2021

DATA CENTER GLOBAL MARKET COMPARISON

A Publication of Cushman & Wakefield's
Data Center Advisory Group

CUSHMAN & WAKEFIELD

INTRODUCTION & METHODOLOGY

CONTENTS

THE DATA CENTER EXPLOSION

In a year full of turmoil and strife caused by an unexpected pandemic, the internet helped people across the globe work, play, and live as normally as possible given the circumstances. By powering all that makes up the internet, data centers were recognized throughout 2020 for their crucial presence in all lives, and for maintaining communication and knowledge during a period of sudden change for humanity. Data center operators and major services held fast throughout the troubled, early days onward; as data centers were identified as truly mission critical, and the advanced planning and scalability that defines the lives of data center personnel maintained uptime throughout the crisis. Companies large and small rapidly scaled up workloads with cloud service providers so employees could access their normal applications; schools and universities moved online as students attended classes remotely; and all people looked to the internet for entertainment as they stayed home for days at a time.

By powering all that makes up the internet, data centers were recognized throughout 2020 for their crucial presence in all lives, and for maintaining communication and knowledge during a period of sudden change for humanity.

Several trends that were beginning prior to the year accelerated rapidly throughout 2020. Businesses were forced to continue their IT transformation with a suddenly fully remote workforce; many moved workloads straight to major cloud services. While most of this will remain in the public cloud environment, costs and regulatory concerns may lead to some moving to a colocation or even on-premises situation. Those who can manage this hybrid IT scenario for highest efficiency and lowest cost will enjoy the greatest returns on investment.

BREAKING THROUGH THE NOISE

Secondary markets continued their growth throughout the year, with many new ventures forming to build out critical infrastructure in markets across Europe and Asia. Funded by an amalgamation of pension funds, private equity, and sovereign wealth, the capital invested in these companies will enable powerful platforms in markets that had been ignored for lack of volume in previous years. Major cloud services assisted in the launch of many of these markets, expanding significantly in local ecosystems, with new and familiar entities following their lead shortly thereafter. The battle for market share across these markets will define the industry over the next several years.

The Global Market Comparison for 2021 reviews all factors in our previous edition, with the addition of a "Smart Cities" category this year, reflecting the importance of a strong local environment to a data center market. As befitting a year of interest in secondary locations, an additional ten such markets have been included across Europe, Asia, Central America, and Africa. Data sets across the board have been refined and expanded, with a shift from the 2020 edition in the final results.

CONTROL GROUP STATS

30
Research Sources

1,189
Data Centers

48
Global Markets

METHODOLOGY

MENU

Each data center was individually scored across thirteen weighted criteria in three distinct categories: **real estate and physical considerations** (development pipeline, environmental risk, land price, vacancy), **ecosystem advantages** (cloud availability, fiber connectivity, market size, sustainability), and **political and regulatory review** (government incentives, political stability, power cost, taxes). Then, it was possible to assign each metropolitan area an **overall market score**.

HIGH WEIGHT
Cloud Availability
Fiber Connectivity
Market Size

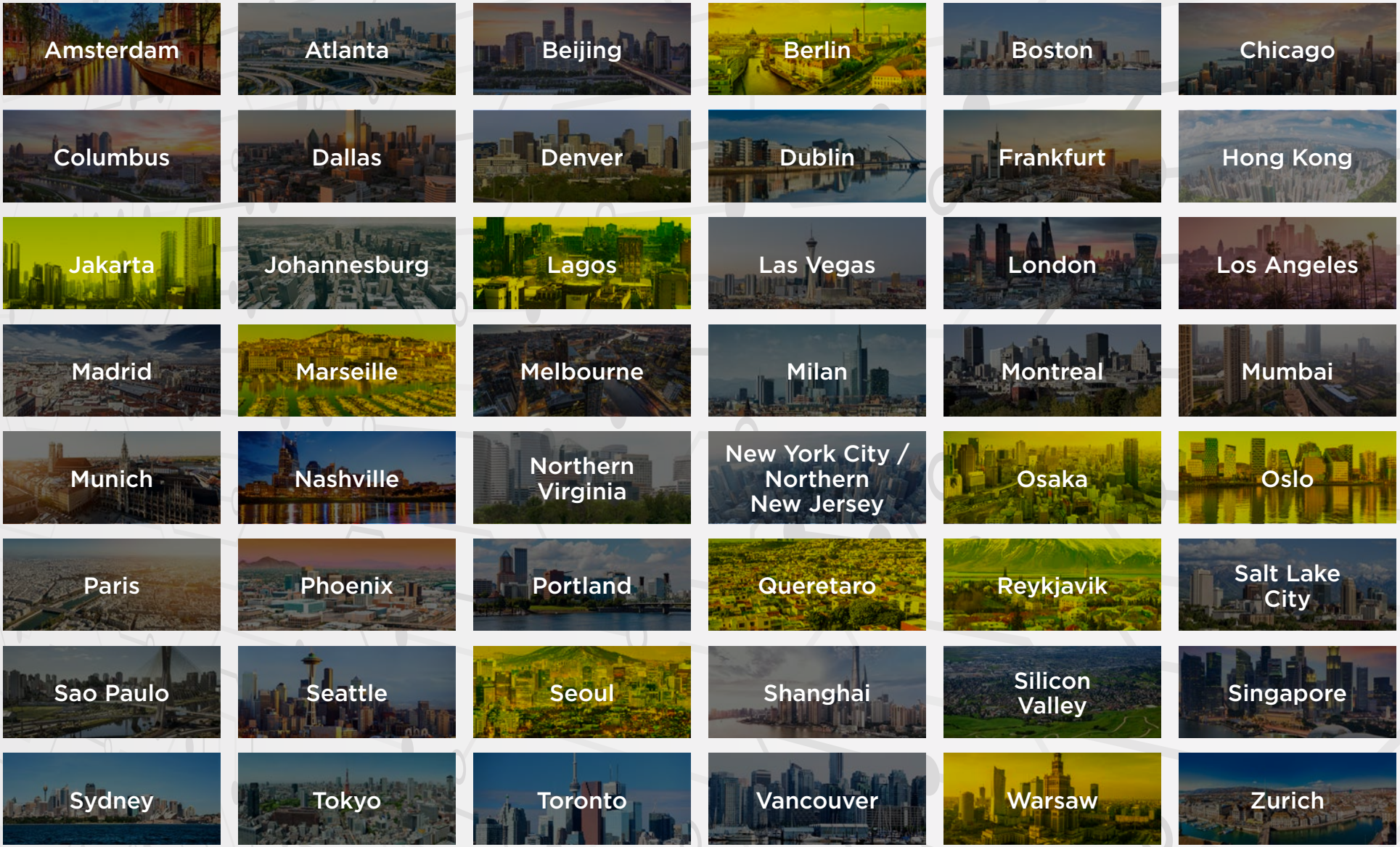
MID WEIGHT
Development Pipeline
Government Incentives
Market Vacancy
Political Stability
Sustainability
Taxes
Smart Cities

LOW WEIGHT
Environmental Risk
Land Price
Power Cost

The goal of this system is to mirror how data center markets truly function and to identify what factors data center investors, owners, operators and occupants value. The results of this report indicate distinct parallels between these findings and what has transpired as data center growth has occurred.

MARKETS ANALYZED

INDICATES NEW MARKET IN 2021 REPORT



INTERACTIVE MENU

Click below to jump to section.

CATEGORY 1

REAL ESTATE & PHYSICAL CONSIDERATIONS

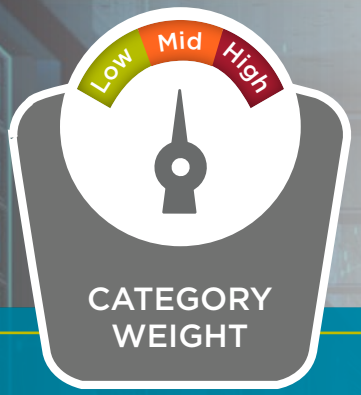
Development Pipeline

Environmental Risk

Land Price

Vacancy

DEVELOPMENT PIPELINE



An active development pipeline is a useful indicator of market strength, as it signifies continued local demand leading to the creation of ever-greater supply. Development underway shows that local authorities are willing to approve new builds, that power and fiber were obtainable at the site, and that project financing is available. Few developments in the data center realm are launched speculatively; more often an anchor tenant has signed on for a significant portion or all of an initial phase. Signing a major hyperscale, corporate, or government tenant also assists in the creation of the local ecosystem, as enitities with similar requirements often follow.

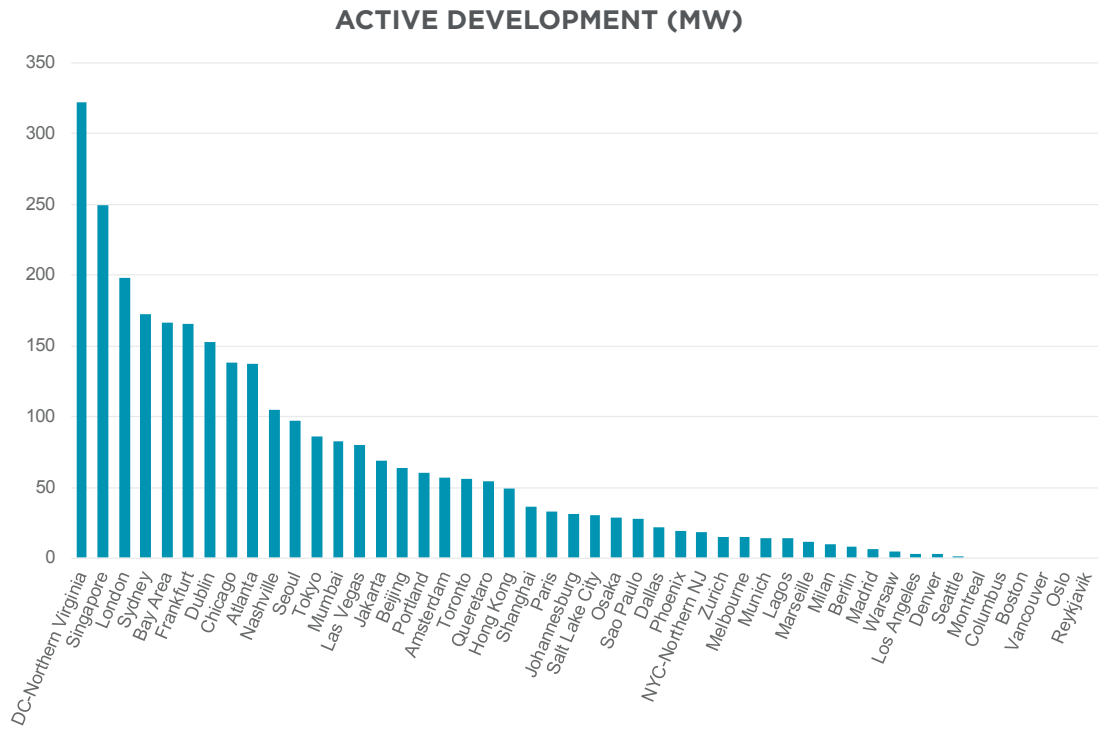
While the recent pandemic has caused construction difficulties across all sectors of commercial real estate, data centers have been less affected than most as their early designation as essential operations indicates. Construction continued at most locations with appropriate safety measures, and although supply chains occasionally tightened, many new builds suffered minimally. This is reflected in the overall increase in construction from our previous study to this year. Our 2020 report tallied 1.6 gigawatts in progress across the 38 markets reviewed, while this edition totals 2.9 gigawatts across 48 markets. Organizational needs and the move to modernize information technology have pushed operators and hyperscalers alike to action.

Leaders in active development include many of the global primary markets: Northern Virginia, Singapore, London, Sydney, and Silicon Valley round out the top five, with Frankfurt, Dublin, and Chicago following. Several of these markets are experiencing shortages of potential sites (London, Sydney, Silicon Valley), power (Frankfurt, Dublin), or both (Singapore) and it remains to be seen if local concerns over further builds will lift throughout 2021. Of note are the number of secondary markets where the colocation sector continues to blossom, including Seoul, Mumbai, Jakarta, Portland, and Queretaro; these fast-growing regional hubs are emblematic of the smaller market expansions that began in earnest in 2020, and expectations are high for similar growth worldwide.

An active development pipeline not only means that there is client interest in-market but that local agencies are willing to assist with approving potential projects and sourcing power, water, and potentially fiber.

TOP TEN

NORTHERN VIRGINIA
SINGAPORE
LONDON
SYDNEY
SILICON VALLEY
FRANKFURT
DUBLIN
CHICAGO
ATLANTA
NASHVILLE

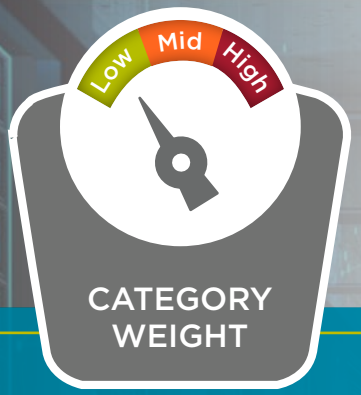


Source: Cushman & Wakefield Research

WHAT TO WATCH

Server sales remained excellent throughout 2020 and supply chains kept up with demand. As new markets continue development it will be key that suppliers are able to scale with the needs of new builds.

ENVIRONMENTAL RISK



Mission critical means mission critical when it comes to data centers, and not only must the facilities be constructed to high fault tolerances; the locations chosen for these critical assets are just as important to avoid potential disasters. This can be a difficult task as large population centers that drive data traffic are often located in coastal areas susceptible to flooding, earthquakes, hurricanes, or other natural mayhem.

Flood maps were reviewed for each facility to determine if the building sits in a 100-year floodplain (a 1% or greater chance of severe flooding each year) or in a 500-year floodplain (a 0.2% chance of severe flooding). Despite recent advances in liquid cooling, servers and large amounts of water generally don't mix well and lead to considerable expenses incurred for damaged equipment and potential payouts to clients for downtime. Current colocation inventory has been constructed entirely outside of floodplains in Dublin, Sydney, Mumbai, Columbus, Vancouver, Madrid, Johannesburg, Queretaro, Oslo, Osaka, Marseille, and Lagos. Despite the coastal location of most of these metropolitan areas, careful planning can enable flood avoidance.

Earthquakes can cause immense damage in cities, and those data centers that are built in such areas must be constructed to extremely high tolerances. Companies that have their primary facility in these regions often choose to have a disaster recovery location in a less seismic location to ensure full backups should anything be lost in such an occurrence. Many markets free of such faults are found mainly throughout Europe (Dublin, Amsterdam, Paris, Madrid, Warsaw, Oslo, Berlin), with Dallas, Hong Kong, Seoul, and Lagos also included in this category.

Tornadoes and hurricanes bring extreme winds and considerable destruction to an area, leading to downed electrical grids and the need for data centers to use generators and backup systems. Although rare, these events can lead to considerable reconstruction expense and long lead times for network and power repairs. Most markets throughout Europe and the western United States are free of this menace, as are Singapore and Vancouver.

Each data center was reviewed to determine earthquake, tornado, and hurricane risk, or if the property sits in a 100-year or 500-year floodplain. The absence of these factors resulted in higher scores.

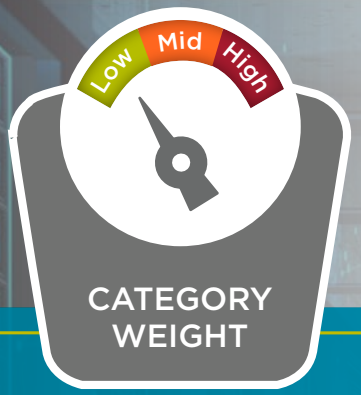
TOP TEN

* NEW MARKET IN 2021 REPORT

WHAT TO WATCH

The 2020 hurricane season on the Atlantic Coast of North America was the busiest in history, adding an increasing concern for data center operators in this area.

LAND PRICE



While often a small fraction of the overall construction costs of a large data center, land cost is among the first costs incurred prior to operations beginning. An excellent site requires multiple factors highlighted throughout this report, including access to power and continuous grid uptime, strong fiber connectivity (ideally via multiple networks), local government incentives, considerable available water for cooling, limited natural disasters, and a helpful local permitting process. The availability of land often determines the overall structure of a data center; due to the dearth of available sites, multi-floor builds have become typical in constrained markets throughout Asia and Europe.

The most densely populated global cities provide the largest immediate user bases for data centers, but these are often the markets with the greatest competition for land. Areas such as Hong Kong, Singapore, Silicon Valley, London, Tokyo, and Seoul have sites that could be multi-floor distribution warehouses or multifamily housing, and even the sprawling Northern Virginia market is encroaching on residential areas. This competition for robust sites with other asset classes will increasingly define site selection in coming years.

As noted in the previous edition of this report, many of the top finishers in land cost are in less constrained secondary markets across the United States, including top finisher Columbus, Nashville, and Denver, though a mix of larger data center markets in the U.S. (Phoenix, Dallas, Atlanta, Chicago) also placed highly, suggesting that larger campus builds remain cost-effective in these locations. Two African markets (Johannesburg, Lagos) also offer low-cost land acquisition and finished among the top ten, albeit in smaller available parcel sizes reflecting the density of these major cities.

Affordable land eases the cost of entry to a market and likely indicates considerable availability. Large sites are increasingly prized by data center operators for development across several phases.

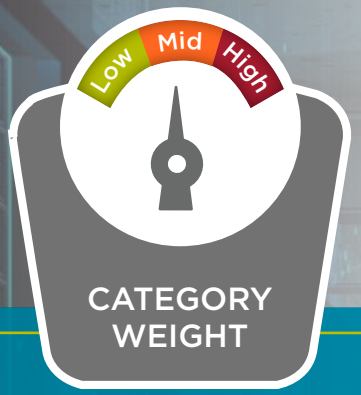
TOP TEN

* NEW MARKET IN 2021 REPORT

WHAT TO WATCH

Creativity on data center location will define builds in coming years, as the same sites in tight markets will be pursued by all real estate asset classes. Re-purposing already developed and/or brownfield sites may offer advantages over limited remaining greenfield locations.

VACANCY



As reflected in all sectors of commercial real estate, low vacancy is a good indicator of a strong market with development potential and a target for new entrants. This is also the case with data centers; once a major cloud service enters a market, data center operators tend to follow. As enterprises pursue their hybrid IT strategies, there will be potential for several layers through a market to benefit; the cloud service that will likely take on the bulk of the workload (and who may lease from a local colocation provider), the colocation operators who directly work with the enterprise, and potentially local carrier hotels for connectivity and peering opportunities.

Although headline vacancy numbers certainly show strength of a market, it must be noted that in certain primary locales (Northern Virginia in particular) operators will often attempt to have some vacant space to attract the continued insatiable demand. By constructing additional phases as soon as the currently operational capacity is spoken for, this strategy allows for more immediate deployments for clients in need.

Nine markets of the 48 studied currently show sub-10 percent vacancy, led by perennial number one Northern Virginia at a record low of just over 2%, tightening from the usual 5-5.5% band. Other primary data center markets have enjoyed continued absorption over the past year and remain tight, including Silicon Valley, Toronto, Dublin, Paris, and Frankfurt. A more intriguing pair of front-runners are two cities in the southern United States, with Nashville and Atlanta tightening up considerably over the past year to 6.4 and 7.1 percent respectively, suggesting interest at the regional edge.

While single large deals in small markets can tighten these locations, a single new build can loosen them considerably. This volatility is limited the larger the market grows, continuing to add to the investment premium and perception for “safer” assets in major areas.

TOP TEN

NORTHERN VIRGINIA

DUBLIN

SILICON VALLEY

LOS ANGELES

NASHVILLE

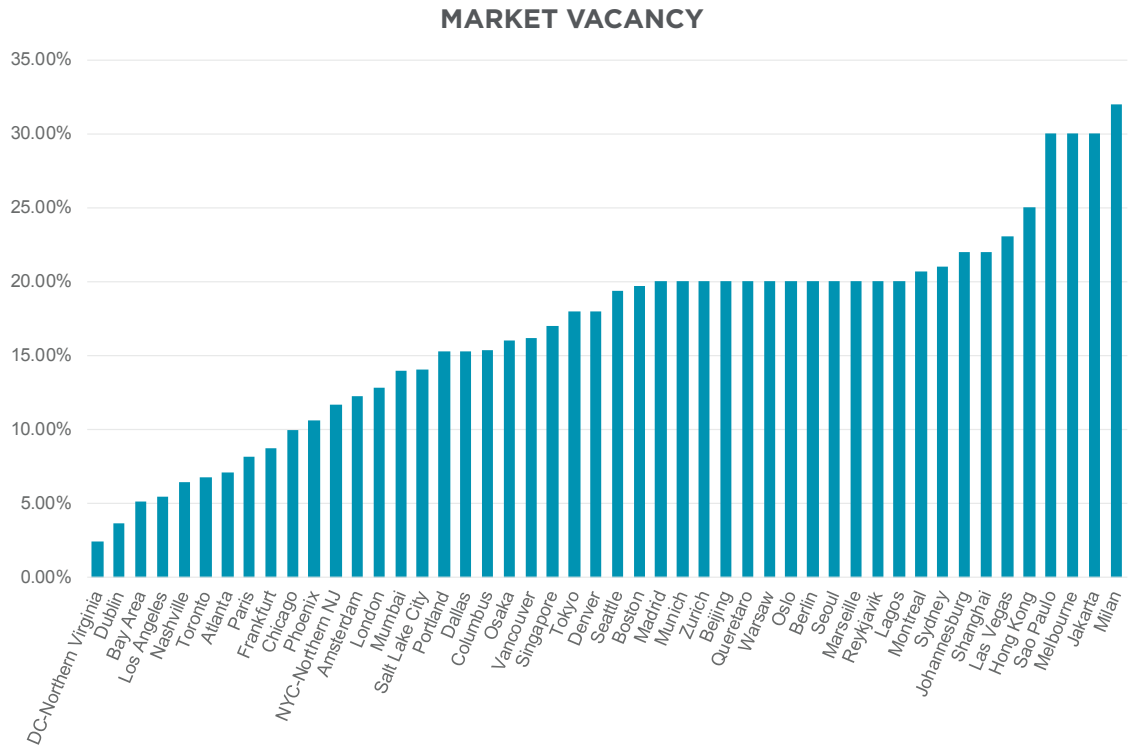
TORONTO

ATLANTA

PARIS

FRANKFURT

CHICAGO



Source: Cushman & Wakefield Research

WHAT TO WATCH

Secondary markets around the globe have trended toward an 18-20% rate of vacancy for the past several years. As the “edge” develops to bring computing closer to users, average vacancy in smaller areas may well tighten.

CATEGORY 2

ECOSYSTEM ADVANTAGES

Cloud Availability

Fiber Connectivity

Market Size

Sustainability

Smart Cities

CLOUD AVAILABILITY

The unexpected pandemic raised the profile of the major cloud services in 2020 as mid- and large-size organizations rapidly moved or expanded workloads onto these platforms in response to a fully remote workforce. Companies attempted to replicate in-office setups with varying degrees of efficiency, and those that could rapidly offer scalable and accessible solutions experienced the best productivity. As everything from video-conferencing to video-streaming to gaming gained in daily importance and usage, those services that were cloud-centric or at the very least cloud adaptable were early winners.

Despite the headline changes in individual lifestyles, these moves to the cloud were already long contemplated by major organizations; the pandemic merely hastened them! IT transformation has long been mooted as a key productivity driver for a multitude of organizations whether they be corporate, educational, or government, and the flexibility revealed by doing so during this troubled period will continue throughout the foreseeable future.

Revenue for the major cloud service providers skyrocketed throughout 2020, often outpacing overall revenue for their respective larger corporations. The three major global cloud services (Amazon Web Services, Microsoft Azure, Google Cloud) have continued their rapid expansion, with a multitude of new regions either active or soon to be. At the release of this initial report last year, 21 of the markets profiled had local availability to all three services, increasing to 27 this year with several smaller cities included. Leases signed by these services are coveted by operators, as they tend to absorb available capacity in large (10 MW+) quantities.

Increasingly major services are going above and beyond a standard data center cluster, with agreements to train and develop local staff and partnerships with government entities planned in several secondary data center markets worldwide. These agreements assist in the creation of the local market ecosystem, with colocation operators providing cloud on-ramps from their nearby facilities, smaller cloud services following the larger platforms, and interconnection and peering opportunities and exchanges throughout. Further new market announcements are planned over the next two years, enabling the growth of the data center landscape.

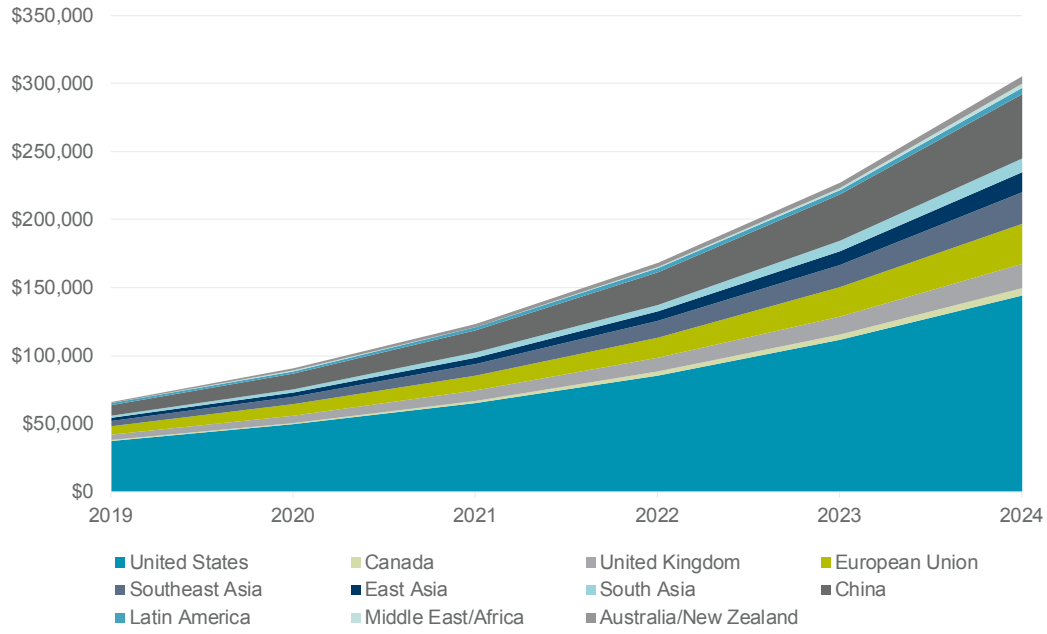
As the largest cloud service companies expand, there is an increasing number of markets offering access to all three services. Highest scores were awarded to those markets with in-place availability.

MARKETS RECEIVING THE HIGHEST SCORE (ALL THREE SERVICES):

TORONTO
MONTREAL
NORTHERN VIRGINIA
CHICAGO
DALLAS
LOS ANGELES
SILICON VALLEY
SAO PAULO
LONDON
AMSTERDAM
FRANKFURT
PARIS
SINGAPORE
TOKYO
HONG KONG
SYDNEY
MUMBAI
PORTLAND
SEATTLE
ZURICH
MADRID
MELBOURNE
WARSAW*
SEOUL*
OSAKA*

*** NEW MARKET IN 2021 REPORT**

PROJECTED HYPERSCALE CLOUD (US$M)



Source: Cushman & Wakefield Research; Structure Research

WHAT TO WATCH

Several new cloud services companies have launched their own expansions via market initiatives, including Oracle, IBM, Alibaba, Tencent, and many others. These platforms will take down an increasing amount of data center capacity as they grow and provide additional options to end users.

FIBER CONNECTIVITY

Fiber serves as the lifeline of the data center world, transmitting information from the end user to the data center and vice versa. As employees left their offices early in 2020 and began working remotely, network capacity gained further importance; those who had slower internet speed suffered from productivity loss as they attempted to access the same videoconferencing and internal applications as their colleagues. From a data center perspective, the more networks that connect to a building the better, for faster and more robust data transmission. Just as a data center ensures internal uptime through redundancy, multiple networks provide further backup potential.

Fiber networks can exist in short-haul form within a metropolitan area or long-haul across regions or countries. Areas that combine terrestrial long-distance networks with undersea cables in coastal areas provide the greatest value for many key companies, particularly those with operations across multiple continents. Those markets that tallied the highest network count per location are mainly found in the United States, with densely populated locations such as Silicon Valley, Northern Virginia, Dallas, Los Angeles, and Seattle at the top of the list. These are longtime data center hubs, with deep ecosystems to match local needs. Network availability is expected to continue to be of prime importance going forward, with telecoms and major cloud and content providers investing in network capacity.

NOTE: While fiber maps were available for nearly all global markets, information throughout East Asia regarding fiber remains very limited. We would like to acknowledge that due to the importance of fiber and the lack of clear information therein, these markets finish slightly lower in total scoring for this reason.

The greater the number of networks, the better connected the data center is to distribute information at increased speed. Each data center was reviewed to determine access to local, long-haul, and international networks.

TOP TEN

WHAT TO WATCH

While undersea cables were traditionally funded by telecommunications companies, an increasing number of these crucial connections across continents are being paid for by the cloud services companies and content providers. Look for this trend to continue as these firms battle for market share.

MARKET SIZE

Total market size is a valuable indicator of strength, for historical, current, and future development. A historical predilection toward data centers leads to the knowledge and planning abilities for further builds; many of the major data center markets such as Northern Virginia or Singapore keenly understand the needs of a major facility and can accurately assess their ability to assist. Current market sizes are reflective of a robust local clientele; modern local client mixes often include hyperscale cloud services, mid-size cloud services, government, financial services, content providers, and increasingly healthcare. Locations that have all these thus have plenty of demand for data center capacity.

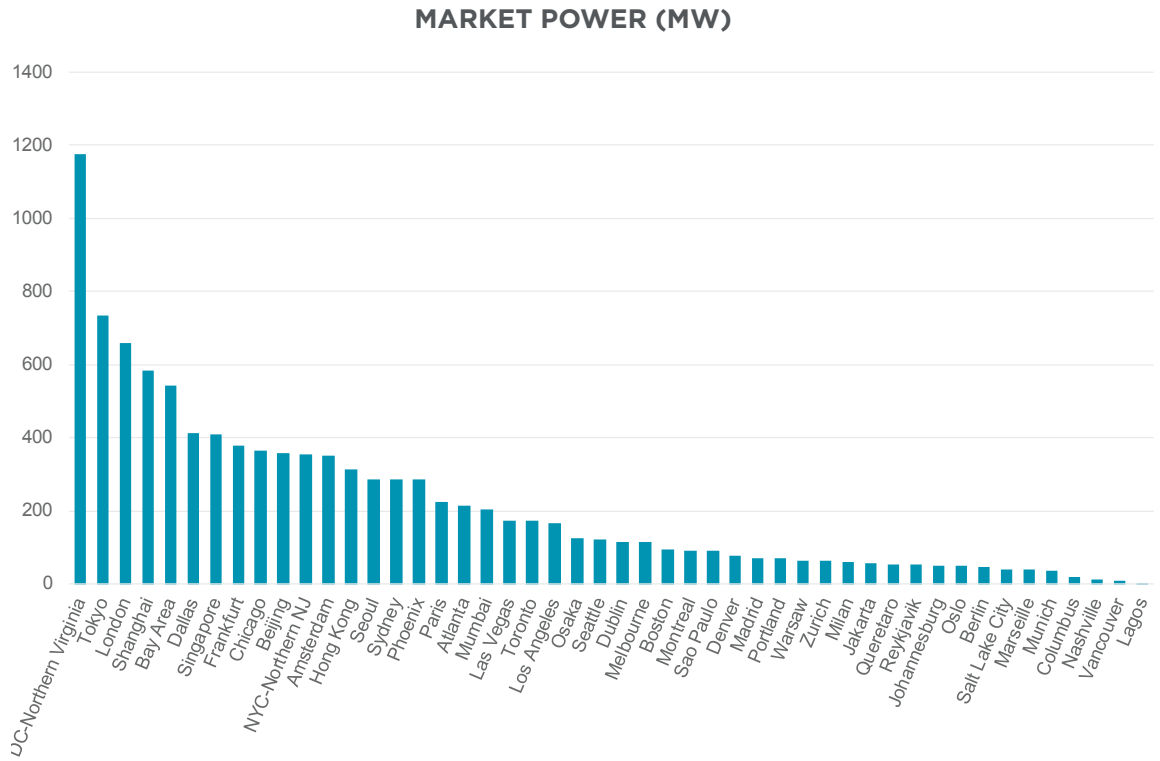
Workloads of the near and far future have the potential to create a more distributed global architecture, leading to the buildout of the "edge," or bringing computing closer to the end user. The Internet of Things (or IoT, essentially adding network capability to devices that previously did not have them) and related intelligent manufacturing could derive greater efficiencies and reduce production costs. Artificial Intelligence (AI) requires an enormous amount of processing power yet could continue to reimagine software development and data processing. Fifth generation wireless networks (5G) continue their ambitious rollout plans and their increased speeds could revolutionize data transmission. All require ever-greater amounts of infrastructure in new locations, and all stand to generate further data center construction.

As for today, Northern Virginia clearly remains the largest market globally as the only location that has surpassed 1 gigawatt of capacity. The current 1.2 gigawatts on offer and the over 300 megawatts currently under construction will keep the area on top for some time to come. Tokyo and London follow, with exciting modern hyperscale builds rapidly adding to the Tokyo landscape for the first time, and London often as the first port of call for those entering Europe. Many markets profiled in the current edition of this report expect to double or triple in size over the coming decade, as several large cities throughout Europe and Asia have yet to develop data center markets to match. The battle for market share will likely take place in an ever-increasing array of locations, and those with the ability to scale accordingly will win.

Large markets lead to increasingly scalable ecosystems across an ever-growing number of building expansions, networks, and software options. Smaller markets thus have multiple layers that must be built on to approach large market value.

TOP TEN

NORTHERN VIRGINIA
TOKYO
LONDON
SHANGHAI
SILICON VALLEY
DALLAS
SINGAPORE
FRANKFURT
CHICAGO
BEIJING



Source: Cushman & Wakefield Research

WHAT TO WATCH

Cities with the highest rate of growth add capacity at anywhere from 20-50% increases over a two-year span. With ever larger builds targeting the largest operators, average market size will continue to trend upward over the next decade.

SUSTAINABILITY

As climate change continues to alter the course of human endeavor, power generation and the largest users of power have come under review for the sake of efficiency and cleanliness. A large data center campus can use as much power as a medium-sized city, thus making data centers a major concern despite their overall benefits to society. Data centers that utilize renewable power have dual positives, as renewables are often far more cost-efficient for heavy users.

Committing to renewables doesn't just stem from the operational side. A multitude of corporations have committed to reducing their carbon footprints in coming years, including some of the largest users of data center space. Google, Apple and Facebook plan to be net-zero by 2030, and Microsoft plans to be carbon negative by the same date (and remove all its historical emissions by 2050). As governments around the world look to establish aggressive emissions reductions, these major leaders of the tech world will be vanguards of change.

A quartet of markets globally operate with fully renewable energy, which for this report includes hydropower, solar, or bioenergy, including Montreal, Sydney, Oslo, and Reykjavik. Vancouver and Seattle follow closely, with hydropower overwhelmingly being the favorite method of energy production. Colder and wetter environments also allow for free cooling inside the data center, thus driving further efficiencies. Over time as more large organizations adopt loftier sustainability goals, expect markets utilizing these renewables to grow in interest, and others to pursue similar courses of action.

Sustainability starts at the power source and continues through on-premises operations. The greenest data center markets have harnessed hydropower for their needs, with solar power gaining in interest in locations with warmer weather.

TOP TEN

* NEW MARKET IN 2021 REPORT

WHAT TO WATCH

As large corporations and local governments pursue their own sustainability goals, data centers will be required to follow suit to meet future regulatory concerns and obtain further business. Those facilities that maintain a low power usage effectiveness, use water sparingly and utilize renewable energy, will benefit both in cost savings and partners.

SMART CITIES

Just as data centers rely on an ecosystem of buildings, fiber networks, cloud services, interconnections, and any number of other software layers, cities rely on similar ecosystems of human and transport networks, businesses large and small, schooling and university systems, and a great number of other factors that create strong environments. Cities that are safe, offer growth opportunities via high incomes, and have good urban planning are pleasant places to live and retain their best and brightest citizens.

As a proxy for smart cities, the Cities in Motion Index created by the IESE Business School of the University of Navarra has been included in this report, to reflect the strength of key global data center markets and their organic growth potential. The Cities in Motion Index reviews 101 factors that create a dynamic environment, grouped into overarching categories including human capital, social cohesion, the local economy, governance, the environment, mobility, urban planning, international projection, and technology. Depending on the depth or lack of each of these categories, every city receives a ranking to determine final placement.

It will come as no surprise that the smartest cities in the world boast major data center markets; the top four all have them, with London leading New York (and by extension Northern New Jersey), Paris, and Tokyo, with the up-and-coming data center market of Reykjavik taking fifth place. A mix of major cities across Europe and Asia follow, with several mid-size data center cities correspondingly finishing down the rankings just as those with smaller markets sizes do as part of this report. As data center ecosystems continue to resemble those in major cities, expect the outlook of municipalities to influence the outlook of data centers.

Cities that are thoughtfully planned offer excellent resources for scalable development, along with a high quality of life that attracts and retains talent. Often these locations understand the benefits that data centers provide for local business, and assist in the creation and management of key infrastructure.

TOP TEN

* NEW MARKET IN 2021 REPORT

WHAT TO WATCH

Global internet penetration has now reached over half the global population by many estimates, a large increase over the past decade but still indicating the long way to go before universal internet usage. Those areas that can bridge this gap via increased infrastructure and grid reliability have the potential to leap ahead across multiple stages of development.

CATEGORY 3

POLITICAL AND REGULATORY REVIEW

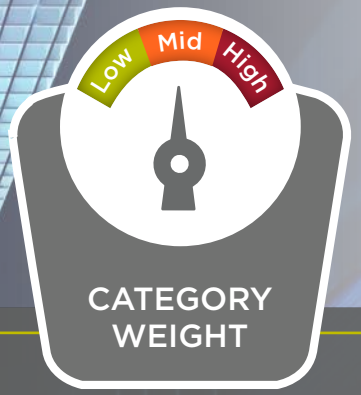

Incentives


Political
Stability


Power
Cost


Taxes

INCENTIVES



A large data center campus can easily cost well into nine figures to build, and careful planning is required for phased development to keep an operator profitable. Reduced sales on the acquisition of supplies or equipment, reduced property taxes, or discounts on power are all attractive incentives for companies that sway data center site selection. Several smaller markets have begun to offer these packages, understanding that they often have cost benefits over some of the primary locations. These areas recognize the uptick in local investment this construction provides and often have utilities that work closely with operators to assist in the development process. Most incentive packages are structured with minimum investment amounts to ensure long-term presence in-market.

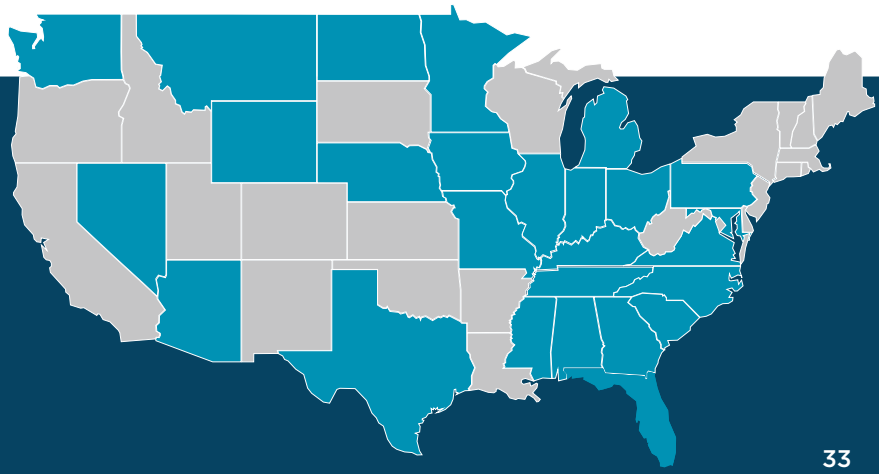
Incentive packages are found throughout the United States, with 26 out of 50 states now offering some form of benefit for data center construction. The state of Maryland is the most recent, and speculation continues whether this will attract development across the Potomac River from Northern Virginia. Phoenix and Las Vegas enjoy incentives that start at just $25 million of initial investment, the lowest such tier in the country. Seattle offers sales tax exemptions related to building size, and even major markets such as Northern Virginia, Chicago, and Dallas have their own packages.

Several markets across Europe have also explored incentive plans, with Paris and Marseille offering lower cost power, Oslo offering equipment tax exemptions and Reykjavik with tax incentives as well. This relief is particularly important as power costs in these locations are often higher than most other areas globally. As smaller data center markets continue to grow, those that can entice the largest companies with these benefits will likely expand faster.

Markets offering incentives acknowledge the economic benefits of a strong data center industry, adding motivation for what are increasingly nine- and ten-figure projects. These choice benefits provide an easier decision-making process for prospective entrants.

MARKETS OFFERING INCENTIVES

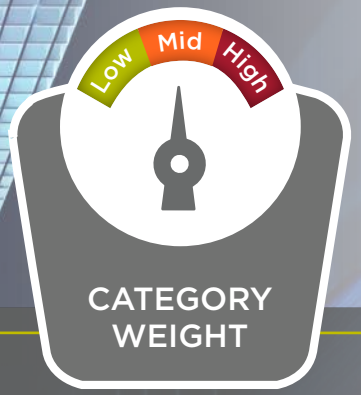
* NEW MARKET IN 2021 REPORT



FAST FACT

A majority of states throughout the U.S. now offer state-level incentives, often sales- or property-tax abatements for long-term investment. Maryland is the latest state to offer these benefits.

POLITICAL STABILITY



Business works best in a stable, highly functional environment and the same holds true for the data center industry. As data centers are considered mission critical to keep applications, networks, and thus entire companies operating at their highest efficiency, the greater political situation of the data center location factors into any decision-making. As an established proxy for stability, the World Governance Indicators created by the World Bank have been considered for each market reviewed. The indicators include **six distinct dimensions** of stability:

Voice and Accountability includes the ability of a country's population to select their government, along with freedom of expression, freedom of association, and free media. From a data center perspective, a government that allows its population to communicate freely means a safer data environment free from interference via censorship or outright theft.

Political Stability and the **Absence of Violence or Terrorism** reviews the likelihood of political upheaval in a country and the violence that could occur during such upheaval. Political violence often leads to chaos, service disruption, and property destruction, all of which are problematic for mission critical applications.

Government Effectiveness includes the perceived quality of public services, civil service and its independence from politics, quality of policy creation and implementation, and the government's commitment to all of this. A highly effective government leads to property being registered properly and on time, electrical grids functioning as they should, and sensible zoning requirements.

Regulatory Quality considers the ability of a government to create and implement regulations that allow private sector development. Well-structured and flexible regulations lead to a clear understanding for development and operation of data centers, as facilities can be more easily designed in accordance with local practice.

Rule of Law indicates the confidence citizens have in laws being followed, particularly including contract enforcement, property rights, police, courts, and likelihood of criminal activity. A strong rule of law provides confidence in the ability for business to flourish in the absence of arbitrary obstruction, leading to leases enforced, land titles remaining with their rightful owners, and less likelihood of criminal entry to a facility.

Control of Corruption includes all forms small and large, along with the takeover and abuse of a state by private actors. Less corruption ties strongly to better contract enforcement, less hassle in operating a data center in the absence of bribes required, and overall better performance of services.

Two markets in Europe tied for the highest score, with Zurich reprising its role on top and now joined by newly reviewed Oslo, with both gaining top markets across each of the subcategories detailed here. Markets in Canada, Australia, and Reykjavik also finished highly, with London and markets in Germany close behind. While many of these markets are costlier to operate in than other locations, the benefits provided by stable local regulation can have positive implications for data centers and beyond.

Markets were reviewed for political stability utilizing the World Bank's methodology for voice and accountability, political stability and the absence of terrorism, government effectiveness, regulatory quality, rule of law and control of corruption.

TOP THIRTEEN

(DUE TO A TIE FOR TENTH- SCORES ASSIGNED BY WORLD BANK ON A COUNTRY RATHER THAN MARKET BASIS):

*** NEW MARKET IN 2021 REPORT**

FAST FACT

As noted in our previous report, those countries that finish highly across the World Governance Indicators accordingly finish highly on the Freedom House "Freedom on the Net" scoring methodology. Countries such as Germany, Canada, and Australia again finish highly across both.

POWER COST

Despite the considerable financial outlay required in building construction, server acquisition, and the permitting process, the highest cost of a data center over the life of the facility is often power. Data centers use immense amounts of electricity, particularly for resource-heavy applications such as artificial intelligence or machine learning, and mitigating power usage to generate maximum efficiency is a unique science by itself.

Power usage effectiveness (PUE) is an oft-used metric to determine this efficiency, but locating a data center in the right climate can play a considerable role. Chillier markets allow for natural cooling in the evening, eliminating much of the building air conditioning cost. Recent advances in liquid cooling have also proven intriguing in certain applications, though water usage can become an issue in the most densely packed hyperscale facilities.

Keen engineering also collides with regulation in certain markets, with the cost of power generation often passed on to heavy users in the form of taxes and additional surcharges. It is here that the cost of power lines up well with the sustainable factors covered elsewhere in this report; those markets that have invested in sustainable hydroelectric energy often wind up with the lowest long-term overall power cost. Several of these markets are represented in the top ten of our list, with Montreal again leading the way for the lowest cost of power in those markets reviewed. This is followed closely by newly reviewed Reykjavik, and Portland, Vancouver, and Seattle all feature in the top ten markets with low cost power, with each focusing on the use of renewables.

Power is a major cost of data center operations, with those areas offering the lowest power cost often the most attractive for large-scale processing. As power bills scale rapidly over multiple phases, it is useful to know where lower costs are available.

TOP TEN

MONTREAL

REYKJAVIK*

WARSAW*

JOHANNESBURG

PORTLAND

VANCOUVER

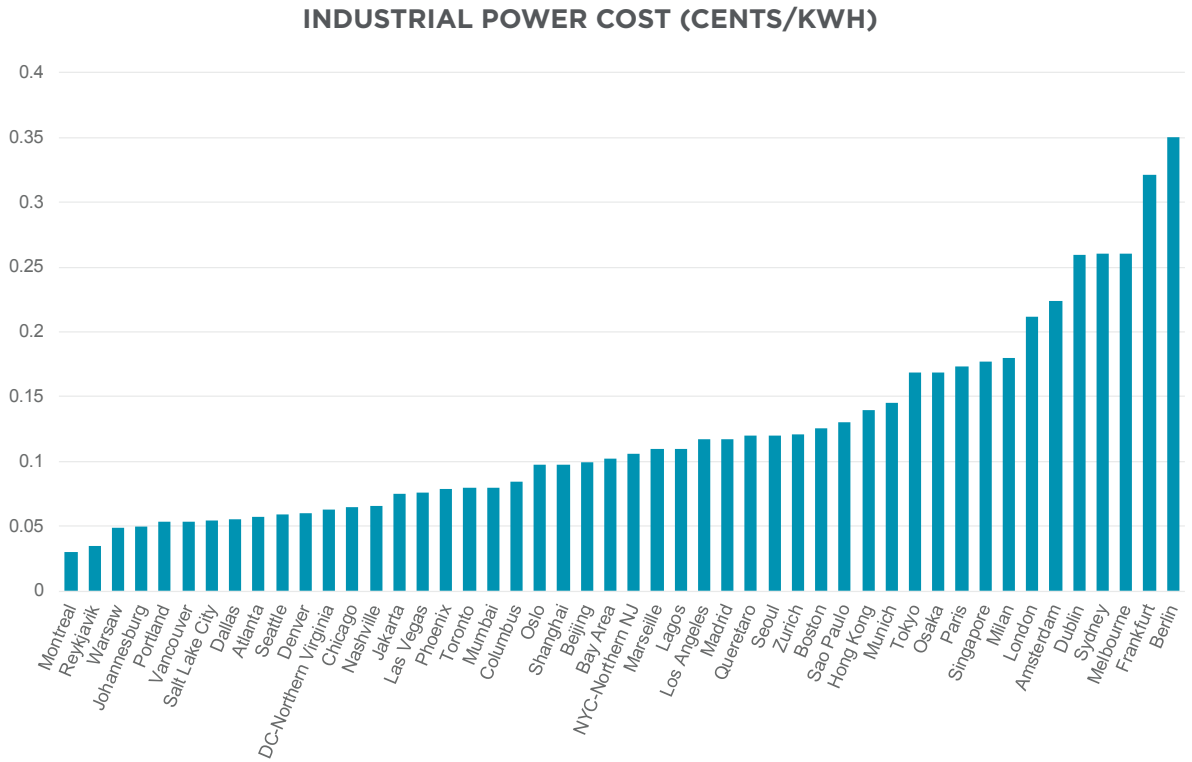
SALT LAKE CITY

DALLAS

ATLANTA

SEATTLE

*NEW MARKET IN 2021 REPORT

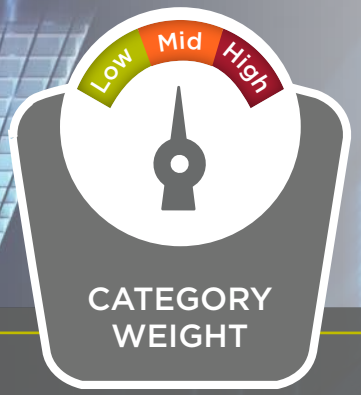


Source: Cushman & Wakefield Research

FAST FACT

According to Enerdata, global power generation increased 3% a year from 2000 to 2018, with a slight decrease in 2019. Coal is decreasing as part of the global energy mix, with sharp increases in renewable options.

TAXES



Data center projects incur considerable equipment acquisitions, from servers and cooling systems to cabling and generators. Each of these purchases often involves the payment of either sales tax or value added tax depending on the location of the facility. A sales tax is a payment to the government for goods sold, while a value added tax is paid by the end user of the value chain. As most data center projects run into eight- and nine-figure sums, taxes can be a sizable portion of the overall expense for those areas without government-sponsored incentives.

As noted in the previous edition of this report, two included markets have neither of these taxes: Hong Kong and Portland. Hong Kong is a global financial and business capital, long considered an attractive hub of free enterprise. Portland's home state of Oregon chooses instead to tax income and property, and thanks to low taxes and good connectivity, the suburb of Hillsboro continues to expand as a key data center market.

Many of the other low-tax locations are in other U.S. markets, including major markets Northern Virginia and Northern New Jersey, and mid-size markets Boston, Seattle, Columbus, and Denver. Singapore also fits in the top ten, confirming their continued attractiveness as a data center locale. At the opposite end of the spectrum are most of the large European markets, many of which have taxes in the 20% bracket.

Lower taxes often suggest a friendlier business climate, enabling further expenditure on development and overall business expansion. Several markets that finish in the top ten for lowest taxes have long been key data center hubs.

TOP TEN

HONG KONG

PORTLAND

NORTHERN VIRGINIA

BOSTON

SEATTLE

NORTHERN NEW JERSEY

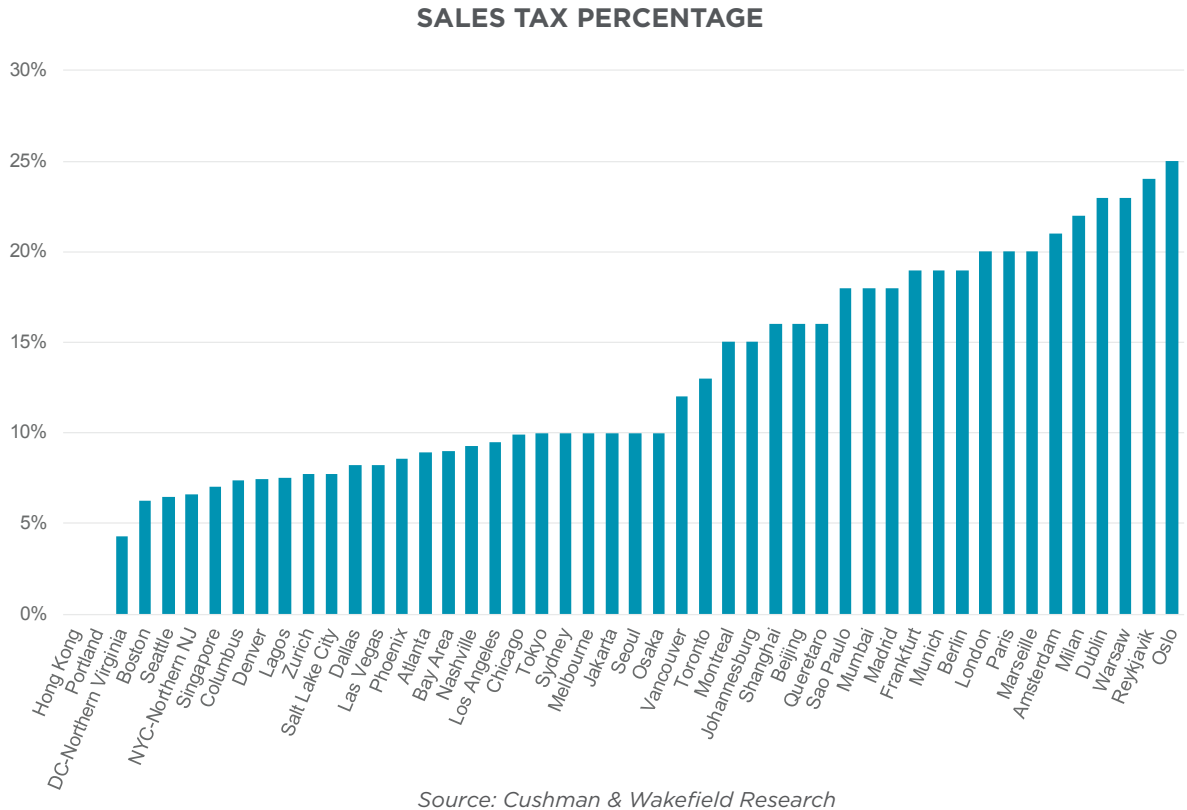
SINGAPORE

COLUMBUS

DENVER

LAGOS*

***NEW MARKET IN 2021 REPORT**



Source: Cushman & Wakefield Research

FAST FACT

As most data center incentive packages have eight- to nine-figure minimum investment amounts, a low sales tax/VAT regime is an attractive location determinant. The wide spread across the 48 markets studied indicates rates in the highest-taxed locations to be two to three times those of the lowest-taxed.

OVERALL RANKINGS

1 NORTHERN VIRGINIA

2 CHICAGO

3 SYDNEY

4 SILICON VALLEY

5 SINGAPORE

6 DALLAS

7 LONDON

8 SEATTLE

SYDNEY

9 NEW YORK / NEW JERSEY

10 AMSTERDAM

OVERALL RANKINGS

For an ever-changing, rapidly evolving data center industry, occasionally some things stay the same, and Northern Virginia again comes out on top of the overall rankings this year. The combination of the largest market size, robust fiber, attractive incentives, low cost power, and largest development pipeline place the current global leader in an excellent place for the future. Despite recent increases in land cost, large, well-connected sites remain a fraction of the cost of other densely populated global markets. Chicago follows in second place, mirroring many Northern Virginia attractions, including low cost land, good incentives, tight vacancy, and a large market with new development underway. Sydney rounds out the podium and features as the biggest mover in the overall rankings, capping off a year of major new development announcements and an ongoing transformation of much of Australia's government IT infrastructure. The business capital of Australia is a key location for initial in-country cloud deployments and enjoys robust regional connectivity.

Although Singapore and Amsterdam both have tempered data center development via local moratoriums, both still finish in the top ten, a testament to their strong existing markets, dense fiber, and array of available services. As other markets continue to grow, it will remain imperative for both to find solutions for future development, potentially through new forms of power generation or further multi-story construction for the limited number of remaining development sites. Dallas and Seattle have both garnered criticism within the United States for being oversupplied, yet both still rank highly for incentives, relatively low taxes and power cost, and strong fiber.

Of the new markets introduced this year, Seoul received the highest overall score, marking an impressive debut for a long-overlooked data center market. Although considered a secondary market, Seoul has nearly 300 MW of capacity, a solid development pipeline, and all major cloud services available. Well managed cities with smaller markets such as Zurich, Melbourne, and Madrid enjoyed continued gains, suggesting growing ecosystems in secondary locations, and long-time data center stalwarts London, Tokyo, Frankfurt, Silicon Valley, and Hong Kong all remain extremely relevant.

Sizable development pipelines exist in emerging data center markets Jakarta and Queretaro, as two of the markets in greatest need of development relative to population are experiencing growth. Both are named frequently as key locations for future expansion, and with continued political and ecosystem development, will likely move up in future rankings.

Although it is tempting to consider the top finishing markets as the best in all circumstances, it is imperative to note that these markets merely remain the highest ranked across the greatest array of factors. For certain specializations, specific individual factors must be reviewed to determine efficacy of the facility and related deployments. Continued development will enable the growth of all markets covered in this report, and all have their own strengths and weaknesses.

Additional markets across the globe are receiving interest from operators and hyperscalers alike, thanks to local demand from key industries. These ten markets are under consideration for future inclusion in this report, as they receive further investment.

TEN MARKETS TO WATCH

ABOUT CUSHMAN & WAKEFIELD'S DATA CENTER ADVISORY GROUP

Cushman & Wakefield's Data Center Advisory Group is a global team of elite professionals delivering specialized real estate solutions for mission critical users, owners, and environments. With scalability, reliability, and security as a driving force, our highly knowledgeable and responsive professionals guide clients to make effective financial decisions. Our expertise includes colocation leasing, hyperscale and enterprise site selection, cloud and hybrid IT strategy, and merger and acquisition advisory services. We lend additional value through our understanding of global dynamics and their impact on local markets.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ABOUT CUSHMAN & WAKEFIELD

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