

GLOBAL DATA CENTERS

The Resilience of Digitalization

November 2022 | Investment Research

EXECUTIVE SUMMARY

- Despite the recent deterioration in the macroeconomic outlook, the growth of the information and communications technology (ICT) sector illustrates how important technology has become to societies and how significant associated ICT infrastructure growth is expected to be.
- When it comes to real estate, the ICT sector is the underlying driver of demand for data centers — buildings designed specifically to house computer systems and network equipment to support digital information processing.
- Globally the public cloud services market is forecast to grow approximately 20% per year to reach almost US\$600 billion by 2023¹, and cloud data centers are expected to remain the main growth driver in data center Internet Protocol (IP) traffic.
- This demand for cloud data center capacity is further accelerated by various underlying drivers, particularly among native technology companies.
- Such strong structural demand has been met with significant investment activity in the sector, and whilst this has rapidly driven new supply, supply is expected to soften due to the cyclical slowdown in economic activity and the large rise in construction costs.
- According to current forecasts, North America is expected to remain the largest data center market by commissioned power. But with APAC and Europe set to post stronger supply growth, both will gain market share over the next few years.
- As the pace of development varies across markets, portfolio diversification will be an important strategy for investors as they manage their cash flows, occupancy rates, development and leasing exposures.
- The energy-intensive data center sector is under increasing scrutiny. While there have been successes in increasing energy efficiency, leading data center operators and cloud providers have committed to self-regulatory pacts such as the Climate Neutral Data Center Pact.
- After record-high investment activity, we expect transaction volumes to be down by around 30% from that reported in 2021. Volume is expected to pick up again in 2023.
- After a strong performance in 2021, returns are moderating in 2022, largely driven by yield shift rather than weakening occupier demand. However, strong investor interest points to a bounce back in 2023, in line with an expected improving market outlook.

¹ Gartner, *Forecast: Public Cloud Services, Worldwide, 2020-2026, 1Q22 Update*, April 2022.

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INTRODUCTION

While the COVID-19 pandemic caused the largest economic shock in generations, it led to a significant increase in the mass adoption of advanced technologies. As we highlighted in our previous paper², the use of technologies that enabled remote working, distance learning and online entertainment and shopping resulted in unprecedented increases in global internet traffic and data volume. The reality is that both the application of and advances in technology will continue to cause a strong upward trend. Despite the recent deterioration in the wider macroeconomic outlook, the growth of the information, communication and technology (ICT) sector illustrates how important technology has become to societies and how significant associated ICT infrastructure growth is expected to be.

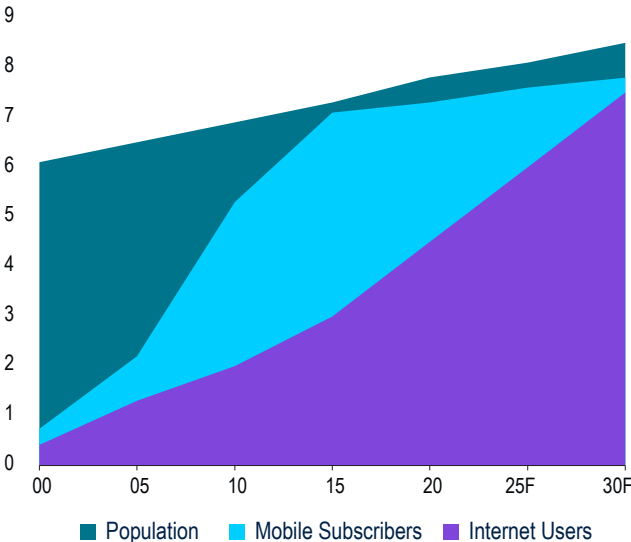
When it comes to real estate, the ICT sector is the underlying driver of demand for data centers — buildings designed specifically to house computer systems and network equipment to support digital information processing. Based on current structural trends and the latest available data, this sector will continue to grow significantly in the coming years.

STRONG STRUCTURAL TRENDS CONTINUE TO DRIVE ROBUST DATA CENTER DEMAND

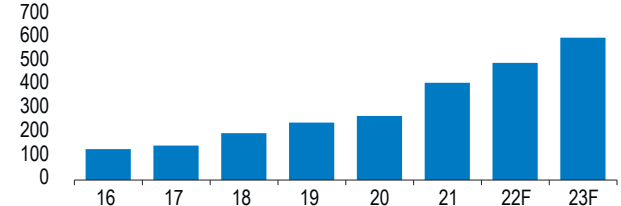
Strong tenant demand forecasts for data centers comes from the vital role they play in a technology-driven world and as such they are firmly entrenched as an integral part of corporate IT architecture. In particular, as more businesses embrace the public cloud to streamline this architecture and improve efficiency and security, they have gradually been migrating or integrating their IT infrastructures to incorporate the public cloud. As a result, the public cloud services market is forecast to grow globally by approximately 20% per year to reach almost US\$600 billion by 2023³, and cloud data centers are expected to remain the main growth driver in data center IP traffic (Exhibit 1).

Exhibit I: Estimating the Growth in Demand for Data Centers

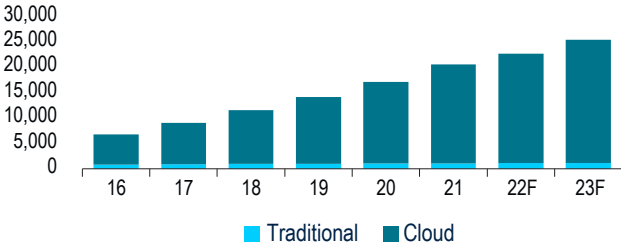
Global Population, Mobile Subscribers & Internet Users (US\$ billion)



Global Public Cloud Spending (US\$ billion)



Global Data Center IP Traffic (ExaBytes p.a.)



Sources: Oxford Economics, Cisco, Statista, PGIM Real Estate. As of November 2022.

² Global Data Centers: Getting Connected with a Niche Sector, PGIM Real Estate, February 2021.

³ Gartner, *Forecast: Public Cloud Services, Worldwide, 2020-2026, 1Q22 Update*, April 2022.

This demand for cloud data center capacity will be further increased by various underlying drivers as the upstream IT demand broadens across industries, particularly among native technology companies. Despite the sharp declines in share prices of technology companies in recent months amid falling stock markets, many of these drivers are expected to remain in place, driven by long-term needs.

E-commerce has been one such driver, with online sales forecast to grow globally by over 10% per year in the coming years. Its structural rise has spawned wave after wave of pure-play internet retailers, as well as traditional retailers, to establish an omnichannel presence. Along with the growing sophistication of retailing services provided, a robust online infrastructure capable of handling large bursts in user traffic will require improved data storage facilities.

The increased integration of artificial intelligence (AI) is also driving the demand for data centers. AI applications require substantial amounts of data, and with companies trying to collect as much data as they can, there is a constantly increasing need for storage. Also, as AI is democratized and less technical expertise is required to gain access to point-

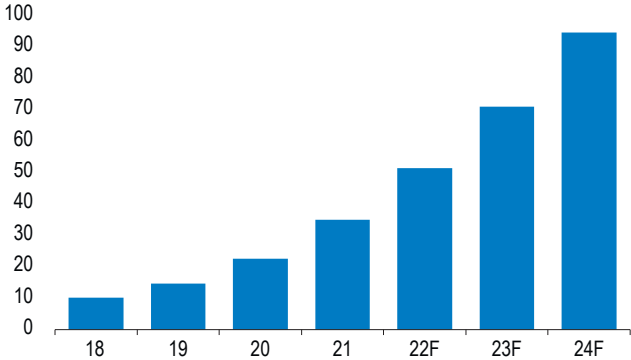
and-click analytical tools, much of the computations are being done in the cloud. With the industry expected to grow 38% per year over the next few years, this will help drive demand for data centers.

The “metaverse” is a term that refers to a virtual reality space where users can interact with a computer-generated environment and other users. While it is still in its early stages, retailers such as Nike, Gucci and Ralph Lauren are already investing in this technology, creating virtual spaces that represent their brands. No different from other online activities, users want low latency to minimize lag for optimal performance of the platform. As these virtual spaces gain traction, with physical and virtual businesses as an avenue for marketing, demand for computing will grow exponentially (Exhibit 2).

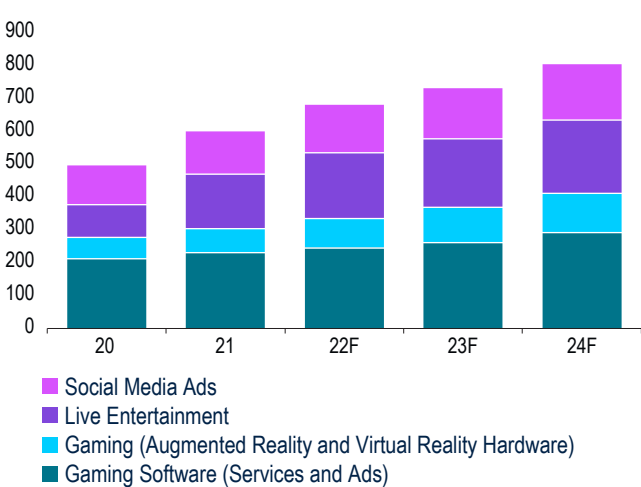
One consequence of this growth in demand is the rise in the need for hyperscale data centers: generally very large facilities that have the ability to scale up further as demand grows. The number of facilities tracked by Synergy Research has grown at an average rate of 12% per year since 2018 and is expected to hit 1,000 globally by end 2024⁴.

Exhibit 2: Estimating the Growth in Demand for Data Centers

Global AI Software Revenue (US\$ billion)



Metaverse Market Size (US\$ billion)



Sources: Statista, Bloomberg, Newzoo, IDC, PwC, As of November 2022.

⁴ Synergy Research, Pipeline of Over 300 New Hyperscale Data Centers Drives Healthy Growth Forecasts, March 2022.

EUROPE AND APAC REGIONS WILL CONTINUE TO GAIN GLOBAL MARKET SHARE

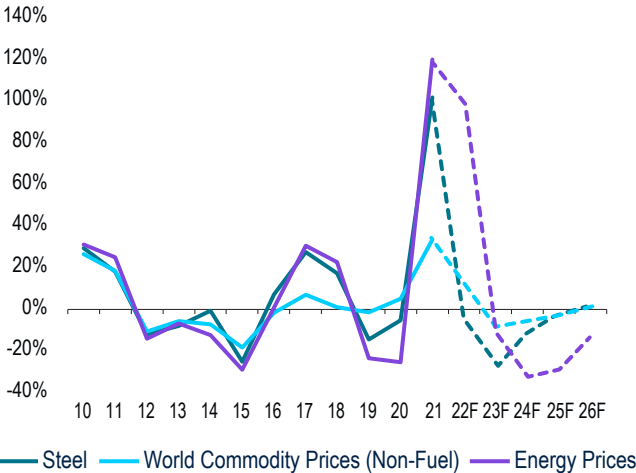
Strong structural demand has been met with significant investment activity in the sector, in turn rapidly driving new supply. Data center supply rose 20% per year between 2016 and 2021, led by the APAC region, which saw supply grow 30% per year over the same period. Growth was particularly strong during 2018 and 2019, when development rose sharply as the region played catch-up to the more mature U.S. market. Looking ahead, global supply growth is expected to moderate to 13% per year over the next three years. The supply pipeline in APAC is also expected to moderate, though certain markets such as Sydney and Tokyo will remain focal points of capacity growth. Growth in Europe is expected to remain relatively stable at 15% per year. Recent development trends have seen strong activity in secondary markets outside the traditional four to five major data center markets in each region. These tend to be high population density markets, with less-developed data center infrastructure but better land and power availability, where cloud operators set up facilities to complement those in major metros nearby.

Part of the reason for slower supply growth reflects an expected cyclical slowing in demand as global economic uncertainty takes hold — but part of the story is due to escalating construction costs. Costs have steadily increased over the past few years across all property sectors due to scarcity of raw materials and shortage of labor. However, they have jumped significantly over the past 12-18 months, largely due to the additional challenges of post-COVID-19 supply chain disruptions, as well as the ongoing conflict in Ukraine driving up commodity and energy prices. Steel is an important construction material for data centers, and prices for it are also spiking.

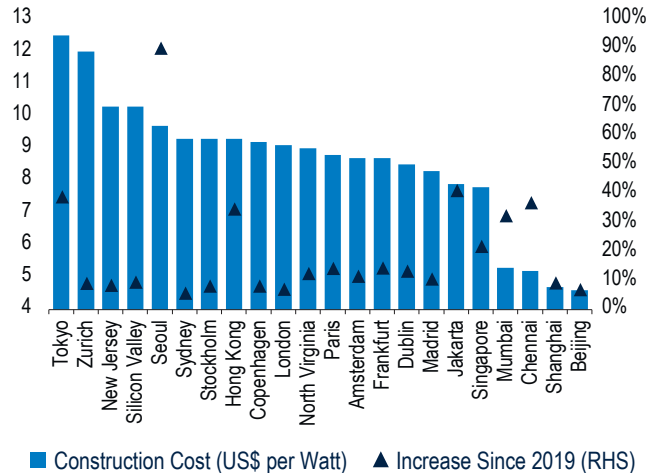
The surge of material prices has led to significant rise in data center construction costs across the global market. Data center construction costs in APAC, for example, have risen notably higher, up by an average of 30% since 2019, as reported by Turner & Townsend. The U.S. and European markets have also experienced cost inflation of around 10% over the same period. Elevated construction costs will weigh on developers’ profit margins and potentially dampen data center supply — as we have seen delays and cancellations of new development projects in other sectors (Exhibit 3).

Exhibit 3: Estimating Data Center Costs of Construction

Costs of Construction Inputs (% p.a.)



Data Center Construction Costs (US\$ per watt)



Sources: Oxford Economics, Turner & Townsend, PGIM Real Estate. As of November 2022.

Based on current forecasts, North America is expected to remain the largest data center market by commissioned power. The approximately 5,600 MW in the region makes up approximately 44% of total global supply, though this is expected to decline to 37% by 2024. APAC and Europe contribute approximately 25% and 23% of the global supply, respectively, but stronger supply growth there means both will gain market share over the next few years. While increasing capacity in a market inevitably points to a more competitive supply-side picture, the story is still one of ongoing strong demand requirements and growth potential — cloud availability is an important indicator of market development status. The relative sizes of the major regional markets suggest a global portfolio allocation of 40%-60% in the United States and 20%-30% in Europe and APAC (Exhibit 4).

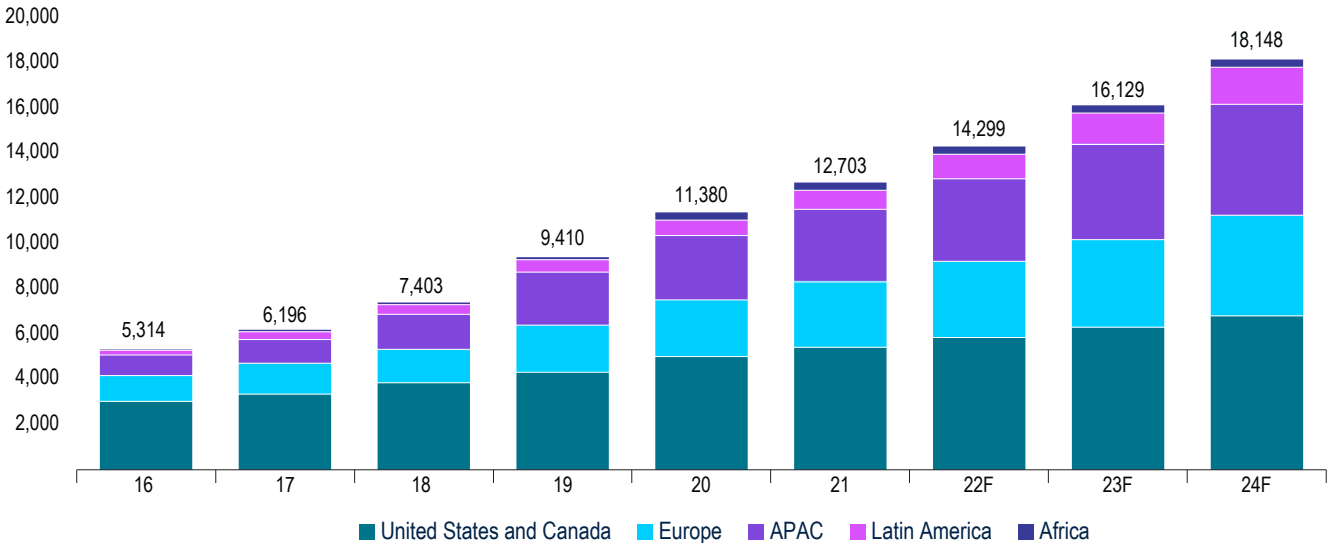
Looking specifically at major data center markets, those with the largest supply pipeline (excluding self-build) are located in APAC. Sydney and Tokyo, in particular, have a significant amount of supply under construction, and the total data center market size in both these markets is expected to almost double within the next three years. It

is worth highlighting that China is the second-largest data center market outside the United States, though most market statistics exclude China due to the dominance of three major local telecom carriers collectively having more than 60% of the market share⁵ with self-built facilities and little to no data transparency around colocation data centers.

Supply in the United States is concentrated in key markets such as Northern Virginia and California, where today, construction is at an all-time high. However, this is much needed supply as vacancy rates in both markets are at historic lows. Furthermore, it is estimated that 70% of the world’s internet traffic flows through Northern Virginia, and there is no shortage of technology users in San Francisco to drive demand. Among the major data center hubs in Europe, the supply pipeline is most active in London and Frankfurt. And yet it has been increasingly more challenging to initiate new developments owing to soaring construction costs and difficulty securing power, according to CBRE. Data center operators also face pushback from some public policies that are limiting new data center developments.

Exhibit 4: Data Center Stock and Development Pipeline

Global Data Center Supply (Commissioned Power (megawatts))



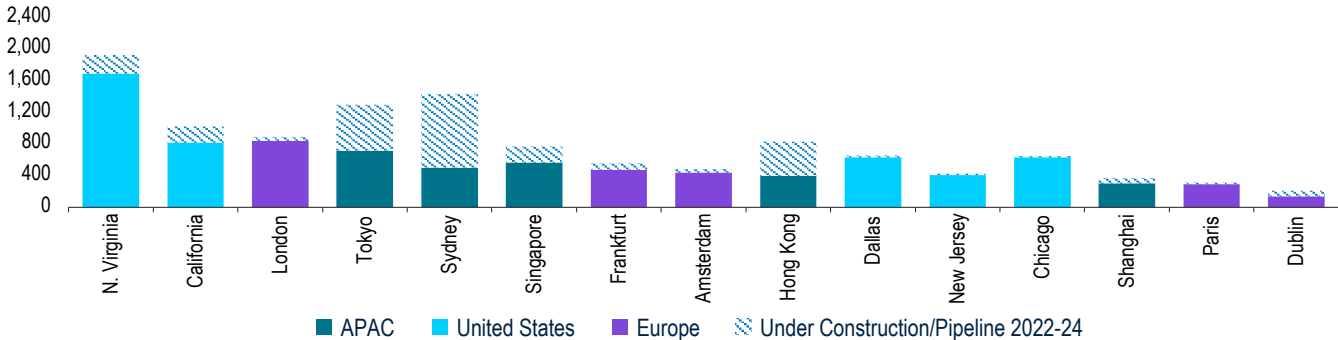
Sources: datacenterHawk, Structured Research, CBRE Data Centre Solutions, African Data Centre Association, Xalam Analytics, Company Reports, PGIM Real Estate. As of November 2022.

⁵ Savills, “Asia Pacific Data Centres Spotlight June 2022,” May 2022.

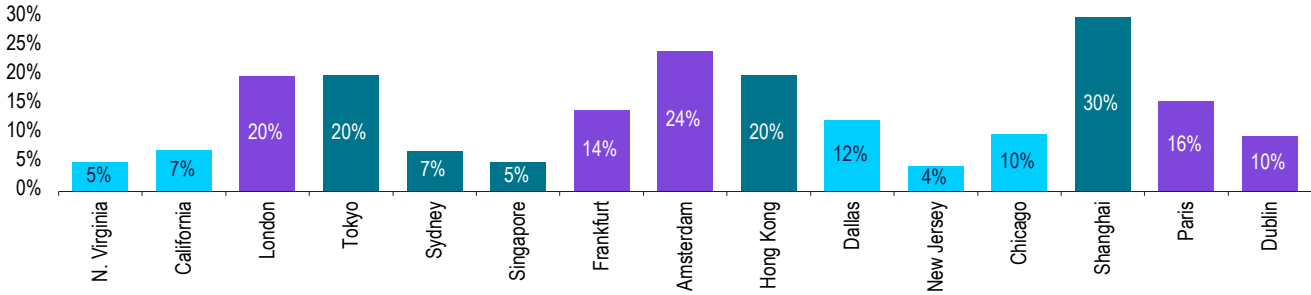
Current vacancy rates (or commitment rates in MW) vary widely across markets, with U.S. markets generally seeing lower vacancies. However, we do see a relatively fast pace of absorption in APAC (Exhibit 5). With the varied pace of development ongoing in these markets, portfolio diversification will likely be an important strategy for investors as they manage their cash flows, occupancy rates, development and leasing exposures. Given that average ticket sizes for high-specification data centers are often large, this will be an even more important component of portfolio strategy.

Exhibit 5: Data Center Capacity and Vacancy Rate

Data Center Capacity in Key Global Markets, 2021 (megawatts)



Vacancy Rate, 2021* (megawatts)



*Rate refers to data center capacity that is fitted out and available for lease. Sources: CBRE, JLL, PGIM Real Estate. As of November 2022.

INCREASING EFFICIENCY AND USE OF RENEWABLE ENERGY

In recent years, addressing climate change and sustainability concerns have risen to the top of companies and investors' to-do lists amid growing awareness. The energy-intensive data center sector, which contributed an estimated 1% of total global energy demand in 2020⁶, has come under increased scrutiny. As global data traffic increases, the same demand drivers for the sector have also resulted in a corresponding need for energy. Data center operators and major tenants from the technology industry have put in significant effort to reduce energy consumption and increase energy efficiency.

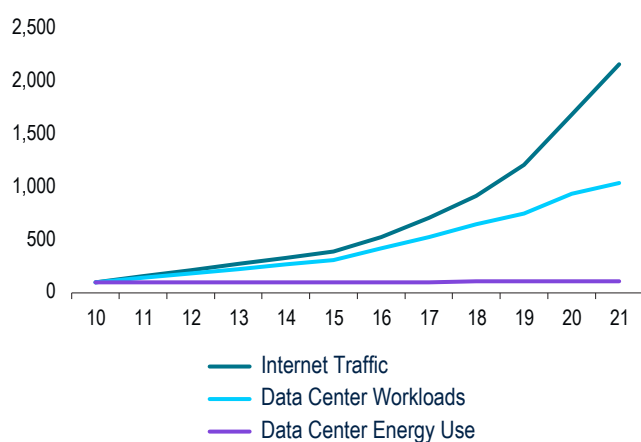
Despite exponentially higher internet traffic and data center workloads⁷, energy consumption in data centers has been relatively stable over the past decade at approximately 200 TWh, according to the International Energy Agency (IEA). This has been possible due to efficiency improvements and modernization in the sector — a major demand driver of hyperscale facilities and evidenced by the decline in energy consumed by traditional data centers as tenants and

operators modernized their portfolio of data centers. These modern hyperscale data centers have much higher energy efficiency, often measured by power usage effectiveness (PUE), which is the ratio of total amount of energy used by a data center facility to the energy delivered to computing equipment. According to Uptime Institute, average PUEs have declined from 2.5 in 2007 to 1.6 in 2020, as older data centers have become obsolete or been upgraded, while new facilities have focused on efficiency gains (Exhibit 6).

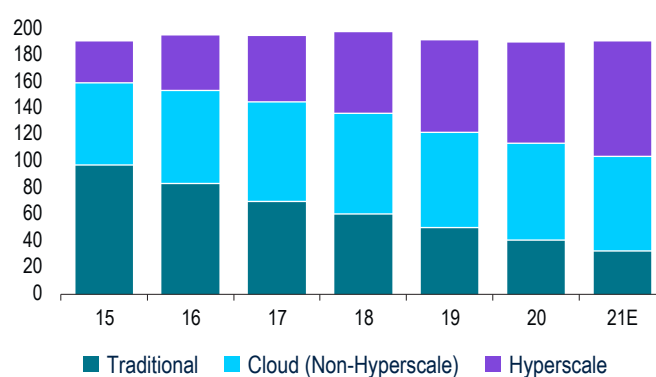
Nevertheless, efficiency gains alone are not sufficient and leading data center operators and cloud providers such as Equinix, Google and Microsoft have committed to self-regulatory pacts such as the Climate Neutral Data Center Pact, with targets to be net-zero by 2030 to reduce their environmental impact and improve brand reputation. As not all data center locations are suitable for large-scale renewable energy generation, power purchase agreements have been a key component of “green strategies,” and companies in the technology and communication sector have become the largest purchasers of renewable energy, accounting for half of global corporate renewable energy procurement⁸.

Exhibit 6: Data Center Energy Use

Internet and Data Center Usage vs. Energy Use (2010=100)



Energy Consumption by Data Center Type (terrawatt hours)



Energy Efficiency of Data Centers

Power Usage Effectiveness (PUE) ¹	1.0 – 1.2	1.2 – 1.5	1.5 – 2.0	2.0 – 2.5
Percentage of Data Center Market	12%	47%	38%	2%

¹ PUE represents the ratio of total amount of energy used by a data center facility to the energy delivered to computing equipment. Sources: IEA, Uptime Institute, Statista, PGIM Real Estate. As of November 2022.

⁶ International Energy Agency – Data Centres and Data Transmission Networks, November 2021.

⁷ <https://www.iea.org/commentaries/data-centres-and-energy-from-global-headlines-to-local-headaches>.

⁸ IEA, BloombergNEF (2021), 2H 2021 Corporate Energy Market Outlook.

With the recent focus on the use of renewable energy to power data centers, ESG requirements are likely to push data center construction costs up further. While the demand for data center capacity is likely to continue encouraging developers of both built-to-suit and speculative projects, the development risks are now higher, particularly for the latter.

TRANSACTION VOLUME SLOWED COMPARED TO 2021

Reflecting investor interest in the structural trend of digitalization, global data center transaction volume reached a record high in 2021 of US\$18 billion. The jump in transaction volume was driven by increased investment activity in the United States and APAC. Portfolio deals continue to be a popular way to invest among investors.

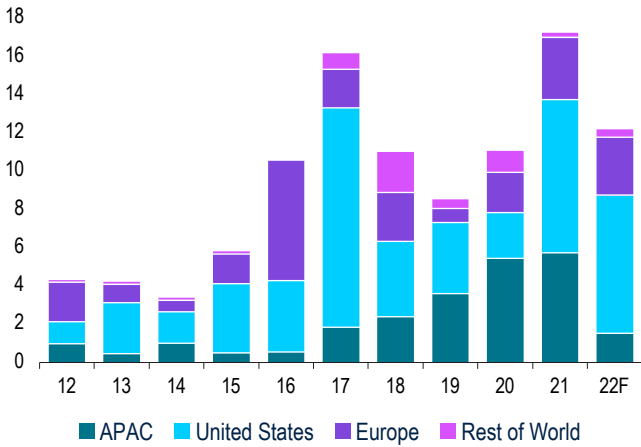
The positive investment momentum spilled over to the start of 2022 with US\$9 billion of data centers transacted in the first quarter alone, but momentum has since slowed significantly with less than US\$1 billion transacted in the third quarter, reflecting market uncertainty. Given

the volatile macro environment, it will continue to be challenging for investors to deploy capital going forward. Looking at the geographical split, U.S. markets continue to dominate the global data center investment market, although APAC has shown significant growth over the last decade with the rapid expansion of major cloud operators into the region. APAC accounted for only around 20% of global data center transactions 10 years ago, rising up to around 40% in 2021. Taking the 1H22 data and accounting for past trends in data center transactions linked to economic activity, we expect transaction volume for 2022 as a whole to be down by around 30% of that recorded in 2021.

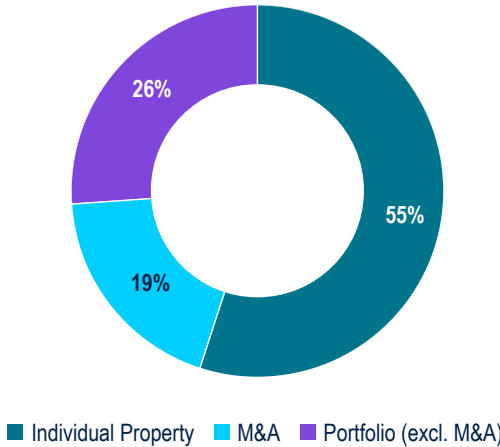
In terms of acquisition structure, around half of data center transactions are done via M&A or portfolio deals rather than by individual property. Notable M&A activity includes the privatization of CyrusOne by KKR and Global Infrastructure Partners and the acquisition of CoreSite by American Tower. M&A and portfolio deals are expected to continue to drive transaction activity going forward, given the potential economies of scale from owning a network of data centers (Exhibit 7).

Exhibit 7: Data Center Transaction Volume

Global Data Center Transaction Volume (US\$ billion)



Global Data Center Transaction Volume Breakdown (2021)



Sources: MSCI / Real Capital Analytics, PGIM Real Estate. As of November 2022.

RESILIENT RETURNS TO BOUNCE BACK

2021 was a record year for the global data center sector, with an average return of 15%, driven mainly by yield compression. This was in line with our expectations of tightening yields as risk premiums between data centers and other traditional commercial real estate sectors declined, as highlighted in our previous paper.

Total returns were the strongest in the United States, at close to 17%, as data center yields fell to 4.7% from 5.9% the year prior⁹. This was driven by a notable increase in investor demand that resulted in 2021 being historically one of the strongest years for transaction activity, second only to the volume witnessed in 2017 and roughly triple the volume in 2020. However, cap rates may have over shot as they have already gone back up to 5.1%, which would represent a mild correction in capital values. At the same time, rental performance has shown some divergence across the regions, with rents dipping slightly in the United States and Europe, though growth still held positive in APAC (Exhibit 8).

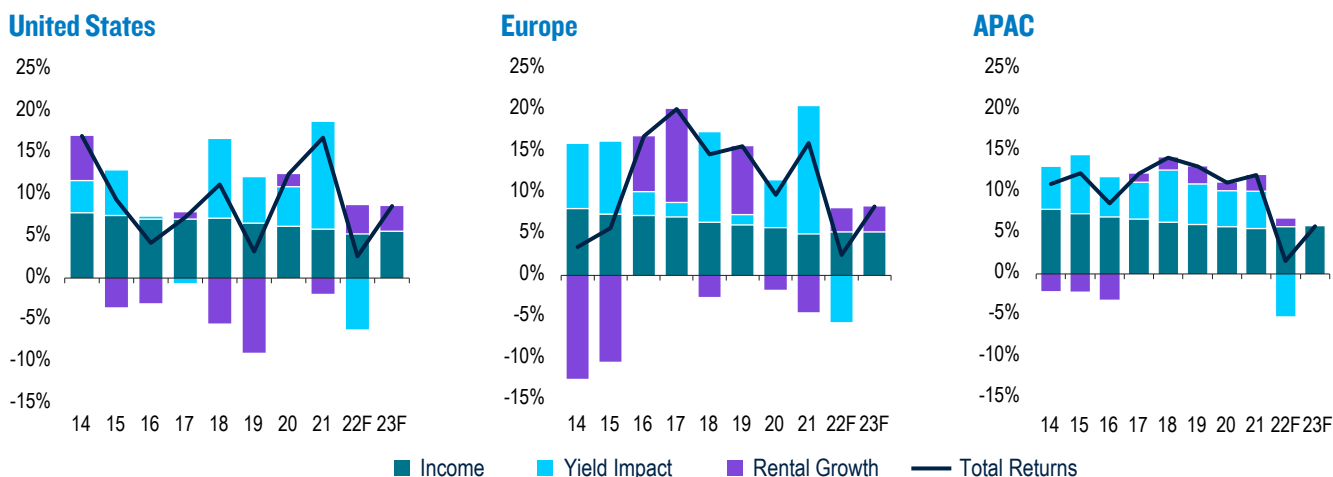
Going forward, the returns outlook across the three major markets tells a similar story — a softer near-term outlook to yields as the economic environment weakens

before recovering ahead of expected improving economic fundamentals in 2024. The similarities across the regions speak to the globally shared critical need for digital infrastructure. Globally, as an unweighted average of the three markets, we see returns bouncing back in 2023 off an expected pick up in economic and transactions activity, hitting an unlevered return of around 7.5% (Exhibit 9).

In terms of risks with construction costs, including those associated with environmental goals, potentially limiting supply by more than expected, global rental growth is likely to pick up by more than expected, driving returns higher.

Investor surveys tell us alternative real estate sectors, such as data centers, healthcare, cold storage and student living, have gradually become more mainstream. Today, almost a third of all investors are seeking investment exposure to the data center sector, compared to only 5% of institutional investors surveyed in 2018 (Exhibit 10). Key drivers for this have been the attractive returns for new entrants alongside compressed yields in the more established commercial real estate sectors. But demand is also being driven by strong underlying structural needs. As with technology, data centers are “a need to have,” and we expect demand to be resilient amid the current challenging economic conditions.

Exhibit 8: Estimated Regional Data Center Total Returns (Unlevered, Powered Shell and Core Assets)

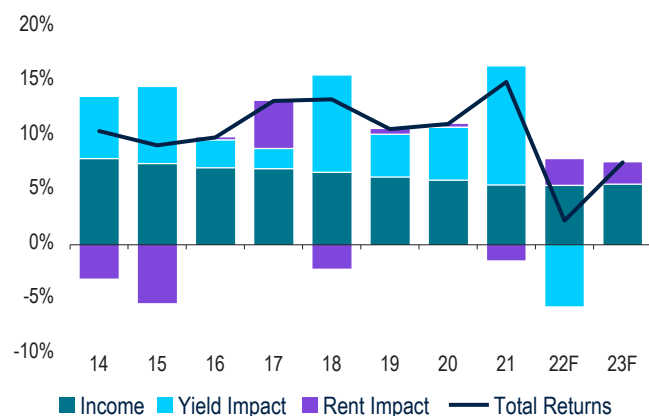


Sources: MSCI, Green Street Advisors, CBRE, Structured Research, PGIM Real Estate. As of November 2022.

⁹ Green Street Advisors “North American Data Center Trends 1H22,” October 2022.

Exhibit 9: Estimated Global Data Center Total Returns* (Unlevered, Powered Shell and Core Assets)

Global

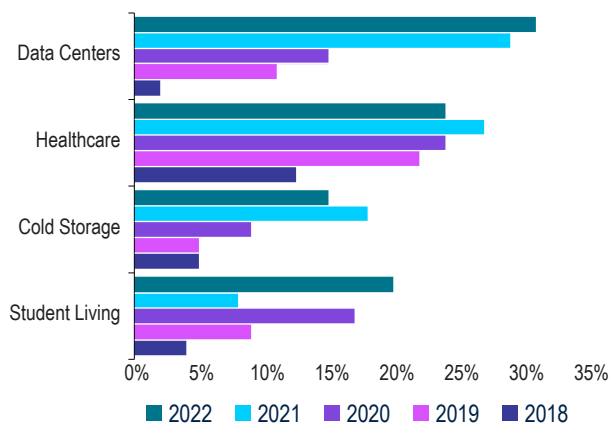


*Unweighted average of our three regional market returns.

Sources: Green Street Advisors, CBRE, Structured Research, PGIM Real Estate. As of November 2022.

Exhibit 10: Investor Appetite for Data Centers

Investor Intentions Survey on Alternative Sectors (% seeking exposure)



Sources: Green Street Advisors, CBRE, Structured Research, PGIM Real Estate. As of November 2022.

CONCLUDING COMMENTS

The mass adoption of new and existing technologies that change the way society lives, works and plays continues to grow at such rates that even the recent deterioration in the wider macroeconomic outlook cannot slow the expected future growth in the size of the ICT sector. This illustrates how important technology has become to societies and how significant associated ICT infrastructure growth is expected to be.

When it comes to real estate, the ICT sector is the underlying driver of demand for data centers — buildings designed specifically to house computer systems and network equipment to support digital information processing. Based on current structural trends and the latest available data, this sector will continue to grow significantly in the coming years.

There are challenges to be sure. We see returns in 2022 softening in line with a fall in investment volume as global economic uncertainty impacts the markets, while at the same time concerns about energy usage and its impact on the environment are growing, forcing the industry to take stock and look for ways to meet sustainability goals. But it is hard to ignore the sheer speed at which technology and the need for data centers is being adopted. With data centers increasingly becoming critical infrastructure to keep economies working, we see investment returns rebounding in 2023 on a global basis — reflecting the commonly held global need for data centers and demonstrating the sector's resilience to short-term market forces.

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