The Future of Data Centers:
Trends, Challenges, and Opportunities

REAL ESTATE | July 23, 2024

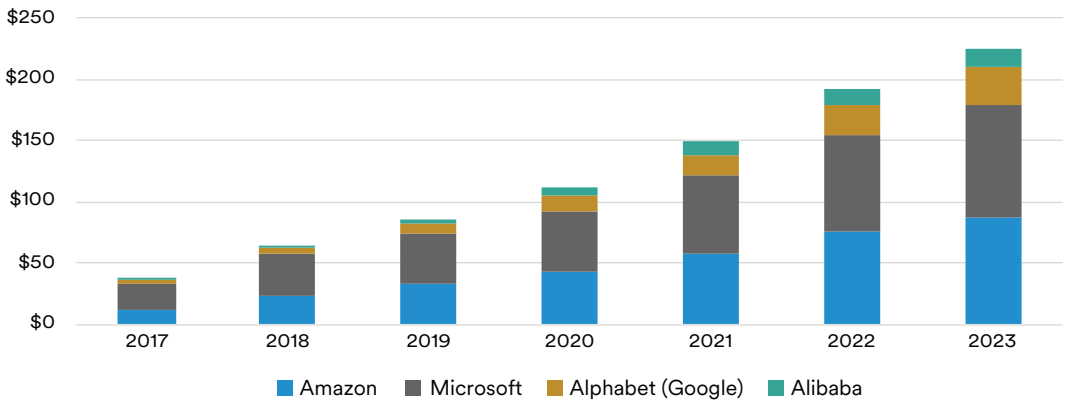
- The growing demand for data centers has piqued interest for many real estate investors over the past couple of years.
- Factors for investors to consider include a data center's power capacity, size/footprint, fiber connectivity/latency, real estate market fundamentals, jurisdictional regulations and environmental factors. Each plays a significant role in shaping investment decisions.
- Risk factors we are focused on include technological obsolescence, future tenant pricing power and limited historical performance information.
- Real estate investors who want a "neutral weight" allocation to data centers may target a 2% portfolio allocation, although we are recommending a modest overweight and a 3% allocation to data centers.

MetLife Investment Management

The Rise of Data Centers

In recent years, data centers have undergone a remarkable transformation, shifting from overlooked utility infrastructure to becoming one of the most sought-after property classes in the institutional real estate market. These specialized facilities serve as the backbone of our digital world, housing the essential components of computing systems, networking equipment and storage infrastructure. The history of data centers dates back to the 1940s when a single computer filled entire floors. As technology advanced, the required space for operation shrank significantly. Today, data centers come in various sizes, ranging from small server rooms to sprawling hyperscale facilities spanning millions of square feet. The surge in demand for data center services has been fueled by the proliferation of cloud computing, big data analytics and artificial intelligence (AI). These technological advancements, particularly in the post-pandemic era, are increasing demand and increased revenue for big tech cloud businesses (Exhibit 1).

Exhibit 1 | Cloud Business Annual Revenue ($bn)



Source: GreenStreet, MIM. As of April 2024.

Third-party landlords own 55% of U.S. data centers (with the remainder owner-users)[1]. Within the third-party landlord space, there is a large concentration of ownership by a few data center REITS, including Equinix and Digital Realty. This concentration allows these REITs to have considerable influence over pricing, service offerings and market trends.

We estimate the investable universe[2] is similar to other smaller property-type segments like self-storage and cell phone towers.

Types of Data Centers

Data centers, with their diverse physical characteristics and usage patterns, offer a tapestry of opportunities for investors. They can be categorized based on their physical characteristics, such as powered shell and turnkey facilities. Powered shells comprise landlord-owned finished structures, connected to power and fiber, rented to a tenant that installs, maintains and owns the long-lived infrastructure (generators, batteries, cooling equipment, power equipment) and short-lived infrastructure (servers, racks, networking equipment) needed to operate the data center. Powered shells typically have a net rent per square foot lease structure. Turnkey data centers offer a fully built-out exterior and landlord-owned long-lived infrastructure; tenants own and maintain their own short-lived infrastructure. Leases are typically structured as gross plus electric, although net leases are not uncommon but nearly always on a $/KW/month basis. Due to the significant capital investment by turnkey landlords, turnkey tenants pay substantially more rent than powered shell tenants, regardless

of the lease structure. Typically, turnkey data centers are priced with higher returns to compensate the investor for the risk of owning the equipment, which can depreciate quickly. MIM is biased toward powered shell facilities, given that they are less susceptible to obsolescence risks associated with owning technology infrastructure.

Data centers can also be categorized by use, including:

1. **Hyperscale Data Centers—**These data centers, operated by tech giants like Amazon Web Services, Microsoft and Google, boast extreme scalability capabilities. Engineered for large-scale workloads, they feature optimized network infrastructure, streamlined connectivity and minimal latency. Hyperscale data centers tend to have a larger physical footprint and are often entirely leased to a single major tenant.
2. **Colocation Data Centers—**Colocation data centers offer an alternative option for organizations with in-house or on-premises servers and/or workloads that don't require vast power consumption that require an entire data center, or whose capital allocation strategy doesn't prioritize the hardware investment. These facilities are occupied by multiple tenants who share operational costs such as power, cooling, bandwidth, communications and security. This shared approach makes colocation data centers a cost-effective solution.

These two types of data centers present different risk profiles. Hyperscale data centers, with their single-tenant leases, may lack the tenant diversification found in colocation data centers. However, hyperscale tenants generally boast excellent credit quality, as they are some of the most profitable and largest companies globally. On the other hand, leases for colocation centers tend to be shorter compared to hyperscale data centers, which are actually favored in the current market conditions as they offer rental rate mark-to-market opportunities. The use, tenant diversity and lease terms across different types of data centers make them suitable for various investors based on their risk tolerance and investment objectives.

How to Select a Site

Considerations for data centers include power, size/footprint, fiber connectivity/latency, fundamentals and regulation/environmental that all have separate impacts on data center investment decision making. Due to their unique set of requirements, data center markets are currently highly concentrated, with several MSA's serving the majority of U.S. computing needs (see Exhibit 2).

Exhibit 2 | Largest Data Center Hubs in the United States

Market	Estimated Power Capacity	Estimated Hyperscale Pricing Range	Estimated Colocation Pricing Range	Cap Rate
Northern Virginia	7,849 MW	$110-150/KW	$185-315/KW	6.50%
Phoenix	1,990 MW	$105-155/KW	$170-320/KW	6.75%
Atlanta	1,750 MW	$110-150/KW	$175-320/KW	6.75%
Dallas	1,550 MW	$110-160/KW	$165-315/KW	6.75%
Chicago	1,229 MW	$115-165/KW	$185-375/KW	6.75%
Northern California	922 MW	$150-205/KW	$215-390/KW	6.50%
Hillsboro/Portland	538 MW	$110-150/KW	$180-330/KW	6.75%

Source: DatacenterHawk, CBRE, MIM. As of May 2024.

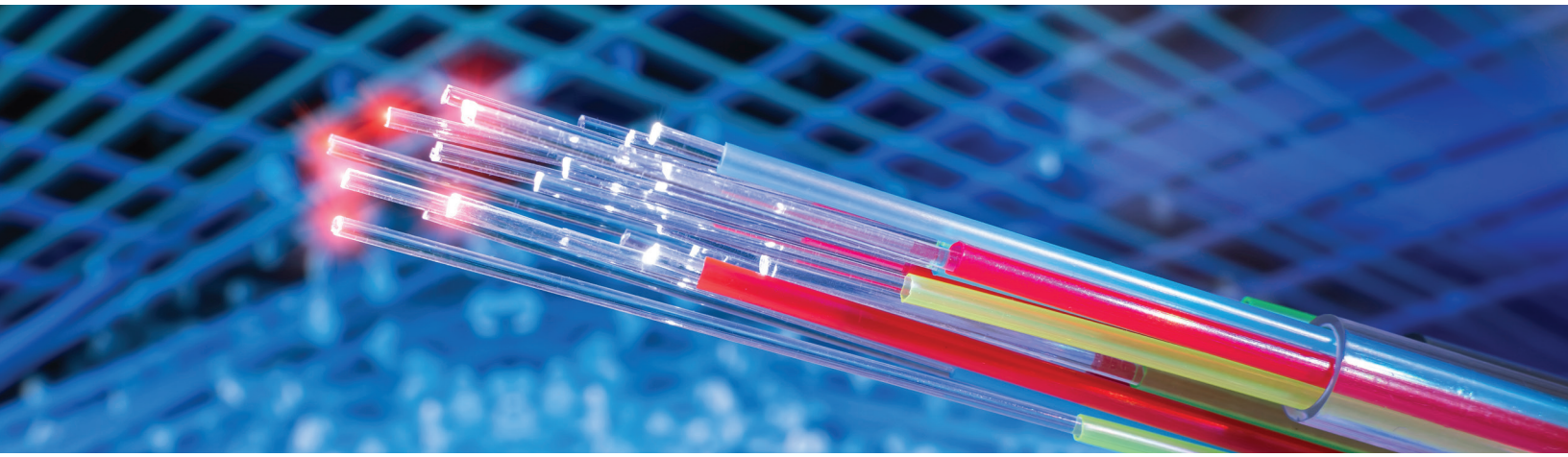
Power—Power availability is the single-most critical factor for investing in data centers. Unlike many real estate investments that are often evaluated on a per square foot or per unit basis, turnkey data center rents are charged on a dollar-per-kilowatt basis. Powered shell data centers are commonly charged on a $/sf basis. Power per site is heavily influenced by the utility provider, and new developments must oftentimes wait in a queue (that can vary based on jurisdiction) for utility providers to build out the necessary infrastructure for a given property.

The overall power capacity of a given market can indicate the attractiveness of a data center site. Regions with large amounts of untapped, ready-to-use power are desirable locations for new data center developments. Additionally, as environmental considerations grow, jurisdictions that source their power from renewable sources like wind, solar and hydroelectric, have become more in-demand.

Size/Footprint—The size or footprint of data centers varies widely, ranging from small server rooms to massive campuses spanning several football fields. Small-scale data centers may serve local businesses or organizations, housing a limited number of servers and networking equipment. In contrast, hyperscale data centers operated by tech companies and modern colocation facilities can house tens of thousands of servers and consume vast amounts of energy to support their operations. Generally, the size of the building can help dictate the price of the data center, and which type of tenant it caters toward.

Fiber Connectivity / Network Latency—In between data centers and end users lies a vast network of fiber optic infrastructure serving as the backbone to global communication networks, the internet and at its core — data transmission. Sites should offer redundant fiber paths from multiple carriers. Dark fiber (point-to-point fiber over a defined physical path) should also be available for users requiring a dedicated path for its sole use. Any given carrier may offer slightly different routes to major internet exchanges and long-haul cables, thus introducing varying levels of latency.

Latency refers to the delay in the transmission of data between users' devices and the servers in a data center. Networks with a longer delay or lag have high latency, while those with fast response times have low latency. It encompasses various factors including the distance between the user and the data center, network congestion and server performance. Low latency is crucial for applications requiring real-time interactions, such as autonomous driving, financial trading, GPS navigation, online gaming and video conferencing. Reducing latency ensures smoother and more responsive interactions, ultimately improving overall efficiency and satisfaction for users accessing services hosted in data centers. Since not all data center workloads have equal latency tolerance thresholds, a site offering access to multiple fiber carriers will appeal to the widest array of data center lessees.



A data center located closer to the end-user will typically have lower latency, which is a key reason why the major data center hubs in the United States are situated close to population nodes. The Northern Virginia region boasts the highest concentration of data centers in the United States, partially driven by the desire to optimize data transmission for the region's government data needs. While certain uses like AI model training don't require low latency, the computing requirements to support widespread consumer adoption of AI lead us to believe that companies looking to reduce latency will increasingly lead to a more-heavily concentrated data center network across a handful of markets across the United States.

Jurisdictional Regulations and Environmental—Local sentiment toward data centers can differ and choosing a location with a friendly regulatory environment is crucial. Water usage, noise complaints, lack of jobs produced and the relative tax-base accretion are all reasons cited against new data center developments. For example, in Atlanta, power constraints and state legislation that paused targeted tax breaks for data centers could impede further growth in the data center market.

As companies push to decrease their environmental impact, there is an increased initiative to locate data centers in jurisdictions that generate power from renewable power sources. We expect that this focus will only increase in the years to come.

Real Estate Fundamentals—The supply-and-demand dynamics of data centers are influenced by various factors in the current landscape. The demand for data centers continues to grow as businesses, governments and individuals increasingly rely on digital services. The emergence of cloud computing, big data, AI and machine learning, and digital streaming are all major factors contributing to an increased need for data centers. In 2018, the total amount of data created, captured, copied and consumed in the world was 33 zettabytes (ZB). This grew to 59ZB in 2020 and is predicted to reach 175ZB by 2025[3]. We expect that these demand drivers will cause data needs to continue to grow exponentially in the future, and with it, demand for data centers.

Exhibit 3 | Strong Occupancy Levels Despite Expected Heightened Levels of New Supply

Market	Supply Growth 2024E - 2028E	Vacancy	Power Costs	Connectivity	Supply Barriers	Grade
Salt Lake City	15.04%	0.4%	Low	Low	Mid	B-
D.C. Metro	9.71%	0.7%	High	High	High	A+
Atlanta	18.95%	0.9%	High	Mid	Low	A-
Dallas	12.31%	1.3%	High	High	Low	A+
Phoenix	15.71%	1.6%	High	Low	Low	A-
Portland	15.72%	1.8%	Low	Mid	Mid	B+
Chicago	10.31%	2.8%	Mid	High	High	A+

Source: DatacenterHawk, GreenStreet, MIM. As of June 2024.

In tandem, supply continues to grow, with supply growth across many key markets projected to average ~10% annually for the next five years (Exhibit 3). Vacancy levels are at record lows across nearly every market, with little evidence they will return to average historical levels in the near term. Exhibit 3 indicates MIM's data center market grade for a select group of markets based on several key factors. The overall market grade suggests where we think the best markets are for stabilized data center investments.

Given the known supply pipeline and current occupancy rates, we anticipate that most markets will continue to be undersupplied through 2028. As a result, we expect hyperscale data center revenue per available foot (RevPAF) growth to average at least 10% per year over the next three years.

Challenges and Risks

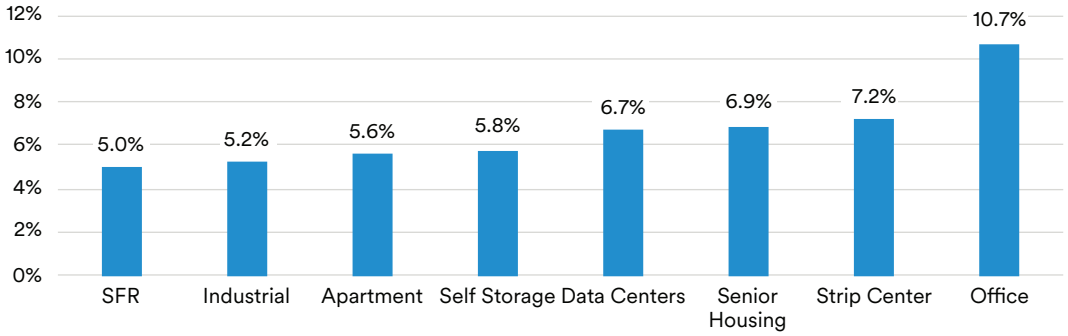
Although the short- to medium-term outlook for data centers appears positive, investing in this sector carries inherent risks. A significant concern is the potential for technological obsolescence. Rapid advancements in technology, such as hardware innovation, software optimization and breakthroughs in areas like quantum computing, pose substantial risks. Furthermore, progress in energy efficiency or data transmission could make developing data centers in less traditional locations, such as rural Oregon, more economically viable, potentially leading to a rapid increase in supply. Lastly, the risk of obsolescence extends to smaller, single tenant-powered shells where the users have a tendency to consolidate into newer colocations and hyperscale data centers.

> We believe there is a 25% chance of commercially viable and disruptive quantum computing breakthroughs in the next decade.

A downside risk to data center investors includes technological breakthroughs in quantum computing and quantum data storage that could allow computers to do more with less power and space. Based on a review of recent company press releases and academic publications, as well as discussions with experts in industry, we believe there is a 25% chance of commercially viable and disruptive quantum computing breakthroughs in the next decade.

Pricing for data centers suggest that cap rates are in the middle of comparable commercial real estate sectors (Exhibit 4), despite the positive outlook for the sector. We estimate the US commercial real estate market to be $17trn, and data centers are $350bn, or roughly 2%. A neutral weight on data centers supports a 2% allocation in a diversified commercial real estate portfolio (Exhibit 5), although we are currently recommending a modest overweight and a 3% allocation to data centers. Proper diversification is harder to achieve for smaller portfolios, so allocations above our suggested target may be required for direct real estate investments.

Exhibit 4 | Cap Rates of Various Commercial Real Estate Sectors



Source: GreenStreet, MIM. As of June 2024.

Exhibit 5: MIM Property Type Scorecard

Rank	Sector	Internal Rank	External Rank	Composite Rank	Neutral Allocation	Strategy
1	Infill Warehouses	1	4	1	10%	Overweight
2	Retail- Net Lease	6	2	2	1%	Overweight
3	Cold Storage	2	7	3	1%	Overweight
4	Manufactured Housing	5	5	4	3%	Overweight
5	Seniors Housing (IL)	3	8	5	3%	Overweight
6	Retail- Mall	14	1	6	4%	Neutral+
7	Data Centers	11	6	7	2%	Neutral+
8	Moderate Income Housing	7	11	8	1%	Neutral+
9	Regional Warehouses	15	3	9	15%	Neutral
10	Limited-Service Hotels	4	17	10	1%	Neutral
11	Retail- Strip/Neighborhood	8	12	11	4%	Neutral
12	Medical Office	10	10	12	2%	Neutral
13	55+ Housing	9	16	13	1%	Neutral
14	Single-Family Rentals	13	13	14	1%	Neutral-
15	Self Storage	20	9	15	3%	Neutral-
16	Student Housing	12	19	16	2%	Neutral-
17	Life Science	17	15	17	4%	Underweight
18	Traditional Apartment	18	14	18	22%	Underweight
19	Office (Excludes Life Science/Medical)	16	20	19	15%	Underweight
20	Retail- Grocery Anchored	21	18	20	4%	Underweight
21	Full-Service Hotels	19	21	21	1%	Underweight
					100%	

Sources: MIM, June 2024. Additional details on property type ranks in Are We There Yet

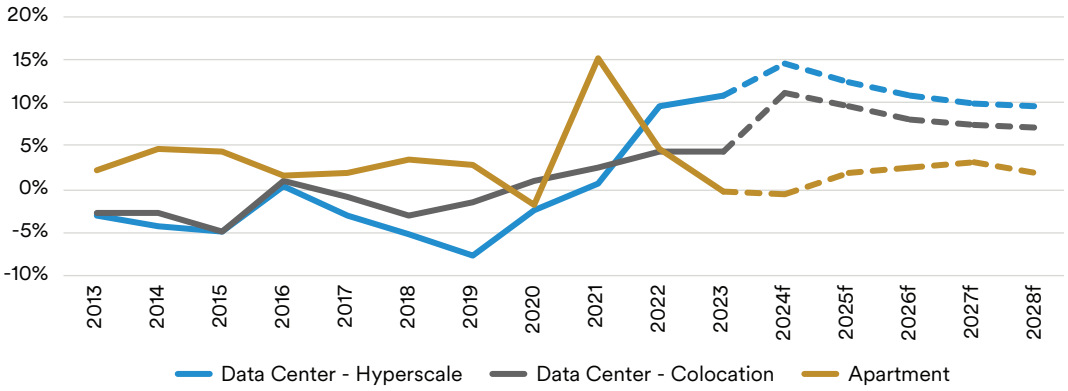
The evolving demands of AI on data infrastructure could accelerate obsolescence. An AI data center may require up to three times the power of a traditional cloud facility, suggesting that future data centers will need to meet different specifications. For instance, a standard data center setup might use 30 kilowatts to power cloud servers, whereas an AI-enhanced version could need 100 kilowatts. This increase necessitates additional cooling equipment and extra servers for AI processing, meaning AI-focused data centers could demand more space, higher ceilings or raised floors.

Managing data centers involves a complex array of operating risks that can impact performance, security and reliability, which require an experienced operator. For example, data centers rely heavily on continuous power supply. Power outages, even brief ones, can cause significant disruptions. As such, backup generators are critical but can fail if not properly maintained. Data centers also generate substantial amounts of heat, requiring robust cooling systems that can prevent overheating that can damage equipment. They also require security from cyberattacks or physical security breaches. There are a multitude of additional risks to data centers, including natural disaster risk, hardware and software failures, regulatory compliance, etc. that all require an experienced operator.

Another risk involves tenant concentration in hyperscale data centers and its impact on pricing power. Hyperscale tenants, with their robust financials, present low credit risk. However, their

limited number grants them significant pricing leverage, potentially securing favorable rental rates and terms. Should the data center market weaken, these hyperscale tenants might gain even more pricing power. This was hinted at before the pandemic-induced surge in demand when RevPAF growth for data centers was flat or negative (Exhibit 6), in part reflecting the pricing influence of hyperscale providers.

Exhibit 6 | Average Data Center RevPAF Growth Across the United States



Source: GreenStreet, MIM. As of June 2024.

Lastly, the sector faces challenges related to underwriting and performance forecasting due to limited data availability. The scarcity of comprehensive and standardized information across the industry hampers efforts to understand data center operations, sustainability, economic impact and investment prospects. While some operators voluntarily disclose data on their facilities, such as energy consumption and efficiency measures, the industry lacks transparency compared to more established sectors like industrial, residential, retail, hospitality and office. This opacity complicates benchmarking performance, assessing environmental impacts and making informed investment decisions in the sector.

Conclusion

Investing in data centers offers compelling opportunities to capitalize on the digital transformation of industries and the exponential growth of data-driven technologies. While data center investments entail challenges and risks, strategic allocation of capital to data centers can enhance returns, while offering portfolio diversification, given that the sector is driven by a unique set of economic and technological factors. As businesses and consumers increasingly rely on digital services and applications, data centers will play an integral role in shaping the future of the digital economy.

Endnotes

[1] Global Data Center Outlook, GreenStreet, April 2024.

[2] Estimating the Size of the Commercial Real Estate Market (reit.com), North America Data Center Report | H2 2023 (jll.com).

[3] The world's data explained: how much we're producing and where it's all stored (theconversation.com)

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