

Executive Summary

Data Center Research Service



Findings

The data center market is in the midst of an unprecedented shift that started—publicly at least—five years ago with the announced moratoria on new development in Singapore and Frankfurt. Those regulatory interventions shone a light on the challenges the industry faces in securing sufficient power. Since then, it turned out that data centers would need much more power than had been realized—just at a time when regulators and community organizations were growing increasingly critical of the sector's existing demand.

The accelerated commercialization of AI in 2023 took this problem to a whole new level. The data center industry has rallied to implement innovative power and cooling solutions while securing new energy partnerships. Meanwhile, utilities struggle to update power grids in the face of growing public opposition.

As we launch the current refresh of our Data Center Research Service, we're excited to announce a few major updates. First, you'll notice the user interface, which now features easier navigation tools to peruse the database and analysis. We also include direct links to recent presentations from our analysts that delve into topics related to the data center industry.

Another new feature is our Market Connectivity Score (MCS) tool. The MCS is our answer to the question “Where is the next big hub going to be?”, and pulls from our wide array of research areas to evaluate the health of more than 3,000 metropolitan markets worldwide. The MCS can be found in our Data section. This section also includes several metro market profiles, with commentary and rich visuals extracting insights from the MCS tool. In the Analysis section, you will find a new chapter of analysis that navigates practical questions and answers using the tool.

Let's delve into some of the findings from our 2024 Data Center Research Service update.

Market Connectivity Score

First, we'll take a brief look at a few of the markets highlighted in the Market Connectivity Score.

Frankfurt: Long-established as a regional center of networking, peering, and data center development, Frankfurt tops the MCS list as the strongest connectivity market in the world. The home of the world's largest data center-neutral IX, DE-CIX, Frankfurt has the world's strongest peering ecosystem (both by numbers of IX platforms present and numbers of ASNs connected) and strongest level of cloud development. No other city has more connected international internet capacity or number of transport carriers serving the market.

Singapore: Singapore is indisputably one of the world's strongest interconnection hubs, but it's not without weaknesses. The first market to introduce a moratorium on new data center

development in 2019, its government has struggled with increasing concerns over the power used by the local data center sector. It may surprise some to see that the MCS ranks Singapore not just among the largest, but also among the *fastest-growing*, markets in Asia. The reason is the city-state's subsea sector. Not only does it have a massive concentration of cables already, but more new cables are slated to land there in the near future than anywhere else in the world.

São Paulo: São Paulo is a critical market for Latin American connectivity, ranking highest not only in Brazil but in the entire region. Among other metrics, it benefits from favorable IP Transit pricing, with Miami-São Paulo remaining one of the most competitive routes to or from Latin America. São Paulo also hosts an incredible number of internet exchanges alongside a high number of ASNs connecting to those exchanges.

Power Scarcity

Several critical hubs have undergone major power scarcity crises, but utility problems are global and not confined to only a few major markets. Formally and informally, operators indicate that markets across the globe are seeing increased delays in securing power for new builds. Existing generation and transmission resources are proving insufficient to meet the surge in demand for cloud and AI computing.

One key and growing response to the crisis has been to deploy new data centers closer to the source of power generation. AWS has proactively taken this approach in a few different markets, most recently with its purchase of the Cumulus data center campus that's colocated with the Susquehanna Steam Electric Power Station in Salem Township, PA.

The data center industry is anxiously awaiting the commercial availability of small modular reactors (SMRs) as a potential source of ample power generation. Such technology would allow for nuclear reactors of around 300 MW to be deployed at data center campuses, providing dedicated power to the sites. Early development of SMRs is already underway in several countries.

AI's Effect

Compounding the existing constraints on the data center market, we've reached a major inflection point in the development of artificial intelligence (AI), and more specifically in the development of generative AI.

AI work consists of two basic phases: training and inference (the work for which the model is trained). Each has a different impact on data center market.

Training. In the training phase, workloads don't need to be located close to where the application will ultimately be run, so they can be conducted outside of core markets. The main requirements are that significant power, space, and GPU capacity are available. For this reason, AI training demand creates significant opportunity for data center operators in secondary and more remote markets.

Inference. In the inference phase, compute has to be done close to end users and is much more latency sensitive. At this point workloads must shift to network and cloud-dense locations, creating further demand in highly concentrated markets. But in addition, inference loads will also need to be distributed closer to edge markets to reach more end users.

AI will require many changes within data centers. The most immediate concerns include the provisioning of higher density cooling and higher capacity interconnection. Standard air-cooling systems can't support GPU-based, power-intensive AI applications, so liquid cooling solutions will become far more prevalent within data centers, particularly where AI applications are being run.

Many data centers will be unable to accommodate such computational advances without extremely difficult and expensive retrofits. Many new AI-ready data centers will be in demand at a time when the data center market is already under regulatory scrutiny and power is becoming scarce. The full effects of AI on data center markets are as yet unknown. However, it is clear that these technologies—after

years of development and impressive results—are here to stay.

Data Center Developments

The Washington metropolitan area—or more specifically Northern Virginia (NoVA)—dominates as the world's largest data center market. As of 2024, we estimate its gross commercial data center capacity at more than 24 million square feet of operational capacity.

Despite an impressive 16 to 17 million square feet of capacity, Beijing remains a particularly closed ecosystem with heavy restrictions on international investment and carrier presence. China Telecom, ChinData, GDS, and several other sizable operators have deployed extensively across the metro area, most heavily in Beijing itself and in Langfang, approximately 40 miles from the capital.

Asian and U.S. metro areas account for 8 of the 10 largest data center markets. In Europe, only London and Frankfurt make the list of largest markets.

Digital Realty and Equinix have greater scale and geographical diversity than any other operator. Both control over 30 million square feet of operational data center capacity and have significant presence in every global region. NTT, the third largest global data center operator, has a heavily concentrated footprint which is smaller than Equinix's but still twice as big as the next-largest provider.

More than 60 commercial data center providers control more than 1 million square feet of operational capacity each. While few compare to the behemoths that top this list, many are growing rapidly, are flush with new investment, and are critical players in global interconnection development.

By our tally, no large market comes close to the 4-year growth seen in Johor Bahru. The promise that pent up demand for access to Singapore would spill over into Malaysia has come true. JB's commercial data center market growth has exceeded 40% CAGR since 2020.

We estimate that there are 24 metropolitan markets that have more than 1 million square feet of operational data center capacity *and* 4-year CAGR of at least 10%. Nine of those 24 markets are in Asia and 7 are in Europe. Even more extraordinary—4 of the Asian markets are in India alone. Mumbai, New Delhi, Hyderabad, and Chennai have all seen commercial data center capacity growth of 15% or more since 2020. In Europe, Warsaw, Berlin, and Madrid are all seeing robust growth.

Many markets, small and large, see low growth over time and periods of no new data center builds going into operation. Amsterdam, Dallas, New York, Hong Kong, and Singapore all have new data center capacity growth of less than 5% CAGR since 2020.

Digital Realty and Equinix dominate the scale and geographical diversity of recent market growth, as they do overall capacity. But Vantage and STT's group of companies have also built out more than 4 million square feet of new data center space in the past two years. STT's new builds have launched across Southeast Asia and India, though the pace of GDS rollouts in China has largely driven the overall growth for the STT group. Vantage's new data center launches since mid-2022 have been truly global, spanning core U.S. markets, Canada, several German locations, Australia, Taiwan, South Africa, and more.

Among operators tracked in our database, nearly 400 data center sites are known to be in the construction pipeline right now. While this development is spread across global regions, Europe and Asia outpace other regions with the largest percentages of new site deployments.

Power

We estimate that, as of 2024, colocation operators in the top ten data center markets by MW consume about 13 gigawatts (GW) of power. That's enough power to generate electricity for roughly 10 million homes—or, in this case, only about 1,000 commercial data centers!

Only 17% of data center sites reporting are able to provision high-density aisles that exceed 20 kW per rack. This is troubling, especially when considering the fact that AI applications will require density levels in the range of 45 to 80 kW per rack—far in excess of traditional standards of high density.

Connectivity

Lumen, Cogent, Zayo, Verizon, and AT&T are the most prominent carriers across global facilities. These five operators are especially widespread in the North America and Europe. Elsewhere, providers like NTT, Cirion, Vocus, du, and MTN Group are ubiquitous in their respective regions.

By our estimates, CoreSite's LA1 data center in Los Angeles is the most carrier-dense colocation site in the world. Equinix's Kleyerstraße 90 site in Frankfurt and TELEHOUSE's London Docklands campus are also central nodes of international internet connectivity.

We continue to see new peering exchanges coming online across the globe in both established and developing markets. Recent deployments are geographically dispersed, with new IXs coming online in almost every region of the globe each year between 2020 and 2024.

Pricing

Current Trends

Starting in 2022 and continuing into 2024, anticipated price inflation has become a reality in the colocation market—at least in Europe and Asia. Between H2 2021 and H1 2024, the average price per kilowatt for colocation in our market sampling increased between 20% and 40% in Europe and Asia, respectively. Colocation prices have largely leveled off since H1 2024 as wholesale electricity rates have stabilized and dropped significantly since their 2022 peak.

Colocation prices in the U.S. have remained largely stable throughout the period of volatility elsewhere. Persistent "local turf wars" and vacancy issues among some operators have essentially kept prices flat. More critically, U.S. markets have not been as exposed as European markets to fluctuations in gas and coal prices.

Singapore is routinely among the most expensive markets we track. With the new licensing regime in the city-state, supply has become incredibly scarce. As a result, median rates surge 20% year-on-year to exceed \$600 per kilowatt in H1 2024. At the end of 2023, Singapore's median rate reached an all-time high and has only decreased slightly since then. In Europe, London prices have crept upward, breaching \$500 per kilowatt in the last half of 2023, and remaining there this cycle.

Regardless of the predictability of median price changes across markets, the average reported price *range* (low to high) for base colocation rates within markets can vary. The average range across markets covered in the H1 2024 update cycle was just above \$200 per kilowatt between low and high quotes. Some markets had variance as little as \$100, while others had differences of more than \$400.

In the eleven years that we've tracked data center pricing, we've observed a consistent gap among North American, Asian, and European cross connect prices—with the prices in North America the highest. The disparity between the U.S. and Europe narrowed leading into H2 2020 but has since widened again, generally hovering around 2x for the past two years.

In our study, we model TCO for colocation rates assuming the average monthly cost of a cabinet with either one or five fiber cross connects. The average TCO in European markets when one cross connect is assumed (\$2,000) was about 50% higher than that in North American markets. The gap between average TCO in Europe and the U.S. grew dramatically between 2022 and 2023 (having previously been closer to 15%). This was largely due to the sharp upturn in European prices per kilowatt contrasted with the continued, muted response to macroeconomic conditions among many U.S. operators.

When five cross connects were assumed in our TCO model, the difference in TCO between these two regions became essentially non-existent. The drastic increase in base colocation pricing seen in European markets over the past few cycles counter-balanced the U.S.'s high cross connect rates.

Expectations

It appears that as of H1 2024, operators are no longer expecting drastic colocation price changes in the near term. Lower, stabilized wholesale electricity rates seem to support the sense that colocation prices will settle down.

Here are a few general trends to watch as we move into 2024:

Falling European electricity rates do not preclude continued volatility for colocation pricing. Complications in power delivery specific to individual countries, government actions, and lags in wholesale contract renewals will be among many factors complicating the relationship between spot rates and the ultimate power prices passed down to data center operators and their customers.

The biggest ongoing concern in the data center market will be the availability of power and space to develop further in key markets. This challenge will be compounded by the rapid growth of generative AI applications. While the scramble for resources needed by power-hungry AI clusters will more directly affect the wholesale side of the market in the near term, the overall effect of data center capacity constraint is bound to hit the colocation market as well.

The content on the preceding pages is a section from TeleGeography's Data Centers

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TeleGeography

Washington, D.C. / Exeter

U.S. tel: +1 202 741 0020 / U.K. tel: +44 (0) 1392 493626.

www.telegeography.com