Data Centre Market Overview

DC Byte, 13 May 2024

GLOBAL DATA CENTRE MARKET

The global data centre colocation market supply continued to expand by 13.0% in 2023. This was slightly slower than the 13.4% recorded in 2022 and tampered by intense competition for power and land in major developed data centre markets.

The rise of generative Artificial Intelligence ("AI") and Machine Learning ("ML") is expected to propel the growth of data centre infrastructure. Operators and hyperscalers have begun expanding operations beyond traditional established clusters, seeking regions with abundant land and power resources to cater to the specialised requirements of AI applications. Bloomberg estimated that the revenue generated within the AI infrastructure market is projected to reach a 10-year compound annual growth rate ("CAGR") of 30% between 2022 and 2032F. While many of the generative AI programmes are in training stages and take place predominantly in the United States, Europe and Asia Pacific are expected to follow closely behind.

Data centres with higher power density are required to support the high compute workloads required by generative AI and ML. In the United States, data centres need to have a higher rack density of 100 kilowatt ("kW") to 125kW per rack (up from the average of 15kW to 60kW per rack). This also necessitates the use of more efficient cooling methods such as liquid cooling. The transition to high density racks and implementation of liquid cooling into data centre designs are expected to take several years, with short-term AI demand being deployed on cloud platforms in the interim.

Power supply constraints pose a key challenge to data centre developments in established data centre markets like Tokyo, Northern Virginia, and the FLAP-D (Frankfurt, London, Amsterdam, Paris, and Dublin) markets, where the waiting time for power can range from three to 10 years. Regions with available power, especially from renewable sources, are prioritised by operators and cloud service providers. This can be seen from the rise in mega green campuses and active exploration of different renewable sources (hydrogen fuel cells, geothermal power and hydroelectric) and even nuclear small modular reactors. This has led to the spillover demand for data centre space in secondary markets, underpinned by the cloud service providers' decentralised strategy to set up cloud zones close to end users in edge deployments.

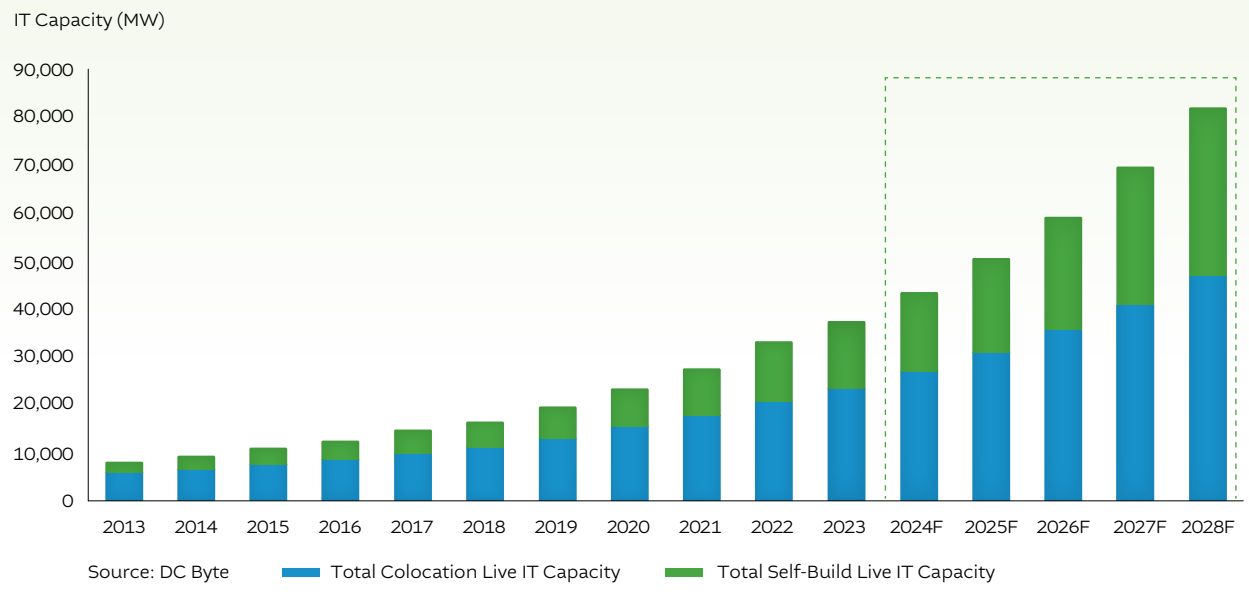
With the exponential growth of the global digital economy, robust digital infrastructure and regulations on data protection and security will be required. Governments have embarked on initiatives to foster data centre investments and to regulate data storage and cross-border flows of data both domestically and internationally. These efforts include introducing tax incentives, establishing specialised data centre parks, revising policies, setting up regulatory bodies, and formalising data adequacy agreements.

Supply chain issues are expected to persist, leading to protracted construction lead times especially in established data centre hubs. The limited natural resources and labour shortages had resulted in an increase in data centre construction costs by an average of 4.9% year-on-year in 2023.

Self-build and Colocation Data Centres

The global self-build data centre market has seen an unprecedented growth trajectory in recent years. It comprised about 37.2% of the global live IT capacity in 2023, recording a five-year CAGR of 20.8% from 2018 to 2023. DC Byte expects this growth trajectory to continue, as cloud computing is expected to be one of the key factors for global data centre growth in the age of digital transformation.

Figure 1: Composition of Colocation and Self-Build Data Centres
Worldwide Colocation and Self-Build Data Center Live IT Capacity



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Global colocation demand continues to be underpinned by cloud service providers such as Amazon Web Services ("AWS"), Microsoft Azure and Google Cloud. The surge in cloud adoption is a key driver behind the increased demand for data centre space. Businesses and governments adopt cloud solutions due to cost-effectiveness, operational efficiency, enhanced security measures, redundancy, flexibility, and scalability. This has led to a corresponding uptick in the demand for more data centre facilities as well as services offered by cloud service providers.

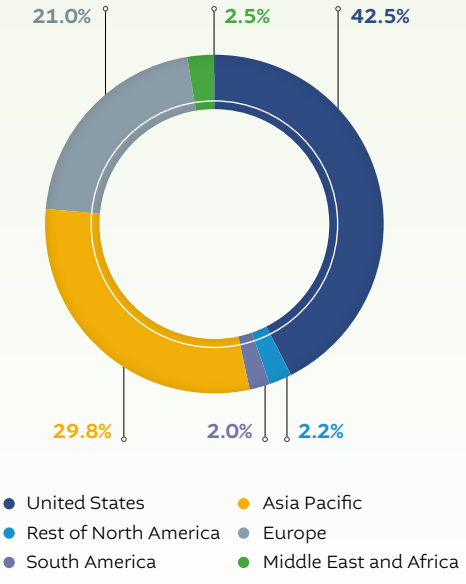
The global colocation data centre market made up a larger share of the global live IT capacity at 62.8% in 2023, recording a five-year CAGR of 16.1% from 2018 to 2023. While the cloud service providers tend to pursue a mix of self-build and colocation strategies, wholesale colocation remains an attractive option as it offers a flexible and scalable option with a shorter lead time to delivery of capacity compared to a self-build strategy.

Regional Data Centre Overview

The Asia Pacific data centre market has experienced the fastest regional growth, underpinned by the accelerated growth of developing markets. It was the second largest region and accounted for 29.8% of the global live IT capacity. Supported by a mature technology market, the United States took up the world's largest share of live IT capacity at 42.5%. Europe, which was ranked the third largest region, accounted for 21.0% of the global live IT capacity. As Europe is a relatively mature data centre market, demand from key cloud service providers continues to drive cloud computing demand while secondary markets such as Madrid, Lisbon and Milan are also seeing increasing interest from hyperscalers.

Figure 2: Global Data Centre Distribution (By Region)

Breakdown of Data Centre Live IT Capacity by Region as at 4Q2023



Source: DC Byte

NORTH AMERICAN DATA CENTRE MARKET OVERVIEW

In 2023, the North American data centre market (encompassing the United States and Canada) had a total IT capacity of over 42 gigawatts ("GW"). Approximately 39.6% of the IT capacity was live while 12.8% was under construction. The committed and early development stage IT capacity made up 47.6% of market supply.

Wholesale colocation operators topped the North American data centre market share in terms of live IT load at 34.3%, followed by self-build public cloud at 29.4%, retail colocation at 17.1% and self-build social media platforms at 11.5%.

The rapid growth of cloud computing, led by major cloud service providers such as AWS, Microsoft Azure, and Google Cloud, is a pivotal force behind the surging demand for data centre infrastructure in North America. As organisations move their operations to the cloud, there will be a greater need for robust data centre capabilities. The demand for data centres is also boosted by the shift to remote work and the increased reliance on cloud-based collaboration tools and online services, which had been accelerated by the COVID-19 pandemic.

Data centre growth in North America remains robust, fuelled by the adoption of generative AI and ML applications. The United States, accounts for most of the capacity and data centre supply growth in the region. The deployment of AI has been observed in New Jersey, New York, and other secondary markets such as Austin, Reno, Charlotte, Central Washington, Des Moines, Montreal (Canada) and Quebec (Canada). As data centres consume a large amount of energy and emit a significant amount of carbon emissions, concerns have been raised about the environmental sustainability of data centres. Data centre operators are under pressure to adopt renewable energy sources and implement energy-efficient technologies.

The supply of colocation data centres in the North American data centre market has steadily grown in recent years, at an average of 12.4% year-on-year over the past five years (2018 to 2023). In 2023, an additional 1,159 megawatts ("MW") of colocation supply was added, which saw the total live colocation supply increase to 8,812 MW, from 7,653 MW in 2022.

The North American data centre market is poised for continued expansion, driven by the increasing demand for cloud services, technological advancements and the need for reliable and efficient digital infrastructure.

The top 15 data centre markets in North America (as shown in Figure 4) accounted for over 60% of the region's total live supply of data centres and totalled 26,212 MW of IT capacity (live, under construction, committed and early development stage).

Figure 3: North American Colocation Data Centre Live Supply, Take-up and Contracted Capacity

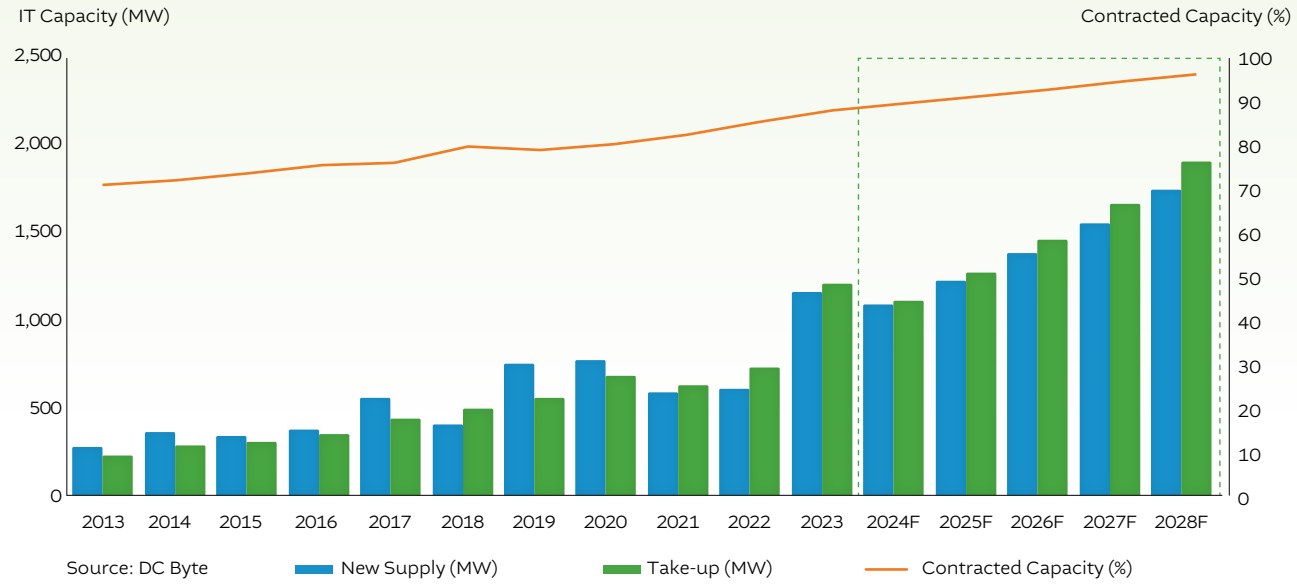


Figure 4: Top 15 Key Markets in North America

Rank	Top Key North American Data Centre Market
1.	Northern Virginia
2.	Dallas
3.	Chicago
4.	Atlanta
5.	Silicon Valley
6.	New York/New Jersey
7.	Phoenix
8.	Portland
9.	Toronto (Canada)
10.	Montreal (Canada)
11.	Pennsylvania
12.	Los Angeles
13.	Houston
14.	Boston
15.	Seattle

Figure 5: Top 15 Secondary Markets in North America

Rank	Top Secondary North American Data Centre Market
1.	Omaha
2.	Las Vegas
3.	San Antonio
4.	Salt Lake City
5.	Nashville
6.	Charlotte
7.	Austin
8.	Sacramento
9.	Miami
10.	Pittsburgh
11.	Cincinnati
12.	Minnesota
13.	Indianapolis
14.	Cleveland
15.	Kansas City

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Northern Virginia

Total Live IT Capacity*	Total Under Construction Capacity*	Vacancy Rate**	Number of Data Centres
3,465 MW	1,635 MW	3.2%	221

* Total includes both colocation and self-build data centres.
** Applies to the live colocation IT power and does not include pre-sold power that is under construction or future phased power.

Northern Virginia has the largest data centre market in the world, totalling 8,885 MW in IT capacity as at 4Q2023. Over 39.0% (or 3,465 MW) of the IT capacity was currently live, 18.4% (or 1,635 MW) of the IT capacity was under construction, 23.4% (or 2,074 MW) was committed, and 19.2% (or 1,711 MW) was in the early development stage.

The colocation market segment had the largest market share at 84.6%, driven by the growth in the colocation wholesale market. Meanwhile, the self-build market segment is driven by key cloud service providers, including AWS, Google Cloud and Microsoft Azure who have an established self-build presence.

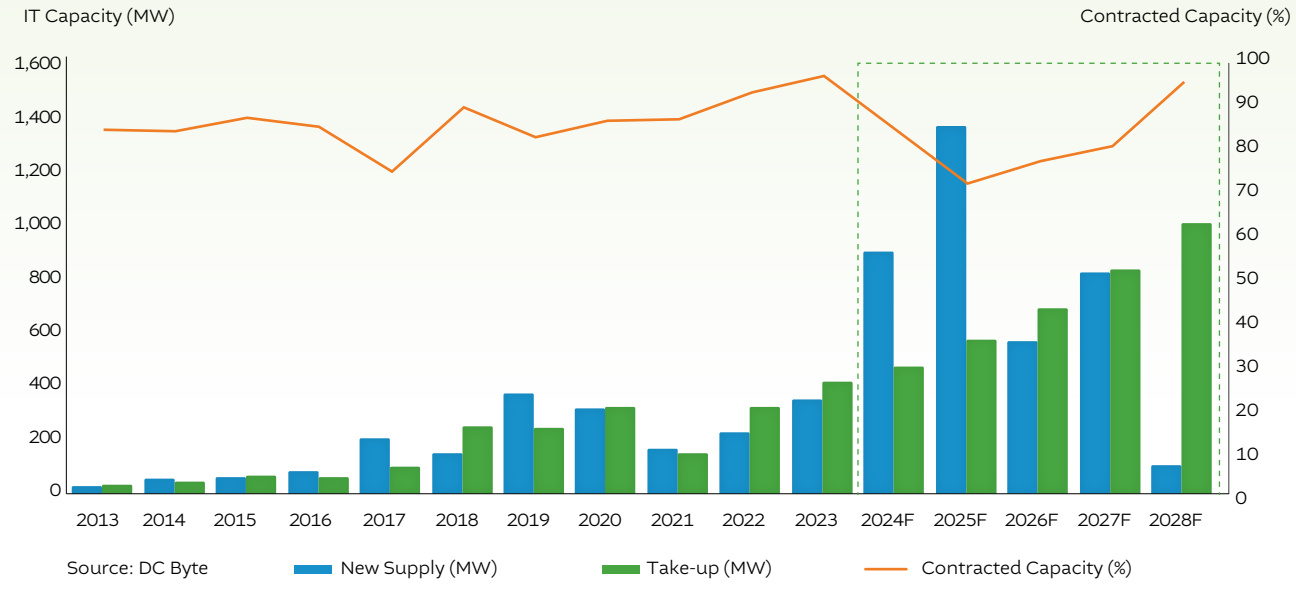
2023 recorded a yearly take-up of 418 MW of IT capacity in colocation data centres, with the contracted capacity rate peaking at 96.8%. Northern Virginia's total colocation live supply reached a CAGR of 21.0% from 2018 to 2023, driven by demand from cloud service providers. Both AWS and Microsoft Azure have existing and upcoming self-builds in Manassas and Sterling, respectively while Google has proposed to build a campus in Bristow.

Given the power constraints in Northern Virginia, there are plans underway for major transmission infrastructure upgrades by primary energy supplier Dominion Power, starting with two 500 kilovolts transmission lines to serve the data centre market. However, delays in power delivery by Dominion Power are expected, resulting in completion delays within the Ashburn submarket as the new power infrastructure will only be completed in 2025 or 2026.

Meanwhile, submarkets outside of Loudoun County are expected to pick up the slack. Over half of the IT capacity that is under construction or committed is located outside of Loudoun County (including William County). There are currently two major campuses that are in the planning stages – the Prince William Gateway by QTS Data Centers and Devlin Technology Park by Stanley Martin.

By-right zoning approvals for data centres have been proposed in several counties in Northern Virginia, including Fairfax and Loudoun County. This will require developers of data centres to seek special approval, signalling stricter zoning regulations for new data centre developments in response to community pushback. One example was in Fauquier County where zoning changes limiting data centre developments in Vint Hill had been approved. Future data centre developments will likely occur outside of the traditional Ashburn submarket in the short term and spillover to the secondary markets that have available land and power.

Figure 6: Northern Virginia Colocation Data Centre Live Supply, Take-Up and Contracted Capacity



Atlanta

Total Live IT Capacity*	Total Under Construction Capacity*	Vacancy Rate**	Number of Data Centres
799 MW	762 MW	5%	55

* Total includes both colocation and self-build data centres.
** Applies to the live colocation IT power and does not include pre-sold power that is under construction or future phased power.

The Atlanta data centre market ranked the fourth largest in North America and totalled 3,565 MW in IT capacity as at 4Q2023. Only a small portion of the IT capacity was currently live, at 22.4% (or 799 MW), while most of the total supply was in the committed stage at 45.3% (or 1,614 MW). 21.4% of the total supply (762 MW) was under construction and 10.9% (or 390 MW) was in the early development stage.

The colocation market segment made up the majority of Atlanta's market share at 79.7% while the self-build market segment made up 20.3%. There has been a rise in interest from hyperscale data centre operators, including Microsoft Azure and Google Cloud in Douglas County and Meta in Stanton Springs.

2023 saw a yearly take-up of 24 MW of IT capacity in colocation data centres in Atlanta, with the contracted capacity rate at 87.1%. Meanwhile, the total colocation live supply grew by a CAGR of 12.2% from 2018 to 2023.

Atlanta has seen a surge in demand for data centres, given the attractive tax incentives and availability of power. Demand for colocation data centre space has more than doubled as compared to five years ago. It is expected to continue growing in the next few years with the proliferation of generative AI. The bulk of the future planned colocation capacity is already being preleased to cloud service providers and enterprises.

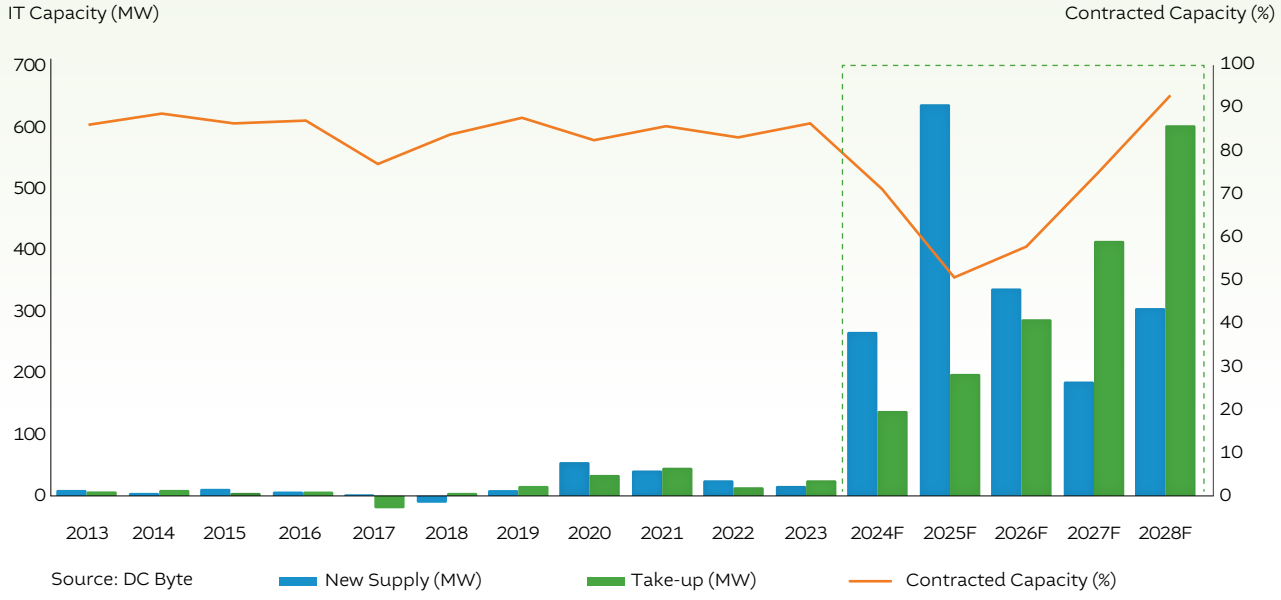
The rapid growth of large data centre projects also puts a strain on Atlanta's power grid. Atlanta's main energy provider, Georgia Power, is seeking to build additional capacity to meet the increased power demand. It is driven by data centres, which makes up 80% of the forecasted demand.

Georgia has also taken a series of steps to manage the strain on the power grid. It announced plans to suspend data centre tax breaks earlier this year, which will come into effect in July 2024. It also commissioned a special study to identify ways to increase the state's grid capacity and energy supply to accommodate the growing power demands from the influx of large data centres.

Notable upcoming developments in Atlanta include QTS's Fayetteville, DC Blox's Atlanta East and West, and Edged Energy Atlanta's facility.

Future data centre developments are likely to shift to other areas, as Atlanta's grid reaches close to maximum capacity, coupled with difficulties in securing power in the short term. Charlotte (North Carolina) has become an attractive alternative as it lies on the same main fibre route between Northern Virginia and Atlanta.

Figure 7: Atlanta Colocation Data Centre Live Supply, Take-up and Contracted Capacity



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ASIA PACIFIC DATA CENTRE MARKET OVERVIEW

In 2023, the Asia Pacific data centre market's total IT capacity increased over threefold from 9 GW in 2018 to 35 GW in 2023. Majority of the increased capacity came from the committed and early development stage supply, which made up over 60% of Asia Pacific's total market supply, while over 30% of the IT capacity was live with 8.2% under construction.

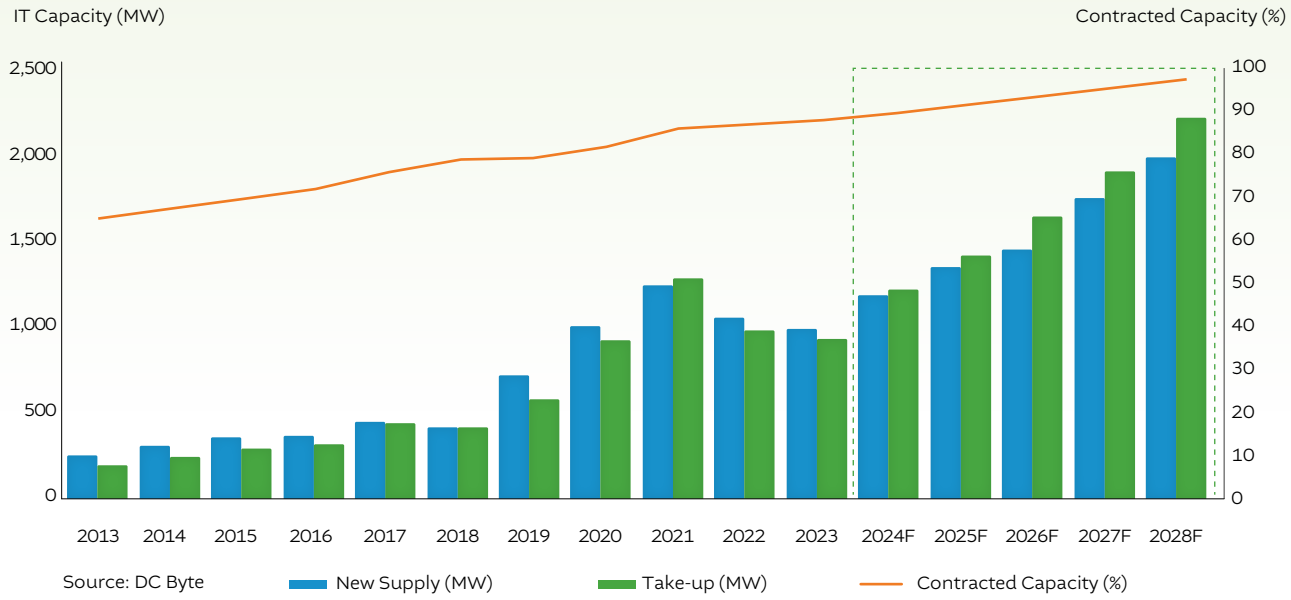
Established markets such as Australia, China, Japan, and Singapore each contributed more than 500 MW to the regional live supply growth of 6.5 GW from 2018 to 2023. Both Australia and Japan saw strong demand for cloud services, with a greater proportion of that in Australia being serviced by self-builds. In contrast, Japan has a higher share of colocation services.

Meanwhile, the Asia Pacific colocation market has seen a steady growth in supply in recent years, averaging 19.2% year-on-year over the past five years from 2018 to 2023. In 2023, it grew by 13.1% to 8,532 MW from 7,545 MW in 2022.

The accelerated digital transformation initiatives across industries in Asia Pacific, including e-commerce, fintech, and smart city developments, have fuelled the demand for data centre capacity to support data-intensive applications and services. This is coupled with the rollout of 5G networks across the region, which has created new opportunities for data-driven applications and services. These have resulted in the need for edge computing and a distributed decentralised data centre infrastructure.

Emerging data centre markets in South Asia and Southeast Asia have witnessed growing investments from investors, developers, and cloud service providers in recent years. The highly populous and young demographic signify considerable untapped potential for data centre demand. As political and economic landscapes evolve to support digital infrastructure investments in these markets, this is anticipated to drive substantial growth in the Asia Pacific data centre market.

Figure 8: Asia Pacific Colocation Data Centre Live Supply, Take-up and Contracted Capacity



Singapore

Total Live IT Capacity*	Total Under Construction Capacity*	Vacancy Rate**	Number of Data Centres
990 MW	69 MW	1.1%	66

* Total includes both colocation and self-build data centres.
** Applies to the live colocation IT power and does not include pre-sold power that is under construction or future phased power.

The Singapore data centre market totalled 1,447 MW of IT capacity as at 4Q2023. Over 68.45% (or 990 MW) of the IT capacity was live, 4.8% (69 MW) under construction, 26.7% (or 387 MW) committed, and 0.05% (or 1 MW) in the early development stage.

The colocation market segment made up over half of Singapore's market share at 57.4% and comprised local operators such as Keppel Data Centres, Singtel and STT as well as international operators such as AirTrunk, Digital Realty and Equinix. Meanwhile, the self-build market comprised Western cloud service providers such as Google

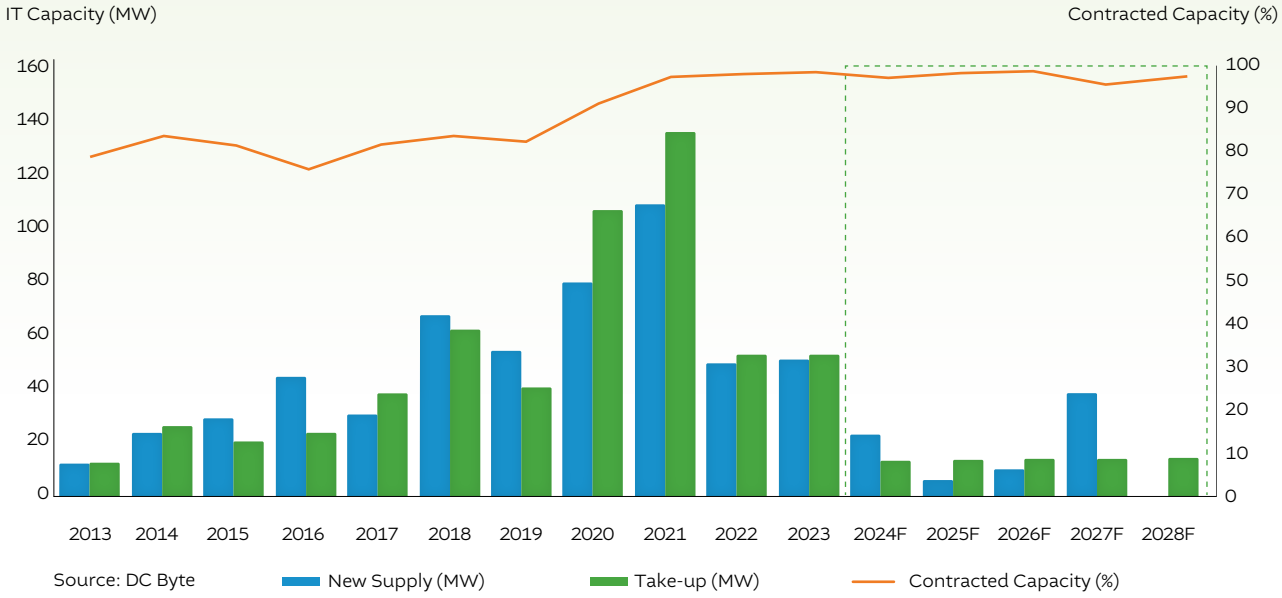
Cloud, Microsoft Azure and AWS. In contrast, the Chinese hyperscalers, which include Alibaba, Huawei, Bytedance and Tencent, opt for a colocation strategy and have a presence in colocation facilities in Singapore.

2023 recorded a yearly take-up of 52 MW of IT capacity in colocation data centres in Singapore, with the contracted capacity rate close to full. This was due to the limited supply caused by the lack of new data centre developments in the last few years. The total colocation live supply grew by a CAGR of 19.1% over five years from 2018 to 2023.

Singapore is a Tier 1 data centre market, and its growth is fuelled by its position as one of the key connectivity and financial hubs in the Asia Pacific region. Data centre demand is expected to grow in Singapore, and it is expected to continue hosting key processes with stringent security and latency requirements like financial service institutions and content delivery networks points of presence.

The moratorium on new data centre developments was imposed in Singapore in 2019. This was to manage the rapid growth of data centres and their corresponding high energy consumption and greenhouse gas emissions, as the country aims to meet its commitments to climate change mitigation and to achieve net zero emissions. Since the lifting of the moratorium on new data centre developments in 2022, there are stringent conditions imposed on new builds such as minimum power usage effectiveness of 1.3 and economic and strategic considerations.

Figure 9: Singapore Colocation Data Centre Live Supply, Take-up and Contracted Capacity



Osaka

Total Live IT Capacity*	Total Under Construction Capacity*	Vacancy Rate**	Number of Data Centres
227 MW	59 MW	11%	73

* Total includes both colocation and self-build data centres.
** Applies to the live colocation IT power and does not include pre-sold power that is under construction or future phased power.

The Greater Osaka ("Osaka") data centre market totalled 829 MW of IT capacity as at 4Q2023. Over 33.4% (or 277 MW) of the IT capacity was live, 7.1% (or 59 MW) under construction, 35.5% (or 294 MW) committed, and 24.0% (or 199 MW) in the early development stage.

The colocation market segment made up the majority of Osaka's market share at 99.6% and consisted of a mix of international players like MC Digital Realty (a 50-50 joint venture between Digital Realty and Mitsubishi), Equinix, Colt and local players like NTT, and KDDI Telehouse.

2023 recorded a yearly take-up of 38 MW of IT capacity in colocation data centres, with the contracted capacity rate hitting 84.7%. Osaka's live colocation supply reached a CAGR of 19.7% from 2018 to 2023, driven by demand from cloud service providers who are active in Osaka and lease space in colocation facilities. Cloud service providers' deployment sizes in colocation facilities are increasing. AWS is the first cloud service provider in this market to have a build-to-suit facility, which began construction in 2021.

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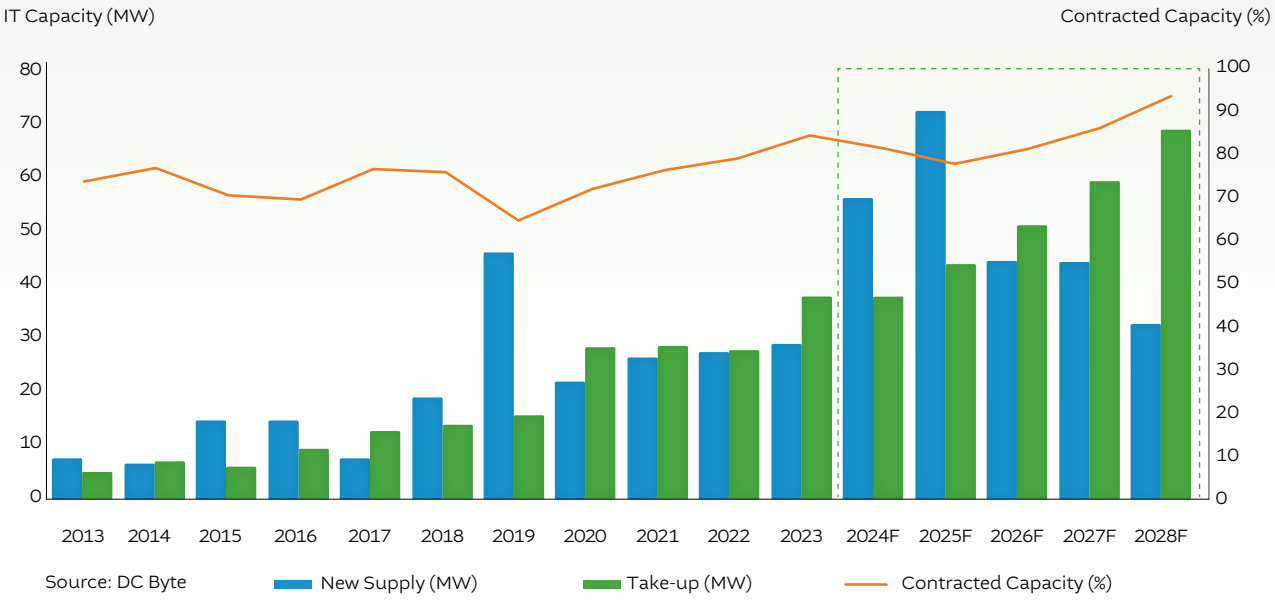
As a separate cloud region from Greater Tokyo ("Tokyo"), colocation demand from cloud service providers in Osaka is expected to remain strong. Players like Microsoft Azure and Oracle have only one existing availability zone in Osaka as compared to the typical three to four availability zones in Tokyo. The number of availability zones in Osaka are expected to increase in the future as cloud service providers seek a more distributed capacity in the region to meet the growing demand from cloud adoption.

Osaka is Japan's second largest market after Tokyo and has a less developed fibre and power infrastructure. In the short term, data centre developments are expected to be concentrated in areas where the infrastructure is already in place.

Most of the current live supply sits in North Osaka while the upcoming supply are evenly distributed across the submarkets. Key upcoming developments includes ESR Group's campus in Central Osaka and pipeline capacity from NTT Global Data Centres, Colt DCS, and MC Digital Realty in Ibaraki (North Osaka) and Keihanna (East Osaka).

The strong pipelines across Osaka's submarkets demonstrated strong growth potential of the data centre market. Operators remained bullish on demand with the acquisitions and developments of large brownfield sites for new data centre campuses.

Figure 10: Osaka Colocation Data Centre Live Supply, Take-up and Contracted Capacity



GLOSSARY

Colocation: facilities built for the leasing of space and IT power within from a dedicated third-party provider of data centre space. Colocation includes retail, wholesale, and build-to-suit facilities. The facilities are typically tagged to the colocation operator, however in the case of the tenant (typically cloud service provider) leasing a shell for its own use, the facility is tagged to the shell owner.

Committed Capacity: the estimated IT power that has a high likelihood to be added to a market's overall supply; however, it does not refer to sold data centre space. This includes powered shell data centres.

Contracted Capacity: proportion of IT capacity that is taken up as compared to new supply during the period.

Early Development Stage Capacity: IT power that has been announced or speculated but has not secured all the required elements (government, land, power, etc.) for development.

Live IT Capacity: IT power that is currently live, fully fitted out with mechanical and electrical infrastructure.

New Supply: IT power that came live during the period.

Retail Colocation: third party data centre space that offers smaller customer deployments, typically under 500 kW.

Self-build Operators: operators that run data centres that are built for their own use. Examples may include banks, telecoms companies or, more recently, hyperscale companies such as the US or Chinese tech giants.

Take-up: for self-build data centres, take-up represents where IT power is either live or under construction, since at that point they are committed to the cost of the scheme. For Colocation data centres, take-up may occur for live, under construction or committed IT power.

Total IT Capacity: includes colocation and self-build facilities that are live, under construction, committed and in the early development stage.

Under Construction Capacity: the estimated IT power that is currently having the mechanical and electrical plant installed to support it.

Vacancy Rate: applies to the live colocation IT power and does not include pre-sold power that is under construction, committed or in the early development stage.

Wholesale Colocation: data centres are developed at scale for large customer deployments.