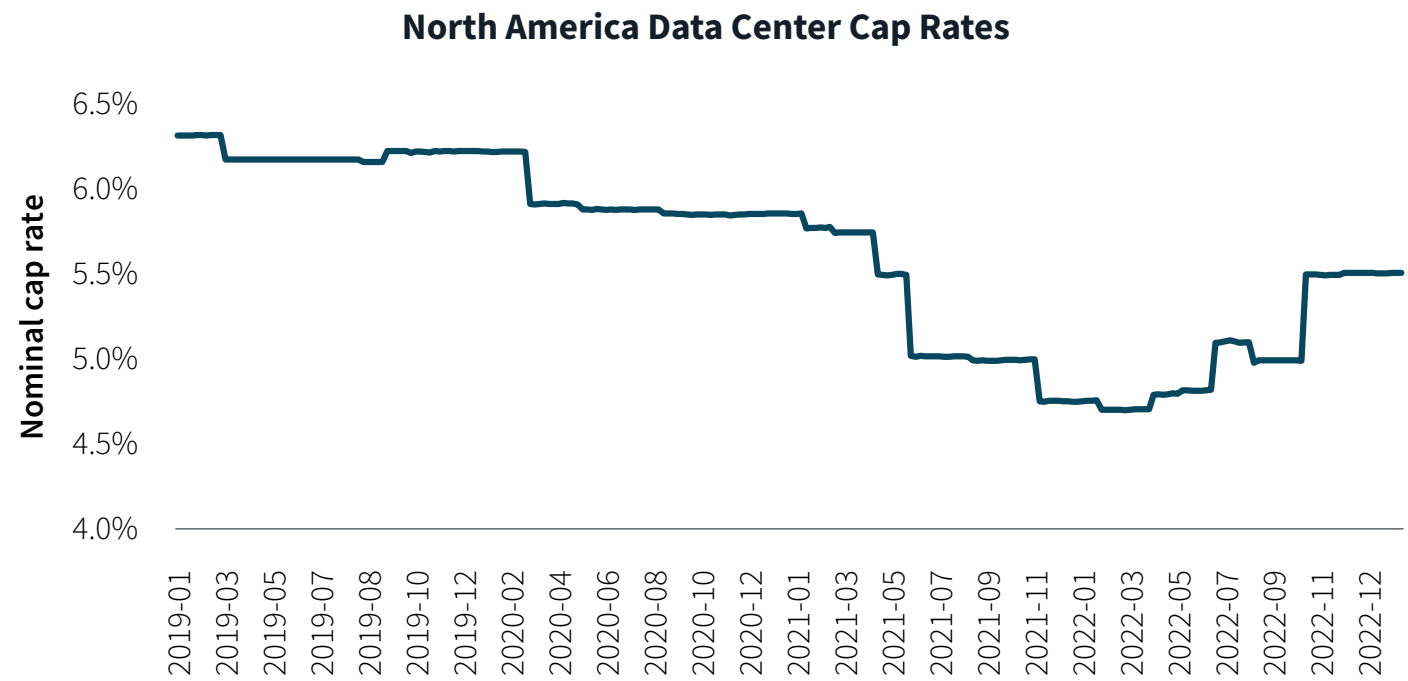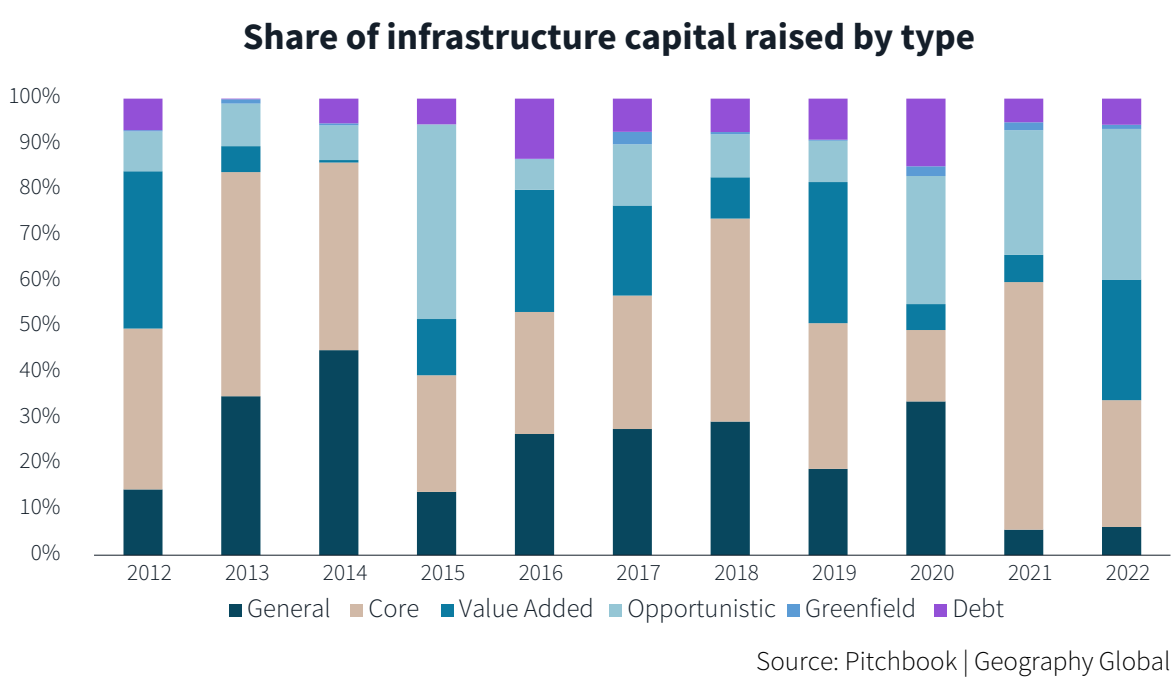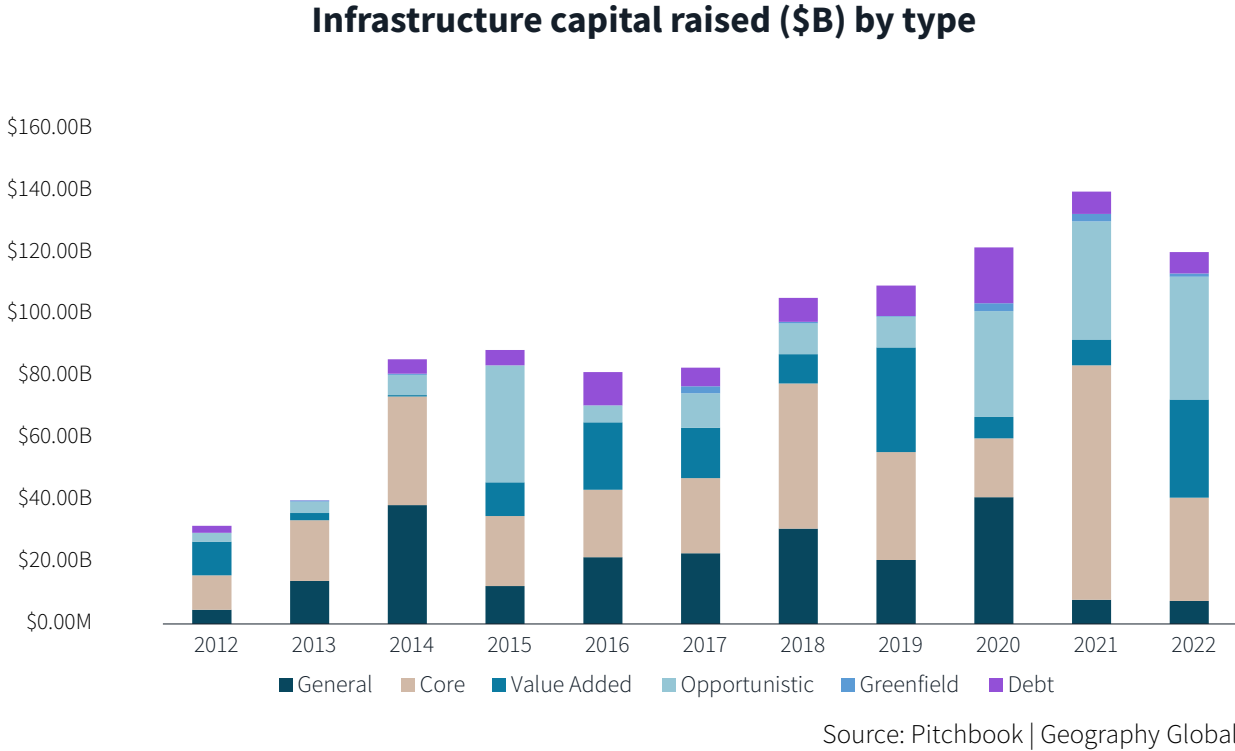
Demand for enterprise sale leasebacks has risen as the existing infrastructure is in place, mitigating the construction and supply chain delays, and these assets provide stable yield. A sale leaseback also enables the enterprise user to focus on their core business, and an investor can typically generate more efficiency from the space, thus generating a stable return.

Market overview

Primary and select growing secondary markets

London, United Kingdom
Total Inventory (MW): 905.7
Under Construction (MW): 121.7

Tokyo, Japan
Total Inventory (MW): 908
Under Construction (MW): 228

Chicago, United States
Total Inventory (MW): 836.2
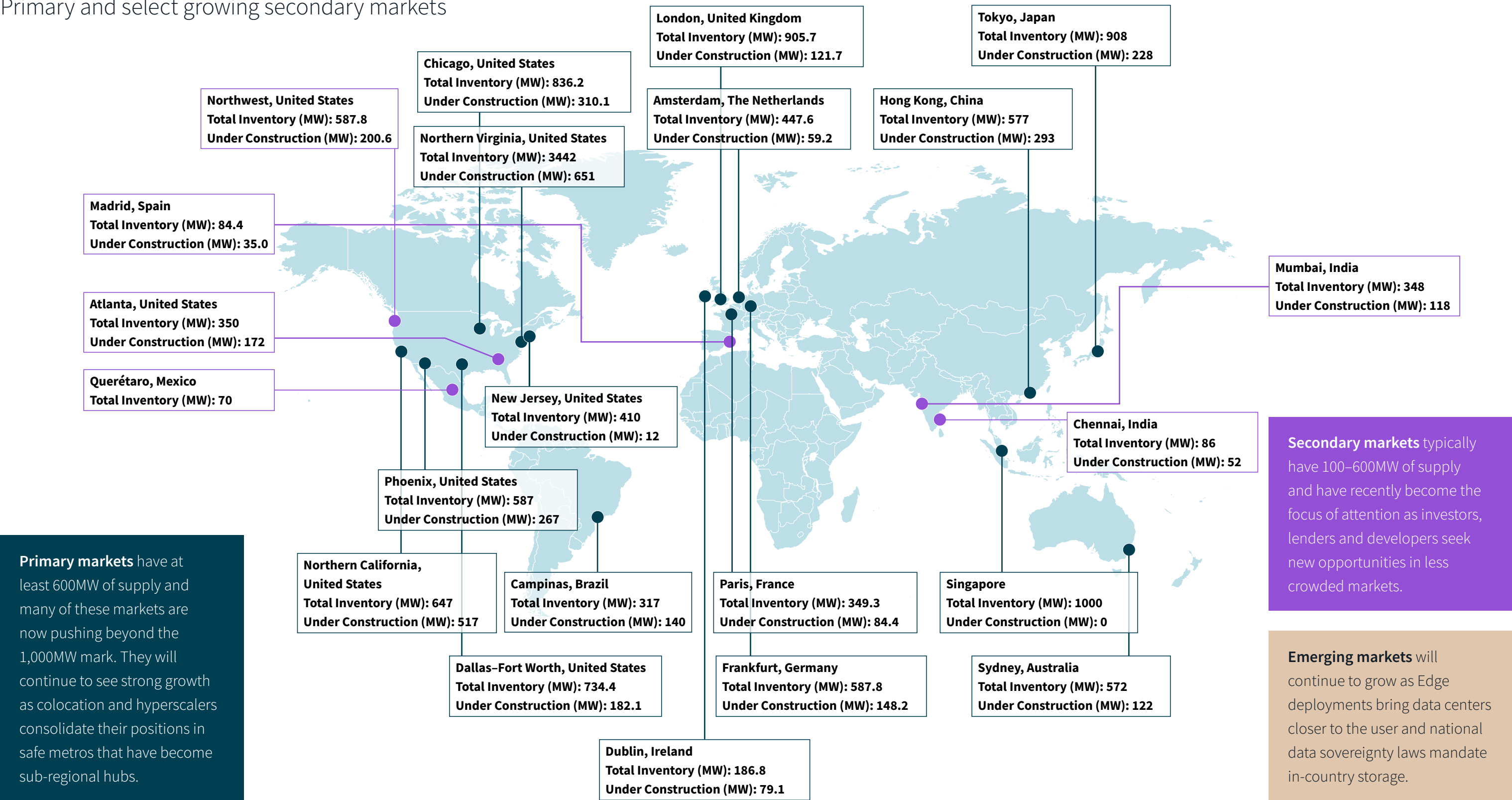Under Construction (MW): 310.1

Northwest, United States
Total Inventory (MW): 587.8
Under Construction (MW): 200.6

Amsterdam, The Netherlands
Total Inventory (MW): 447.6
Under Construction (MW): 59.2

Hong Kong, China
Total Inventory (MW): 577
Under Construction (MW): 293

Northern Virginia, United States
Total Inventory (MW): 3442
Under Construction (MW): 651

Madrid, Spain
Total Inventory (MW): 84.4
Under Construction (MW): 35.0

Mumbai, India
Total Inventory (MW): 348
Under Construction (MW): 118

Atlanta, United States
Total Inventory (MW): 350
Under Construction (MW): 172

Querétaro, Mexico
Total Inventory (MW): 70

New Jersey, United States
Total Inventory (MW): 410
Under Construction (MW): 12

Chennai, India
Total Inventory (MW): 86
Under Construction (MW): 52

Secondary markets typically have 100–600MW of supply and have recently become the focus of attention as investors, lenders and developers seek new opportunities in less crowded markets.

Phoenix, United States
Total Inventory (MW): 587
Under Construction (MW): 267

Primary markets have at least 600MW of supply and many of these markets are now pushing beyond the 1,000MW mark. They will continue to see strong growth as colocation and hyperscalers consolidate their positions in safe metros that have become sub-regional hubs.

Northern California, United States
Total Inventory (MW): 647
Under Construction (MW): 517

Campinas, Brazil
Total Inventory (MW): 317
Under Construction (MW): 140

Paris, France
Total Inventory (MW): 349.3
Under Construction (MW): 84.4

Singapore
Total Inventory (MW): 1000
Under Construction (MW): 0

Emerging markets will continue to grow as Edge deployments bring data centers closer to the user and national data sovereignty laws mandate in-country storage.

Dallas–Fort Worth, United States
Total Inventory (MW): 734.4
Under Construction (MW): 182.1

Frankfurt, Germany
Total Inventory (MW): 587.8
Under Construction (MW): 148.2

Sydney, Australia
Total Inventory (MW): 572
Under Construction (MW): 122

Dublin, Ireland
Total Inventory (MW): 186.8
Under Construction (MW): 79.1

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