March 2022

Global Research

2021 Year-End Data Center Outlook

Insight into the industry's top trends in the second half of 2021

Executive summary

- M&A activity hit a new record in 2021, following a record year in 2020. A whopping $34.5 billion of activity was executed in 2020, only to be outdone by the $47.1 billion recorded in 2021. Notably, KKR and Global Infrastructure Partners (GIP) acquired CyrusOne for $15.0 billion and will close in the first half of 2022.
- The data center sector continues to take action on sustainability. Globally, corporate power purchase agreement (PPA) volumes achieved 31.1 GW in 2021, an immense increase from just 0.1 GW in 2010. Hyperscalers are the top investors in the U.S. for PPAs as they look to increase their renewable energy portfolio performance.
- The global construction pipeline reached a new record in 2021, led by robust activity in the United States, amid supply chain disruptions and project delays in bringing space to market. In the United States, the construction pipeline grew by 18.9 percent year-over-year, reaching 727 MW in 2021.
- Demand reached yet another record in 2021. In the United States, absorption reached a mammoth total of 885.7 MW across 14 domestic markets. The core markets in Europe met earlier projections and recorded 219.3 MW in absorption, an increase of 9 percent year-over-year.

Top global trends

1.

M&A activity ramped up in 2021 with billion-dollar deals

M&A activity hit a new record in 2021, following a record year in 2020. A whopping $34.5 billion of activity was executed in 2020, only to be outdone by the $47.1 billion recorded in 2021.[1] Digital Realty's acquisition of Interxion at $8.4 billion was a key highlight of 2020, but 2021 ushered in new megadeals.

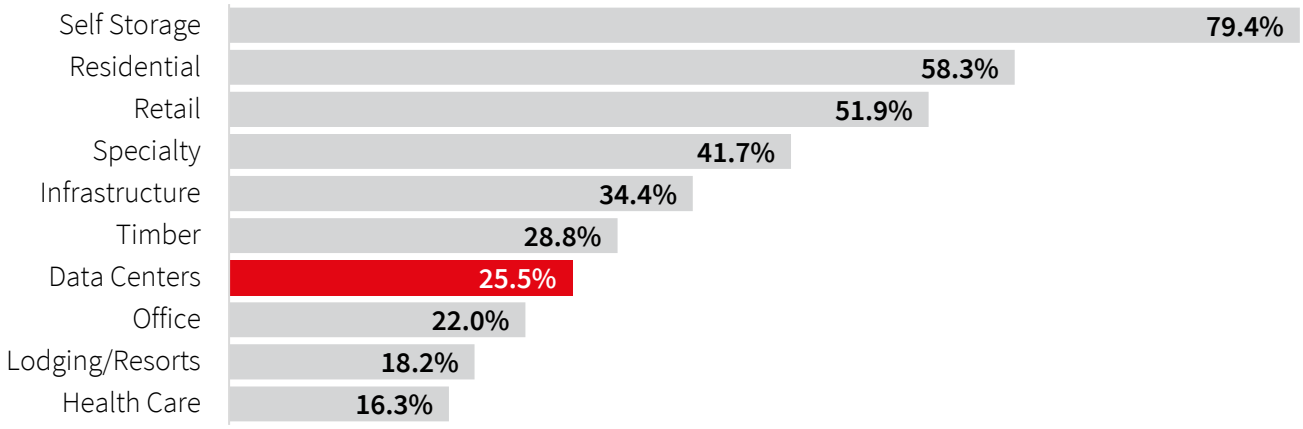
New heights were reached in 2021 with major announcements of acquisitions among the top data center operators. The first of the three major deals was Blackstone's acquisition of QTS Realty for $10.0 billion, which closed in August 2021. The deal significantly expands Blackstone's portfolio as QTS operates in over 14 markets across the globe. KKR and Global Infrastructure Partners (GIP) acquired CyrusOne for $15.0 billion and will close in the first half of 2022. This will facilitate further expansion in global markets. The large cell tower company American Tower Corporation purchased CoreSite for $10.1 billion, which closed in December 2021. The move will allow American Tower to combine its existing facilities with CoreSite's data centers, spreading its edge data facilities' interconnection across the nation.

These megadeals enable large players, with strong financing, to scale rapidly both domestically and abroad. Blackstone's deal with QTS Realty illustrates this theme as it will look to scale QTS Realty's existing portfolio of 7 million square feet. It is also active in APAC, where it invested $150 million into the Chinese provider 21Vianet.

REIT performance as of December 31, 2021, reflects the reentry and reopening of economies. Residential and retail recorded the highest returns in 2021. The data center sector, now reflecting three constituents, recorded 25.5 percent in returns. There continues to be an influx of cash in the sector, with investors targeting increased tenant demand.

As noted in previous JLL reports, the pandemic has accelerated data center demand and sparked interest among investors. The combination of remote work, projected increases in IT spend and even esports has contributed to robust demand. The once-niche industry of esports grew into a billion-dollar industry for the first time in 2021, reaching an audience of 474 million viewers.[2] Further highlighting the gaming industry's growth, Microsoft announced its plan to acquire game developer Activision Blizzard for $68.7 billion. This industry is one of many that will increase the need for data center space.

Total Returns by Sector, FTSE Nareit U.S. Real Estate Index Series, as of December 31, 2021



Sources: JLL Research, Nareit, FTSE
**Nareit defines returns as a "stock's dividend income plus capital appreciation, before taxes and commissions."*

[1] *Synergy Research Group*
[2] *JLL Research, "2021 Esports Real Estate"*

2.

Demand and goals for sustainability make way as metrics evolve

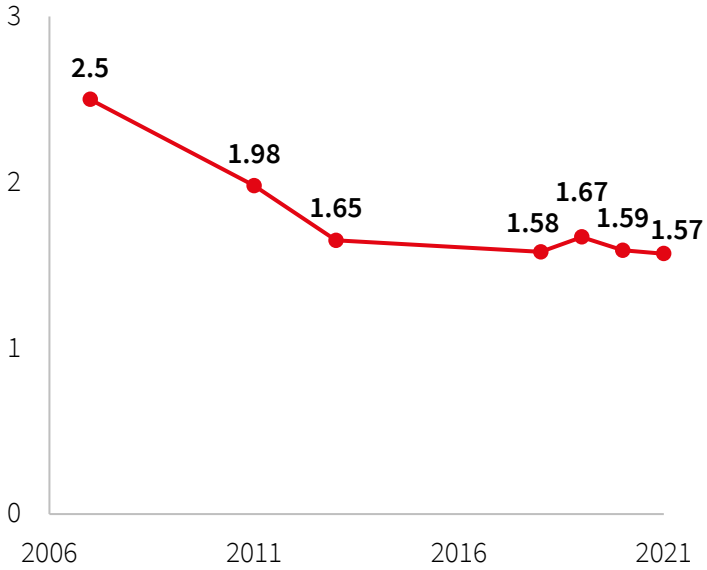
The data center sector has historically been a heavy user of energy resources, but many data center operators have made significant inroads to reduce their data center carbon emissions and increase their energy efficiency. Not only do data center operators have their own green goals they have set out to achieve, but they are also meeting hard requirements by their customers, who are also scrutinizing their supply chain as a means to meet their own goals. Major multinational companies across industries now have their own annual sustainability reports to meet ESG plans.

Metrics continue to evolve to meet green goals

One of the most known metrics in the data center sector is power usage effectiveness (PUE). PUE is a ratio used for measuring the energy efficiency of a data center. It is calculated by the total facility energy divided by the energy delivered to the IT equipment. A PUE score of 1.0 would indicate 100% efficiency while a score of 2.5 or above would indicate a very low level of efficiency.

According to the Uptime Institute's 2021 survey of IT and data center managers, PUE greatly improved since 2007 but has remained stable over the past five years. The report cites that many changes in older data center facilities have achieved gains already. Unless it is a new facility, there is little incentive to make substantial renovations to achieve lower PUE.

Average annual PUE



Source: Uptime Institute, Global Data Center Survey 2021

There are also a myriad of other metrics that operators are using. While 70 percent of those surveyed in Uptime Institute's survey stated they track and report on PUE in annual reports, 82 percent track IT and data center power consumption. The same report shows that more improvements can be made for the sector when it comes to more direct green metrics, including the source of renewable energy and water usage. Only a third of those surveyed measure carbon emissions and only a quarter track electronic waste.

The latest green effort in the industry includes SpaceDC's MNL1 development in **Cainta, Philippines**. The Singapore-based provider is set to deliver its campus in 2022 and it will be the largest data center campus in the country. The location will be fully powered by wind and geothermal supply with a PUE of just 1.3.

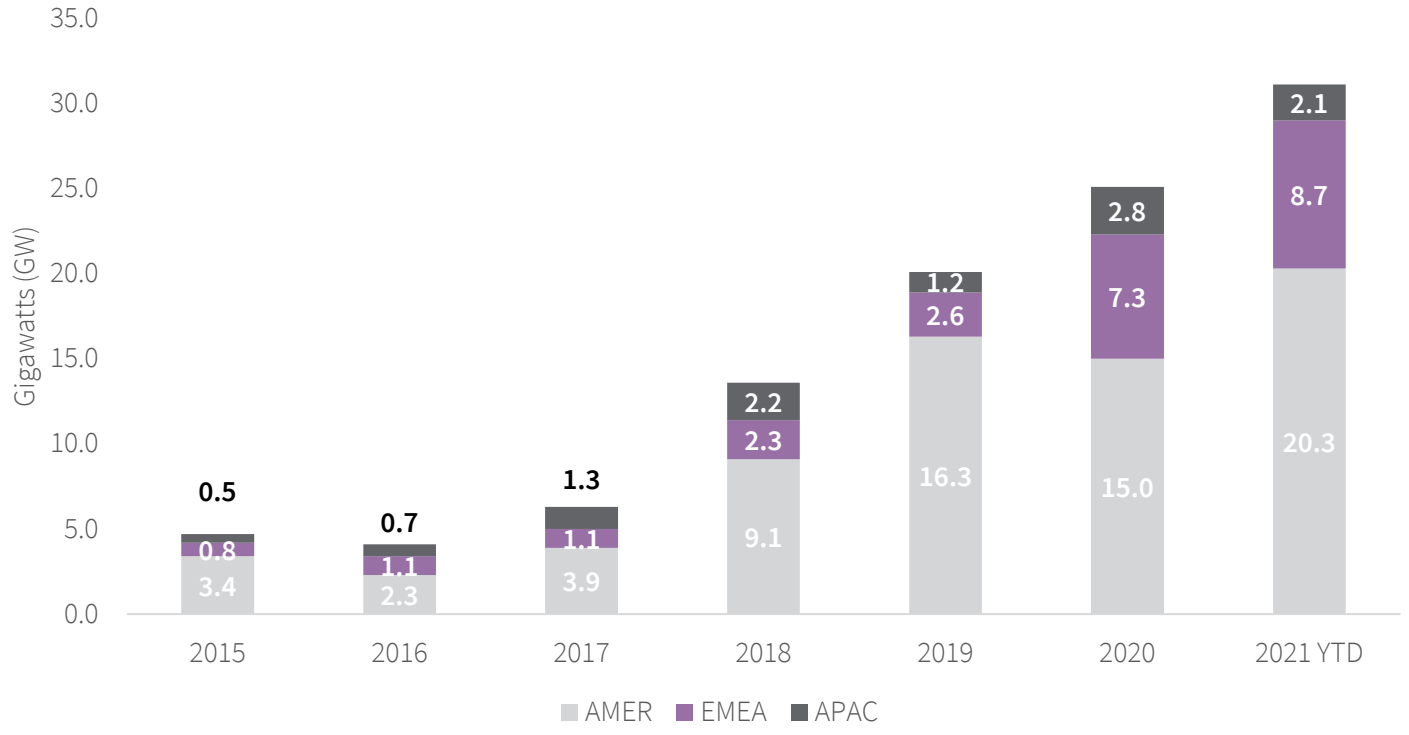
Source: SpaceDC

Strategies to help guide sustainability

PPA (power purchase agreement), REC (Renewable Energy Certification) and CCA (community choice aggregation) are popular methods for data center operators to enhance their renewable energy portfolios and lower their carbon footprint. The Americas led the PPAs market by purchasing 20.3 GW in 2021. Globally, corporate PPA purchase volumes achieved 31.1 GW in 2021, an immense increase from just 0.1 GW in 2010. Since 2010, the PPA volume reached a cumulative 109.0 GW. The technology sector has been the biggest buyer for PPAs in the last five years, with over 12,000 MW PPAs purchased in 2020 and 5,900 MW PPAs purchased in the first half of 2021. Driven by the billion-dollar tech companies located in the U.S., the U.S. is home to the most substantial number of corporations that bought PPA volumes globally.

Hyperscalers are the top investors in the U.S. for PPA deals as they look to increase their renewable energy portfolio performance. This enormous PPA contract volume shows that large data center operators are taking the initiative to work their way to carbon natural commitments and set up an industry standard for the rest of the enterprise and colocation data center operators. As the biggest offsite PPAs buyer, one hyperscaler signed a 118 MW PPA onshore wind deal with Southern Power in 2021. Technology evolution, government incentives such as FITs (feed-in tariffs) and PTCs (production tax credits) are the main factors that will drive more affordable renewable energy.

Annual corporate PPA volumes by region



Source: BloombergNEF, January 2022

3.

Labor shortages amid the pandemic

Data center development, from construction to business operations, cultivates direct and indirect job opportunities in local economies. Despite strong growth over the past decade, the industry faces some labor headwinds over the next five years that could limit the rapid data center expansion currently under way.

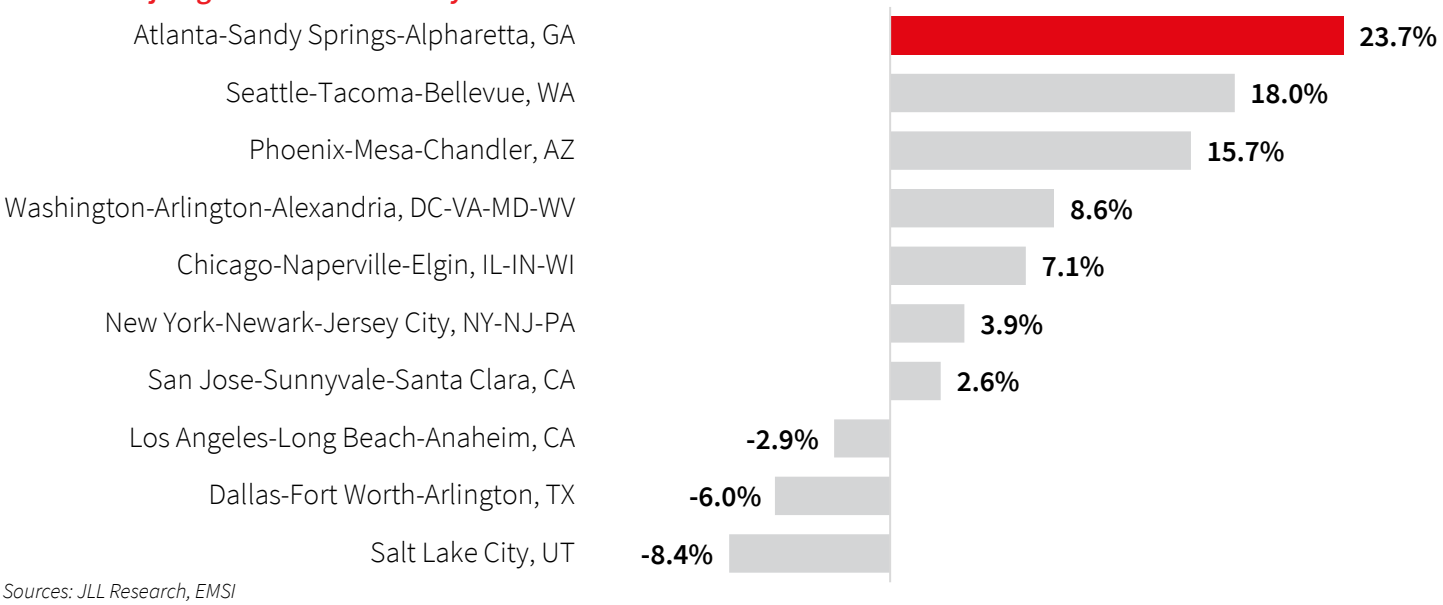
According to Uptime, 2.0 million full-time employees will be needed globally in 2021 and the number will be close or equivalent to 2.3 million by 2025. Forty-seven percent of respondents in its latest survey said they are having a difficult time finding qualified candidates, an increase from 38 percent in 2018. In addition, nearly a third are having trouble retaining staff, which is up from just 17 percent in 2018.[3]

While there will be an overall shortage of data center talent across the globe, the conditions will vary by market, even within regions. In the **United States**, uneven job growth is projected by 2025, with Atlanta, Seattle and Phoenix leading domestic markets, according to EMSI data. Contributing factors to the evolving labor conditions include the COVID-19 pandemic and its public health considerations and supply chain disruption, as well as demographic trends, education attainment and business environment.

How to mitigate the projected labor shortage

- Partner with universities and even high schools to build a labor pipeline.
- Build training programs for new employees, no matter where they are. Include augmented reality (AR) as part of these programs so you can train new employees with real-time guidance without the need to visit a facility.

Data center job growth 2020–2025 by MSA



Sources: JLL Research, EMSI
**Data reflects data processing, hosting and related services occupations*

[3] *Source: Uptime Institute, Global Data Center Survey 2021*

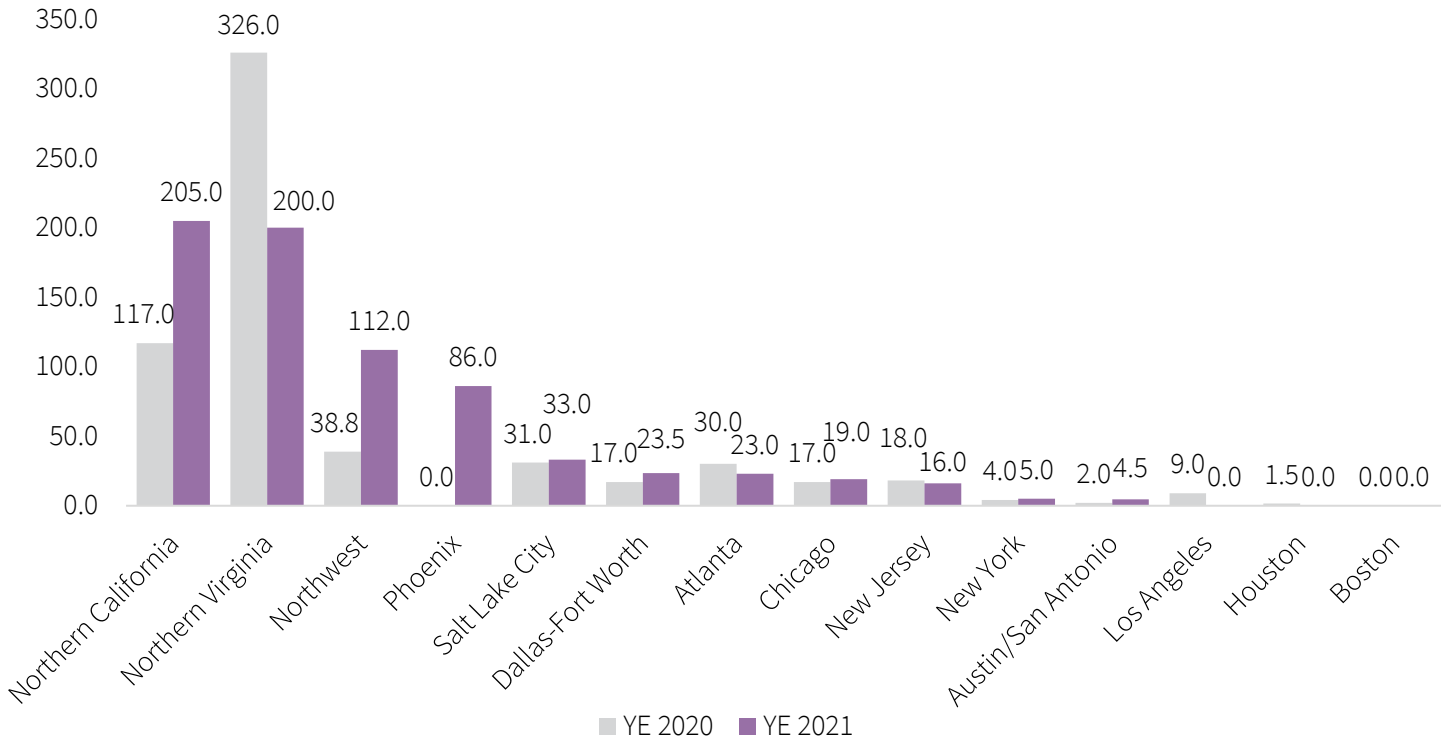
State of the industry

Construction

The global construction pipeline reached a new record in 2021, led by robust activity in the United States.

The construction pipeline is at its highest level on record, amid supply chain disruptions and project delays. In the **United States**, the construction pipeline grew by 18.9 percent year-over-year, reaching 727 MW in 2021. Northern California contributed to this significant increase, recording 205 MW under construction for the year. Despite supply chain delays, the Northern California market continues to see robust investment interest. The Northwest and Phoenix also made significant gains in the construction pipeline, with 112 MW and 86 MW, respectively. Northern Virginia recorded 200 MW under construction, consistent year-over-year as it remains the premiere data center market. In Canada, Toronto recorded consistent supply as well, at 52 MW under construction. Despite supply chain issues and project delays, the pipeline remains strong and should continue to be robust through 2022.

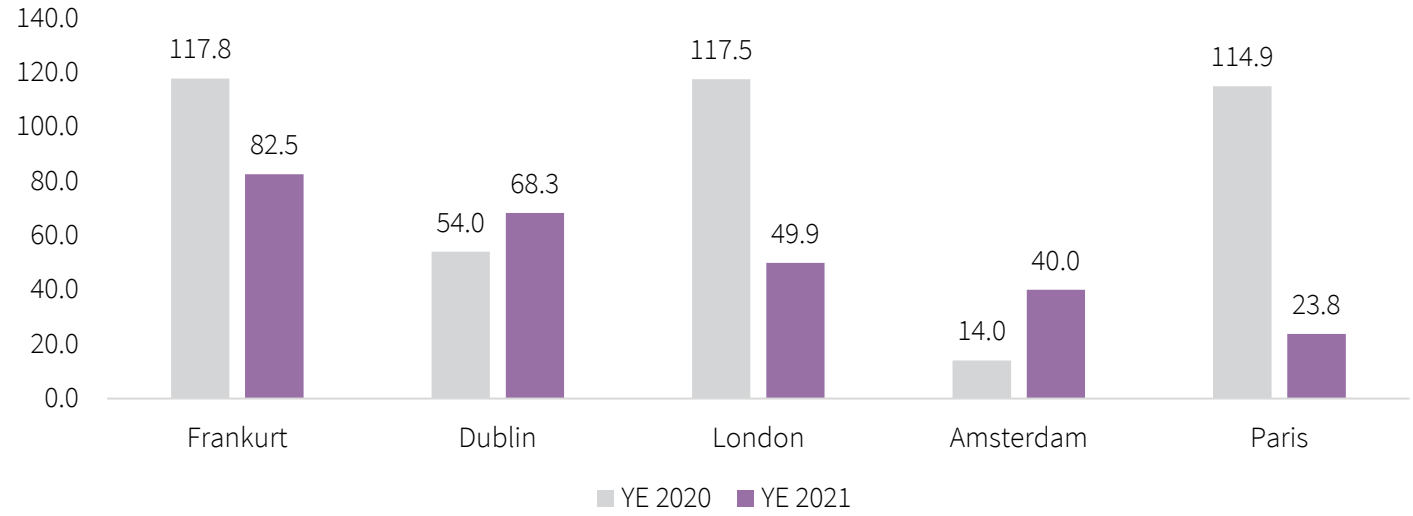
Under construction (MW) by U.S. market, YE 2021



Source: JLL Research

The construction pipeline in **Europe** decreased from 418.2 MW at year-end 2020 to 274.5 MW at year-end 2021. Frankfurt leads the way in construction, despite its pipeline decreasing to 82.5 MW. However, the market is still expanding, with over 95 MW in planned space. In London, nearly 110 MW of space was added to the market. There is currently 49.9 MW of space under construction with an additional 219.8 MW planned. While the prospective product is strong, land availability remains scarce.

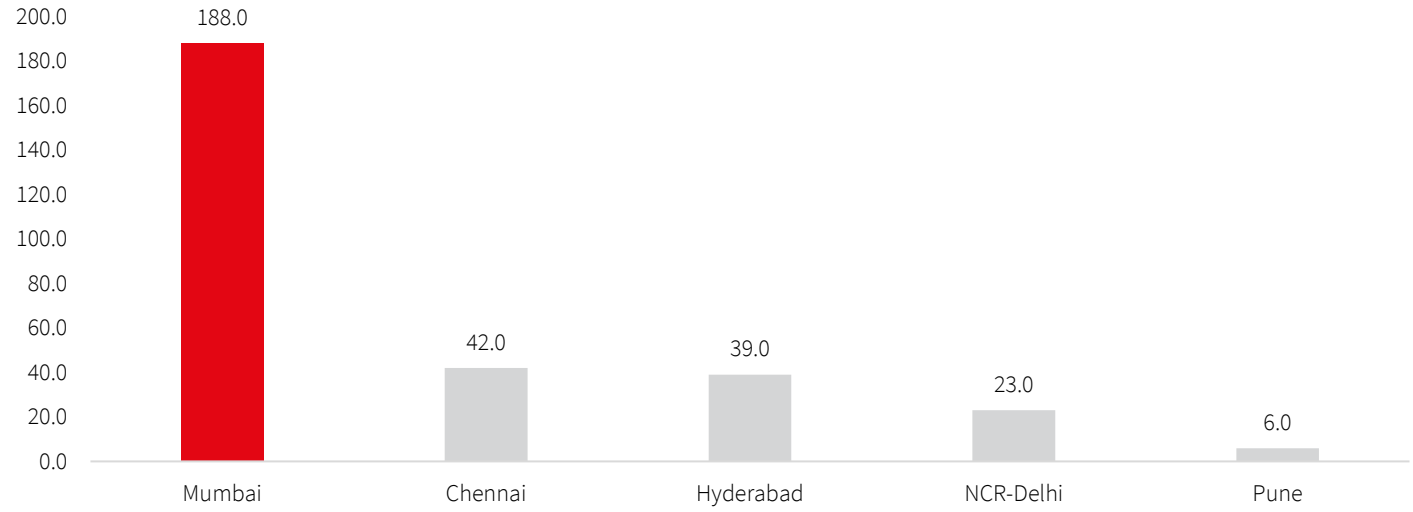
Under construction (MW) by EMEA market, YE 2021



Source: JLL Research

In **India**, Mumbai leads the way in development with 188 MW under construction, mostly driven by large hyperscale activity. Hyperscaler expansions are driving construction activity in the rapidly growing market of Chennai as well, where 42 MW are under construction. India's planned activity is also significant as hyperscalers inked large land acquisitions in 2021. There are nearly 500 MW of planned data center space throughout India.

Under construction (MW) by India market, YE 2021



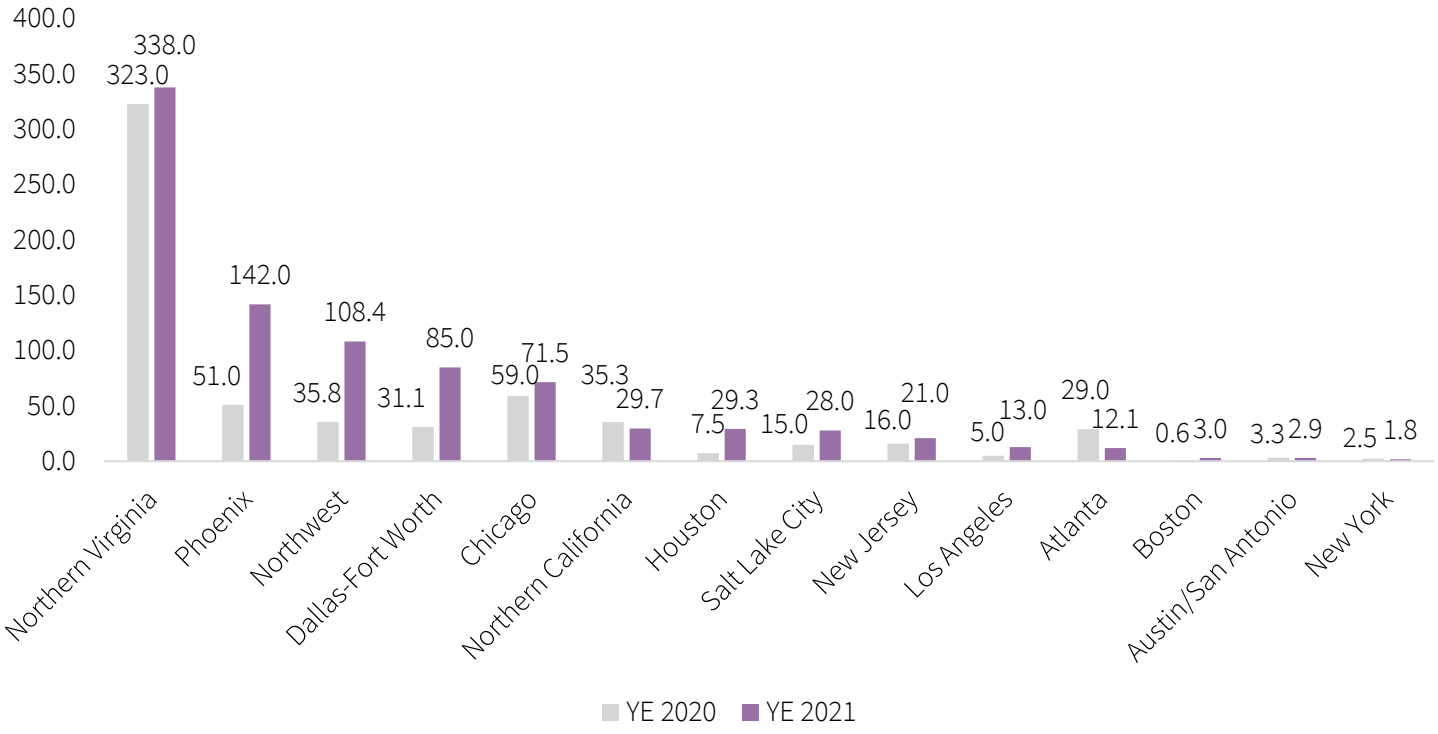
Source: JLL Research

State of the industry

Demand | Demand reaches yet another record in 2021.

In the **United States**, absorption reached a mammoth total of 885.7 MW across 14 domestic markets, due to an impressive second half of 2021 led by large cloud and technology company expansions. This absorption figure is a 44.3 percent increase year-over-year. To fully appreciate this growth, it is necessary to reflect on 2020, which was a record year itself. Year-end 2020 recorded 614 MW absorbed among the same domestic markets, which was an increase of over 70 percent from 2019. The Northwest more than tripled its demand in 2021, due to technology company activity and increases in the average deal size. Expanding hyperscale footprints in Phoenix and Dallas also drove significant gains in absorption, reaching 142 MW and 85 MW, respectively. Social media and technology companies drove consistent demand in Northern Virginia and Chicago.

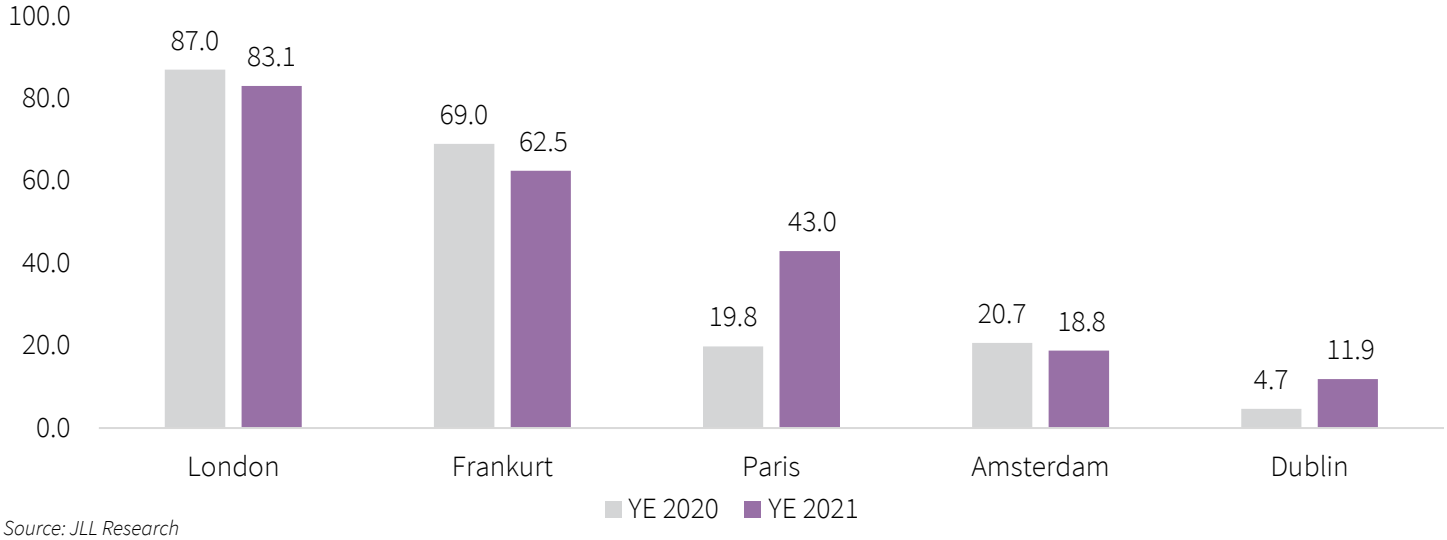
Absorption (MW) by U.S. market, YE 2021



Source: JLL Research

The United States was not alone in recording insatiable demand. The core markets in **Europe** met earlier projections and recorded 219.3 MW in absorption, an increase of 9 percent year-over-year. Preleasing activity has picked up across Frankfurt and Paris. In these two markets, total leasing activity for the year stands at 126 MW and 89 MW , respectively. Paris recorded 43 MW in absorption, more than doubling its amount from 2020, largely driven by cloud companies.

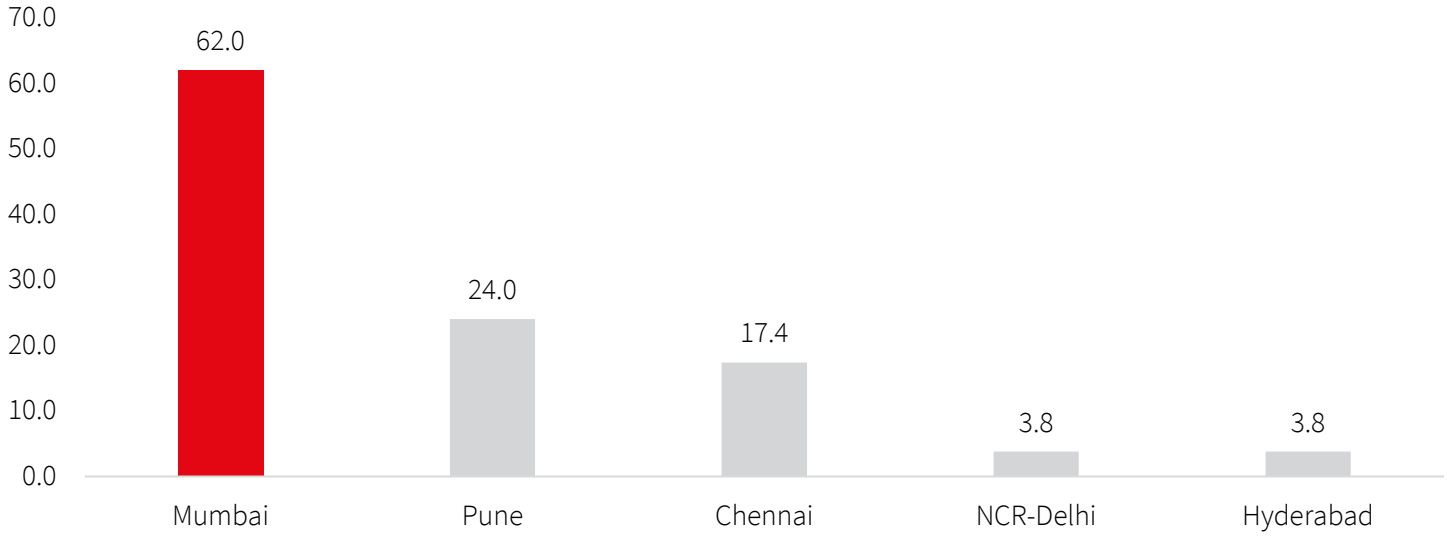
Absorption (MW) by EMEA market, YE 2021



Source: JLL Research

Demand picked up in the second half in key markets in **India**, including Mumbai. In fact, total absorption in the second half of the year increased by 49 percent from the first half in all of India. In Mumbai alone, demand increased by a strong 71 percent in the second half of 2021 and reached 62 MW for the year. This demand was led primarily by cloud companies and banking and financial service companies expanding their footprints.

Absorption (MW) by India market, YE 2021



Source: JLL Research

Phoenix

Cloud, social media and technology companies drive colocation absorption for the Phoenix market

Market overview

Supply

Supply continues to not keep up with demand. As of Q4 2021: Compass leased out its 225,000-square-foot building, CyrusOne leased out its last 36 MW in building 9 as well as 24 MW in building 10, Stream leased 4.5 MW, Iron Mountain has preleased committments for 24 MW and EdgeCore has 100 percent leased out building 1.

Demand

Demand by hyperscale cloud, technology and social media companies continued through the balance of 2021 with multi-megawatt deals, expanding these companies' existing footprints throughout the Valley, one being a 60 MW committment in the East Valley. Financial services, healthcare and software companies are actively pursuing additional options in the Valley.

Market trends

With continued large-scale multisite requirements, as referenced above, colocation developers and operators will continue to expand their footprints with secondary locations throughout Greater Phoenix. These development timelines are being accelerated due to the supply chain and labor shortages. We will continue to see speculative development to meet customer demand.

Outlook

*for **Users***

- Continued cloud strategy pressures from the C-suite
- Deal execution will need to be swift with multiple users pursuing available inventory
- Long ramps will be more challenging to achieve

*for **Providers***

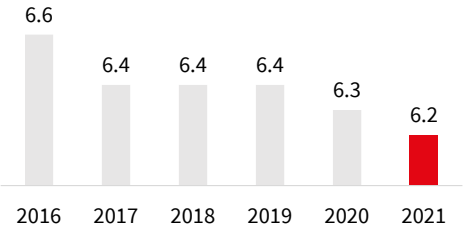
- "If you build it, they will come"
- Go big or go home
- Power, power, power

Supply	s.f.	MW
Total inventory:	5,142,120	472.2
Total vacant:	2,513,493	43.7
Under construction:	561,000	86.0
Planned:	5,773,522	883.0

Demand	MW
Net absorption:	142.0

Rental rates	Low	High
(All-in) sub-250 kW	$175	$275
250 kW-1 MW	$95	$110
1-5 MW	$85	$95
5 MW plus	$75	$85

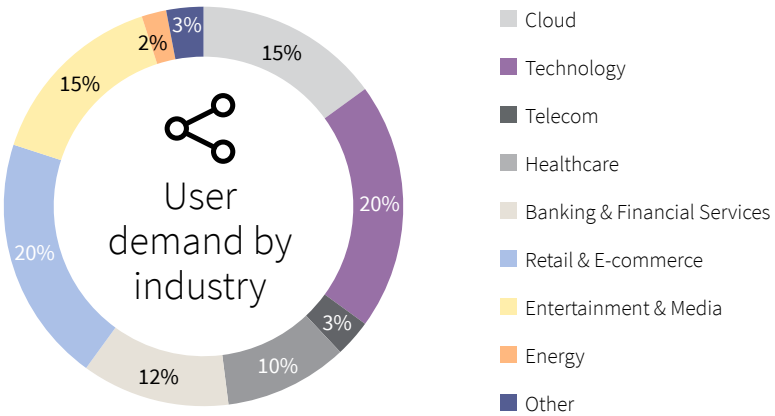
Average power rate (cents/kWh)



Data Center leverage

H2 2019	*H1 2020*	*H2 2020*	*H1 2021*	*H2 2021*

User-favorable market
Neutral market
Provider-favorable market



Authored by: Mark Bauer

See page 42 of this document for contact information.

Looking forward in 2022

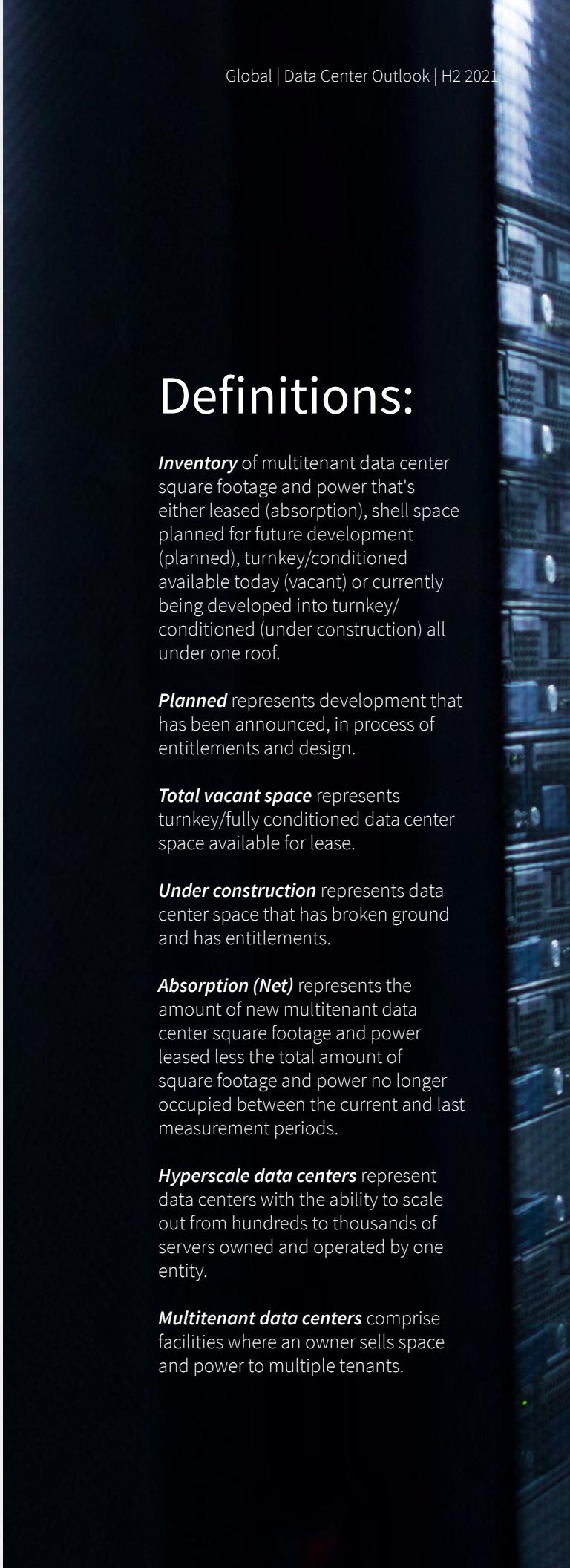
Available landsites in key data center markets have been limited due to competing industrial demand, power deployment constraints and supply chain issues for critical infrastructure. This has resulted in hyperscale users competing for data center space that can accommodate large-scale growth that was previously unheard of (i.e., 36+ MW requirements). There are now more 20+ MW requirements than there are 1 MW requirements.

Despite strong demand and healthy fundamentals, the data center sector is not immune from global supply chain issues. From semiconductors to construction times, the state of the supply chain ecosystem will continue to disrupt data center operations and development in 2022. Equipment and material shortages, combined with construction pricing and insatiable demand for land, will likely lead to an increase in rents. There are several strategies operators are implementing to handle these issues. We expect data center developers and operators to increase their supplier pool to mitigate shortcomings. Other operators have been more proactive, including Switch, which started to design its own equipment to avoid competition for limited supply from other larger operators. Recent data center consolidations will also help increase purchasing power for smaller operators and limit the impact of current supply chain challenges.

Despite record megadeals, strong absorption and increased investor appetite, there are some headwinds for the data center industry:

- Rental rates continue to compress, notably in key markets like Northern Virginia, where development pipelines remain at record levels. However, supply chain challenges may shift costs to users.

- Land is increasingly expensive as development pipelines expand. Northern Virginia and London have experienced record-level price increases throughout the pandemic.



Definitions:

Inventory of multitenant data center square footage and power that's either leased (absorption), shell space planned for future development (planned), turnkey/conditioned available today (vacant) or currently being developed into turnkey/ conditioned (under construction) all under one roof.

Planned represents development that has been announced, in process of entitlements and design.

Total vacant space represents turnkey/fully conditioned data center space available for lease.

Under construction represents data center space that has broken ground and has entitlements.

Absorption (Net) represents the amount of new multitenant data center square footage and power leased less the total amount of square footage and power no longer occupied between the current and last measurement periods.

Hyperscale data centers represent data centers with the ability to scale out from hundreds to thousands of servers owned and operated by one entity.

Multitenant data centers comprise facilities where an owner sells space and power to multiple tenants.

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