

DATA CENTER GLOBAL MARKET COMPARISON

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



**CUSHMAN &
WAKEFIELD**

INTRODUCTION & METHODOLOGY

CONTENTS

INTRODUCTION AND METHODOLOGY

3

RANKINGS BY CATEGORY

6

Real Estate and Physical Considerations

8

Development Pipeline

10

Environmental Risk

12

Land Price

14

Vacancy

16

Ecosystem Advantages

18

Cloud Availability

20

Fiber Connectivity

22

Market Size

24

Sustainability

26

Political and Regulatory Review

28

Incentives

30

Political Stability

32

Power Cost

34

Taxes

36

OVERALL RANKINGS

38

THE DATA CENTER EXPLOSION

More than \$100 billion has flowed into the data center ecosystem in the past decade, with pension funds, private equity firms, infrastructure funds, sovereign wealth and many other organizations recognizing the growth potential of the sector. This capital has allowed the industry to expand at a lower cost, as many funds have taken ownership positions in new companies rather than acquiring data centers asset-by-asset. Investment of this type has been highly beneficial for the data center industry, and these organizations are looking to deploy a similar amount of capital if attractive opportunities arise.

This significant capital inflow has been matched by an equally major technical shift throughout the industry, as enterprises have chosen to move workloads off premises- first to colocation facilities and more recently to a mixture of colocation and public and private cloud computing. This shift has caused the largest cloud platform providers to become the most important players in many markets, signing leases so large they have altered data center sizing by a factor of ten. The 10 megawatt (MW) data center that was impressively sized 10 years ago now pales in comparison to 30 MW leases that are now signed with increasing regularity.

Just as cloud computing has created the largest data center campuses, end user needs have driven the creation of the so-called edge. Devices that are part of the Internet of Things (IoT), the impending 5G wireless networks, and the prospect of self-driving vehicles will require considerable spend on infrastructure, particularly in dense urban areas. These new applications will only function when latency is nearly nonexistent, and the savviest industry players are taking steps to construct platforms that support the biggest and smallest use cases.

The 10 megawatt (MW) data center that was impressively sized 10 years ago now pales in comparison to 30 MW leases that are now signed with increasing regularity.

BREAKING THROUGH THE NOISE

The speed with which the industry is shifting makes the creation of a data center strategy a complex and daunting task. Enterprises must determine whether to stay with their on-premises facility, move workloads entirely to the cloud or pursue a hybrid cloud strategy. Developers and operators require a parcel with robust fiber and access to power while themselves having a thorough grasp of the permitting process. Investors must be able to assess the long-term potential of a data center to hold its value and how easily it can be upgraded. All involved require access to capital and a clear understanding of objectives.

To aid with this difficult decision-making process, Cushman & Wakefield has created the first-of-its-kind Global Data Center Market Comparison report, a unique way to assess and score both primary and emerging data center markets.

CONTROL GROUP STATS

30

Research
Sources

1,162

Data
Centers

38

Global
Markets

METHODOLOGY

Each data center was individually scored across twelve 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

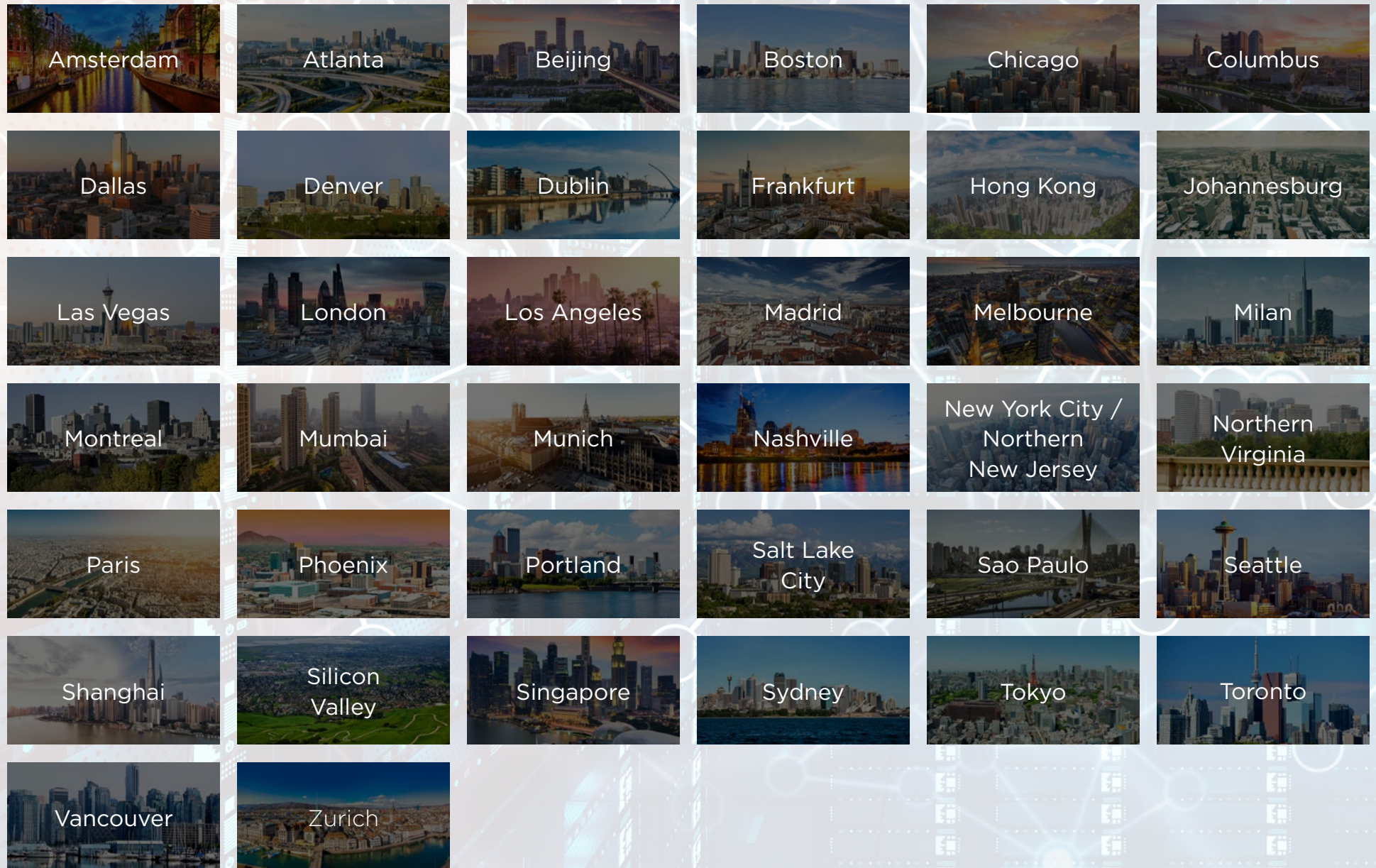
Development Pipeline
Government Incentives
Market Vacancy
Political Stability
Sustainability
Taxes

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



RANKINGS BY CATEGORY

1 Real Estate and Physical Considerations

Development Pipeline

Environmental Risk

Land Price

Vacancy

2 Ecosystem Advantages

Cloud Availability

Fiber Connectivity

Market Size

Sustainability

3 Political and Regulatory Review

Incentives

Political Stability

Power Cost

Taxes



CATEGORY 1

REAL ESTATE & PHYSICAL CONSIDERATIONS



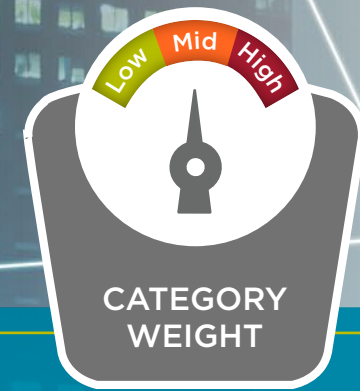
Development
Pipeline

Environmental
Risk

Land Price

Vacancy

DEVELOPMENT PIPELINE



A strong development pipeline is an indicator of many positives for a data center market. It demonstrates that permits are obtainable, land is available, that a utility has promised power, and that the prospect of financing the project exists. Perhaps even more important than all these factors, it indicates that a tenant has expressed some degree of interest in the facility. A large local ecosystem leads to positive network effects, thanks to the strong expertise available and partnership opportunities in construction and financing.

While the positive factors of a strong pipeline largely outweigh the negative, competition does tend to breed further competition and the basic laws of supply and demand apply. When several operators all crowd into a single market at once, downward pressure squeezes pricing, particularly in the negotiations with large cloud services providers. The development of the edge is also leading to the creation of new data center markets entirely, with higher pricing often available to cover any latent demand.

The largest pipelines under active development that currently exist (140 MW+) are in traditional powerhouse markets, with good connectivity and a positive reputation among potential tenants. These include Singapore, Northern Virginia, London, Dublin, and Silicon Valley. Each of these markets has its own challenges: Singapore is extremely land constrained, Northern Virginia has fierce pricing competition, London has political risk as Brexit plays out, Dublin is power constrained and Silicon Valley has some elements of many of these issues excepting power. While the small- and mid-size markets with more affordable land have grown considerably by their own standard, they have yet to develop the inertia of the establishment.

REAL ESTATE & PHYSICAL CONSIDERATIONS

Markets with a strong development pipeline are an excellent indicator of market quality, with the industry deploying capital on the expectation of growth. This growth can stem from local business interest, available connectivity or proximity to other key markets.

TOP FIVE IN DEVELOPMENT PIPELINE



SINGAPORE

Undersea cables and a strong business climate have developers building up.



NORTHERN VIRGINIA

The largest data center market looks to extend its sizable advantage over the next two years.



LONDON

Development continues in the largest European market, Brexit worries notwithstanding.



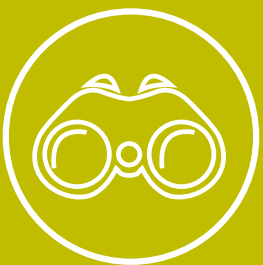
DUBLIN

The local high-tech sector has stimulated data center interest, both in Dublin and regionally throughout Ireland.



SILICON VALLEY

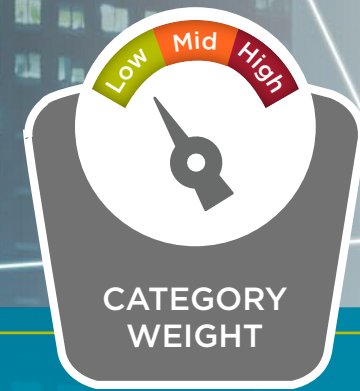
The world's tech capital continues to produce a strong development pipeline and tenants with which to fill it.



WHAT TO WATCH

Of the 1.6 GW currently tallied under active development, nearly 90% of this was in our top ten markets listed. While this clustering effect has been beneficial to the strength of these areas to this point, needs at the edge should contribute to a more varied approach in future.

ENVIRONMENTAL RISK



Mission critical means that even when facing daunting natural disasters that down other business verticals, networks must stay functional, data must keep moving, and disaster recovery must be available if all else fails. In addition to the usual site selection criteria of fiber and power, thought must be spared to a data center's defenses in the face of catastrophe to avoid reliance on short-term backup systems.

Flood risk is viewed through a dual lens: the risk of a 100-year flood (a 1% or greater chance of severe flooding each year) and the risk of a 500-year flood (a 0.2% chance of severe flooding). Flooding can easily destroy any building, with data centers particularly vulnerable due to the expense of server and systems replacement thereafter and payouts due to loss of business. A review of supply shows several markets that have constructed all colocation data centers outside of major flood plains, including Dublin, Madrid, Vancouver, Johannesburg, Sydney, and Columbus.

Earthquakes can impact entire cities and destabilize whole countries, making clean-up and reconstruction efforts frustrating and expensive. Many large data center markets are in coastal zones with large populations, formed by ever-shifting tectonic plates and providing a source of risk for those located nearby. Lowest severe earthquake risk is shared by several markets in Western Europe (Dublin, Madrid, Paris, Amsterdam), the Central U.S. (Dallas), and Hong Kong.

Tornadoes and hurricanes can bring 250-kilometer-per-hour wind and mass destruction. Additional implications for data centers include the downing of electrical grids and the corresponding reliance on generators and backup systems. Areas entirely free of this risk include all markets in Western Europe, the Western U.S. and Singapore.

REAL ESTATE & PHYSICAL CONSIDERATIONS

Each data center was reviewed to assess location in 100- and 500-year floodplains, along with the risk of earthquakes, tornadoes and hurricanes. Accounting for these factors helps ensure continued uptime and client peace of mind.

THE TOP FIVE IN LOWEST ENVIRONMENTAL RISK



DUBLIN

Despite a coastal location, data center inventory in Dublin is located outside possible flood zones.



MADRID

This growing secondary market in Southern Europe is free from natural disasters.



PARIS

The second of the major FLAP-D markets in Europe has a very low risk of natural disasters.



VANCOUVER

A small coastal market that has also largely chosen to build outside local flood zones.



SINGAPORE

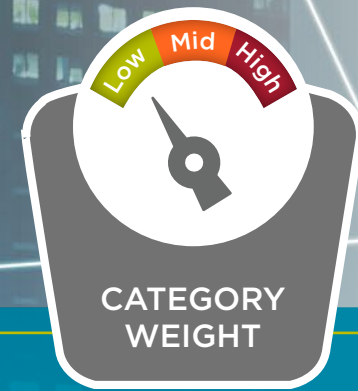
A key business hub in Southeast Asia with very low risk of any natural disasters.



WHAT TO WATCH

The National Ocean Service of the United States predicts that sea levels are rising one-eighth of an inch per year; this could lead to further flood risk in coastal data center markets as local environments shift.

LAND PRICE



As the desire for larger, denser and more scalable data center campuses grows, land availability is becoming an increasing issue for data center developers and operators. A proper site for a successful data center development includes many considerations discussed in this report, including access to fiber, proximity to a substation, a strong and affordable power grid, and available incentives. There are more prosaic real estate concerns too, as in sites certain markets are often available in sizes under three hectares (Hong Kong, Singapore) or are just emerging as data center locations (Salt Lake City, Las Vegas, Portland). Smaller sites often lead to more expensive builds, with multiple levels and higher density being required both for efficiency and to meet customer size requirements.

As in the case in other real estate categories, demand for land is affected by other factors besides physical scarcity. Ease of permitting, zoning or use restrictions, population density, and vendor ecosystem all factor into land acquisition, along with proximity to availability zones of major cloud services providers.

For the markets reviewed, those with the lowest cost of land are in secondary data center markets with low density or geographic restrictions, primarily in the United States. While it may not be surprising that Atlanta, Columbus or Denver have affordable pricing, land in top U.S. data center markets such as Phoenix, Dallas, and Northern Virginia remains half the price of Canadian markets and a tiny fraction of deeply constrained markets in Western Europe or Asia. Large sites in these markets can thus expect to trade at premium pricing, as new operators enter and others expand.

REAL ESTATE & PHYSICAL CONSIDERATIONS

Low cost land removes one of the barriers to development, particularly as land in dense urban areas becomes scarce. Less dense markets offer the potential for larger data center campuses, as large sites in these areas cost a fraction of sites in more constricted areas.

TOP FIVE BY LAND PRICE



SALT LAKE CITY

This growing market in the Western U.S. has lower geographic restrictions than other regional competitors.



ATLANTA

A national hub for many industries, Atlanta has abundant land at an affordable price.



COLUMBUS

This emerging Midwest connectivity point is drawing considerable interest from hyperscalers.



JOHANNESBURG

Land costs remain very low in Johannesburg due to recent economic struggles, though this could lead to long-term opportunity.



DENVER

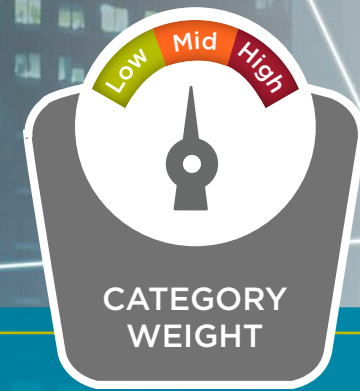
The hometown of many key data center operators has lower overall land costs than other large markets in the Western U.S.



WHAT TO WATCH

With land cost becoming increasingly unaffordable in key markets around the world, multi-level data center construction has become commonplace in Singapore, Hong Kong, Silicon Valley, and even in less constrained areas like Northern Virginia or Montreal. Multi-level deployments will likely become the norm in further markets in the future, leading to differing construction and cooling concerns.

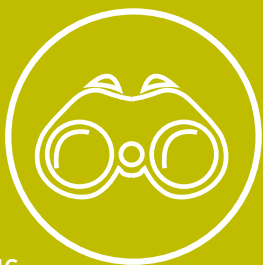
VACANCY



When considering real estate market conditions, data center markets with low vacancy often indicates strong demand. Low vacancy causes prices to rise, leading to further development and opportunities for new market entrants. With the advent of cloud computing and other resource-heavy applications, average deployment size for the largest clients continues to rise. Five years ago, a five-megawatt expansion was considered very large, whereas today 50 megawatts would be considered notable.

Data center operators in markets favored by the big cloud platforms have recently discovered they can often lease a good portion of their facility to a large tenant (for example, eight megawatts of a ten-megawatt building), but then must find several smaller users for the remaining space. This leads to some stickiness with the remaining vacancy, with a headline vacancy figure that does not always reflect market conditions.

Northern Virginia remains the tightest data center market worldwide, with total vacancy below four percent. While this is an expected scenario, this is followed by several markets through the Western half of North America, including Vancouver, Los Angeles, Salt Lake City, Silicon Valley, and Phoenix, all with sub-10 percent vacancy. Development costs and constraints in Los Angeles and Silicon Valley remain formidable, though if these can be overcome it would indicate that latent demand still exists. Amsterdam is the tightest European market (particularly with all development temporarily halted), and developing Mumbai has the lowest vacancy throughout Asia.



WHAT TO WATCH

Markets with the lowest vacancy simply equal those with some of the highest demand. While markets can remain under-built for a variety of reasons, a low vacancy rate implies extreme interest overall.

REAL ESTATE & PHYSICAL CONSIDERATIONS

Simply put, markets with the lowest vacancy equal those with the highest demand. While markets can remain under-built for a variety of reasons, a low vacancy rate implies healthy overall interest.

THE TOP FIVE LOWEST VACANCY

NORTHERN VIRGINIA

Much of the new capacity here is pre-leased long before construction begins as demand remains insatiable.

VANCOUVER

This small market is utilized by content providers and the tech industry.

LOS ANGELES

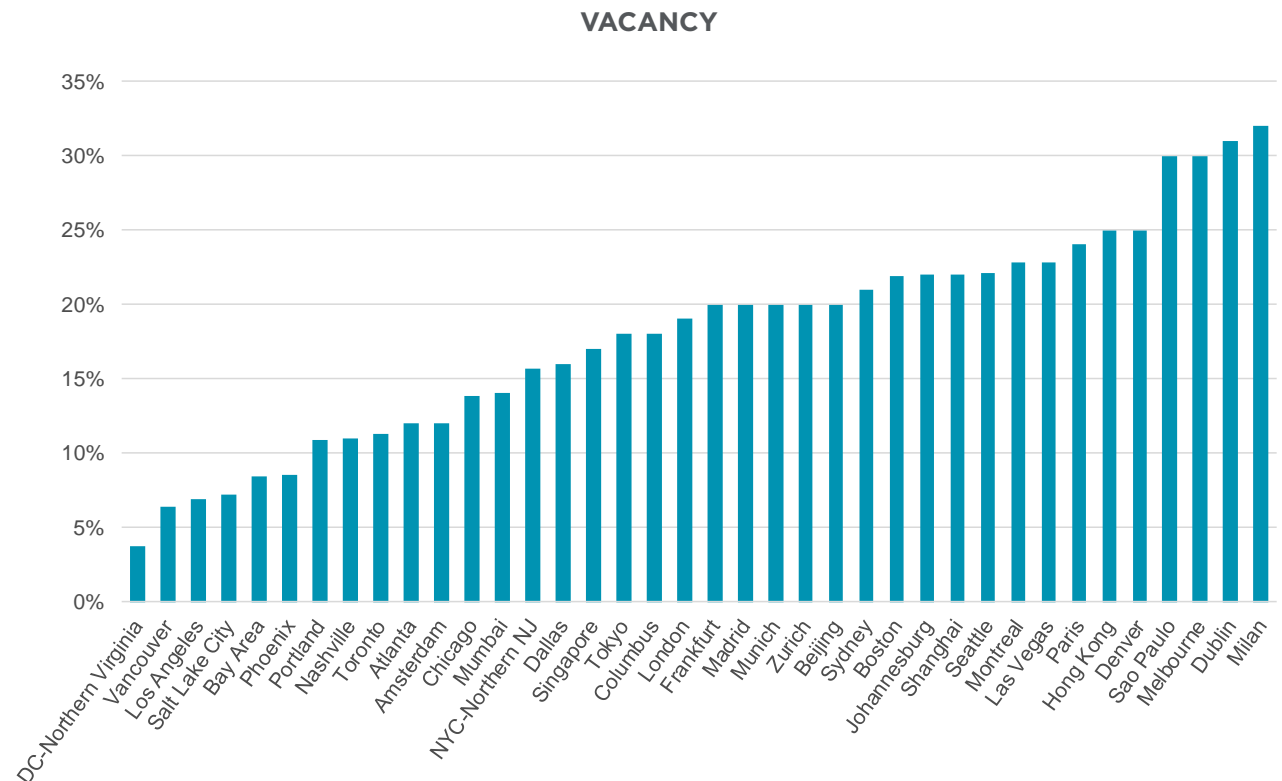
This major West Coast hub is always in demand but difficult to develop in.

SALT LAKE CITY

The emerging Silicon Slopes tech community provides ready-made local market interest.

SILICON VALLEY

The global tech capital enjoys perennial demand from locally based mega-companies.



Source: Cushman & Wakefield Research



CATEGORY 2

ECOSYSTEM ADVANTAGES



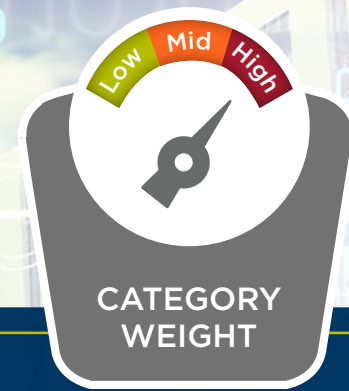
Cloud
Availability

Fiber
Connectivity

Market
Size

Sustainability

CLOUD AVAILABILITY



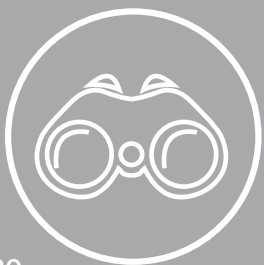
Cloud computing has pushed the full capabilities of the data center and online applications into the hands of small- and medium-sized companies that were previously unable to afford such beneficial technology. Enterprises no longer must maintain their own data center if it is not cost effective or efficient to do so, eliminating the constant upgrade and migration costs.

Three major cloud platforms - Amazon Web Services, Microsoft Azure, and Google Cloud - have continued a relentless expansion in recent years, with an ever-increasing number of availability zones. They have driven the creation and adoption of hyperscale technology, with massive, dense and infinitely scalable data centers acting as the home for this high-level purpose. Amazon, Microsoft and Google have spent billions of dollars developing their own campuses, with millions of square feet of buildings constructed and hundreds of megawatts of power utilized.

The result of this explosion is a new industry standard for a large data center take-up, with 20-50 megawatt leases becoming more commonplace. This has also led to the development of another nuanced ecosystem, with cloud on-ramps at colocation campuses providing fastest access to major cloud platforms.

Today's modern technologies including the Internet of Things (IoT), self-driving cars and 5G connectivity will only thrive across large networks. All related applications also need somewhere to live, most likely on one of the three main platforms.

For this report, markets that were in availability zones of all three platforms received the highest scores. Though several traditionally large data center markets fall in these zones (Northern Virginia, Silicon Valley, Hong Kong, Tokyo, Amsterdam, Frankfurt), several secondary markets now have access and can provide regional competition (Zurich, Sao Paulo, Portland, Seattle). This category will have increasing weight in future as the importance of cloud computing continues to grow.



WHAT TO WATCH

The three major cloud providers (Amazon Web Services, Microsoft Azure, Google Cloud) represent two-thirds of the market, though this may change as other large software companies build out their platforms. In an increasingly cloud-based world of compute, these companies will drive growth both in hyperscale builds and at the edge.

ECOSYSTEM ADVANTAGES

As more workloads migrate to the large cloud services providers, it provides a major advantage to those data centers that are in markets with this accessibility. Each market was reviewed to determine if it fell in an availability area for Amazon Web Services, Google Cloud or Microsoft Azure.

THE TOP FIVE IN CLOUD AVAILABILITY

LOS ANGELES

A massive and diverse U.S. coastal market with access to all major providers.

SAO PAULO

The main data center market in Brazil and possibly all of Latin America has drawn interest from all major cloud providers.

AMSTERDAM

A well-connected and a major business hub in its own right with status as one of the main FLAP-D markets in Europe.

TORONTO

MONTREAL

NORTHERN VIRGINIA

CHICAGO

DALLAS

SILICON VALLEY

LONDON

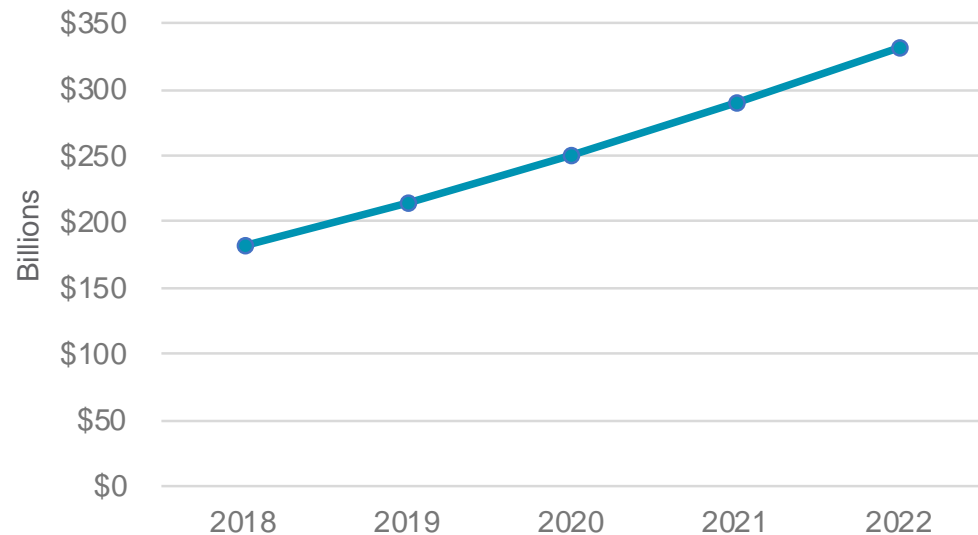
FRANKFURT

PARIS

SINGAPORE

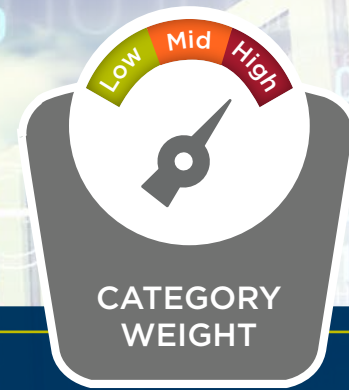
TOKYO

PROJECTED GLOBAL CLOUD SPEND



Source: Gartner

FIBER CONNECTIVITY



If data centers are the brain of the modern economy, fiber networks serve as the nervous system that allow it to move and thrive. Billions of dollars are invested each year in constructing and maintaining these high-speed networks, with telecommunications companies, infrastructure funds and private equity firms fighting for market share. While a data center requires access to just one network to function, the greater the number of networks means the more the facility can prosper. Faster, denser fiber generally allows for the lowest latency and better overall network reliability, particularly when functioning with major cloud services.

Fiber networks can be short-haul and cross a metropolitan area, or longer haul to move data across the country or even past borders. Areas with the highest number of networks are found in densely populated regions of the United States with established data center markets, including Silicon Valley, Dallas and Northern Virginia. These areas form the original backbones of technical and telecom research in the country, and the historical advantage continues today.

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.

ECOSYSTEM ADVANTAGES

The densest fiber connectivity makes an area attractive, with more networks allowing for increased speed. Each data center in each market was reviewed to determine access to local, long haul and international networks.

TOP FIVE BY FIBER CONNECTIVITY



SILICON VALLEY

The densest fiber runs through the technology capital of the world.



DALLAS

This is the geographic midpoint for the United States and a convenient fiber pathway.



NORTHERN VIRGINIA

The largest data center market in the world comes with some of the most robust fiber.



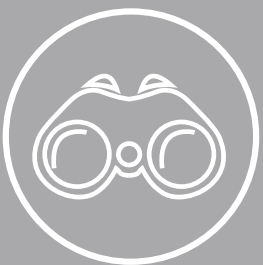
ATLANTA

Atlanta is on the cusp of first-tier status, with existing infrastructure to assist in forward movement.



LOS ANGELES

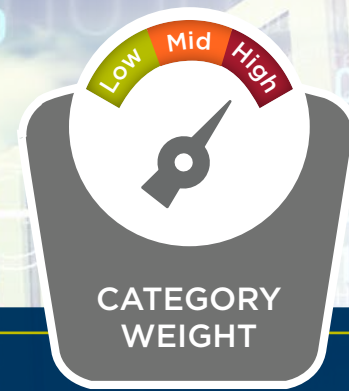
Dense fiber and a large, densely packed population with access to many undersea cables.



WHAT TO WATCH

60 new undersea cables either completed in 2019 or are coming online in 2020, the highest two-year total in history. The continued need for greater bandwidth is expected to multiply over the next decade, as more countries gain internet users and companies develop new applications.

MARKET SIZE



A large data center market not only indicates a historical predisposition to develop in that area, it often facilitates further development thanks to local market awareness and an established network of partners. The historically dense fiber throughout Northern Virginia — largely due to a strong military and R&D presence — gave birth to today's largest global data center market. Financial hubs such as London, New York, Hong Kong, and Tokyo have strong data center connectivity to process these transactions; and Silicon Valley, the technology capital of the world, still boasts a large local market. Networks beget more networks, and with the difficulty of migration it is often far easier to simply expand in place.

The “campus” model that is currently in vogue assists in this current market expansion, with developers and operators acquiring large parcels that will accommodate multiple phases or adding smaller parcels surrounding the current property as demand requires. Continued expansion of certain key markets has caused considerable pressure on infrastructure. In fact, Amsterdam has banned construction of data centers for the rest of 2019 and several other large European markets are heavily power-constrained until further power grid expansion can be completed.

Beijing and Shanghai have continued their expansion throughout China, now placing among the global leaders for market capacity. In North America, Toronto and Montreal are gaining traction for the diverse array of occupiers and low cost of power respectively, and Phoenix has attracted attention recently as new operators continue to enter with plans to build large hubs.

ECOSYSTEM ADVANTAGES

Each of the 38 markets reviewed was analyzed asset-by-asset to determine total current market capacity by power available. Most large markets correspond to a large local population, strong business sector, robust fiber and available power.

TOP FIVE BY MARKET SIZE



NORTHERN VIRGINIA

The past, current and future leader of the data center world.



LONDON

The largest market in Europe, led by a large financial sector and ease of entry.



TOKYO

Propelled by telecoms and now large operators, Tokyo is the largest market in Asia.



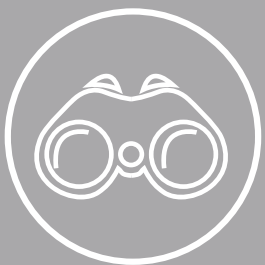
BEIJING

Decades of brisk economic growth have led to a very large market run by a mix of local operators and telcos.



SILICON VALLEY

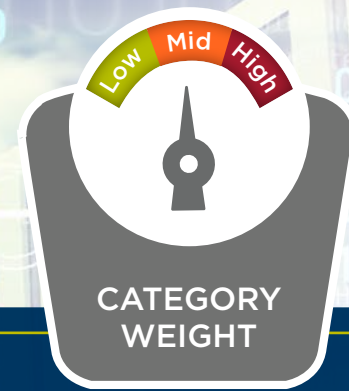
Silicon Valley continues to get the most out of legacy assets with more campus development upcoming.



WHAT TO WATCH

Many of the largest data center markets throughout Europe, Asia and coastal United States are becoming increasingly land-constricted and struggling for access to power. These issues could lead to the development of other in-region markets thanks to lower costs and ease of construction.

SUSTAINABILITY



While climate change threatens the planet and all inhabitants with increased temperatures and corresponding increase in sea levels, the data center industry has a peculiar responsibility to consider. All people rely on a data center for their daily information and workload, yet the largest data centers utilize more power each year than small cities. Sustainability has thus become a critical factor in data center design and location.

Pressure for sustainability not only comes from environmental groups and investors, but through the large cloud service providers and biggest data center tenants. Google plans to have zero emissions by 2030, Amazon plans to be carbon-neutral by 2040, and many cities throughout the world are planning the same by 2050, particularly throughout Europe. These companies and local governments are exploring multiple options to achieve this goal, including solar power, hydroelectricity, wind energy, and the reuse of biomass to provide cleaner, renewable power.

From a data center perspective, locating in markets with sustainable power has another benefit covered elsewhere in this report: it can be cheaper from a user perspective. Montreal has led the way on this for some time, with local utility Hydro Quebec marketing the low cost hydroelectric power as a reason for locating data centers in the province. Sydney has recently stepped up, with all power coming from renewable sources within the year. Markets in the Northwest United States and Canada such as Seattle, Portland and Vancouver also have considerable sustainable power in place.

ECOSYSTEM ADVANTAGES

Sustainability can arise from simply using those energy sources in abundance near each market. Hydropower is a natural choice in areas with large amounts of precipitation, as is solar power in desert locations.

THE TOP FIVE IN SUSTAINABILITY



MONTREAL

Hydroelectric power runs the entire province and particularly the local data center sector.



SYDNEY

Local political commitments to sustainability have led to major improvements in Sydney.



LAS VEGAS

Wind and solar power play well in an arid desert location.



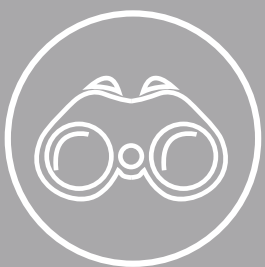
VANCOUVER

Rainy British Columbia provides plenty of water power for the small Vancouver data center market.



SEATTLE

Hydropower is key in Seattle as well, with local enterprises insisting on green energy.



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.



CATEGORY 3

POLITICAL AND REGULATORY REVIEW



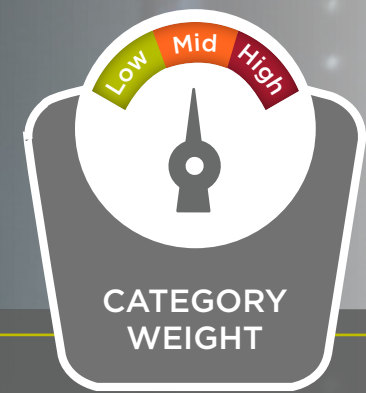
Incentives

Political
Stability

Power
Cost

Taxes

INCENTIVES



To attract data center investment, many areas at the national, state/provincial or local level offer a varying package of incentives in the form of tax relief. This can mean a reduced sales tax on the purchase of equipment, lower or exempted property taxes, or even reduced power taxes for meeting objectives. Most of these incentives require a minimum financial investment, along with multiple permanent employees hired at an above-average wage. While in many countries incentives are determined on a case-by-case basis, certain markets have chosen specifically defined plans.

The United States is leading the way in incentives, with 25 of 50 states now offering their own packages. Nevada and Arizona have proven most aggressive, with exemptions starting at \$25 and \$50 million for Las Vegas and Phoenix, respectively. Other long-standing top tier markets are also buoyed by incentives, including Northern Virginia and Dallas, and Chicago looks to benefit from a new package launched by the State of Illinois in 2019 for invested amounts of \$250 million and 20 permanent hires.

An intriguing new incentive came online in 2019 for data center development in Paris, with the French government offering an electricity tax cut that halves the price of electricity for large projects. Operators would be required to adhere to strict environmental standards, though these may also prove cost effective.

POLITICAL AND REGULATORY REVIEW

TOP SIX IN INCENTIVES



PHOENIX

Aggressive incentive packages and proximity to California have drawn multiple new operators over the last two years.



LAS VEGAS

Las Vegas has been attractive to those serving larger regional markets.



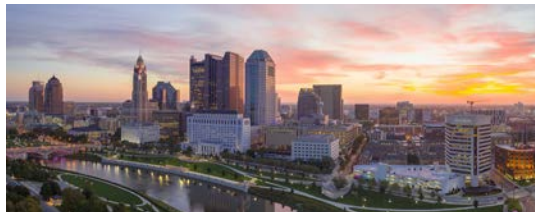
PARIS

Rare tax incentives here have been created to compete with other large markets throughout Europe.



SEATTLE

Washington state incentives are available through 2024, with the possibility of extension thereafter.



COLUMBUS

Ohio incentives have attracted hyperscale builds throughout the greater Columbus market.



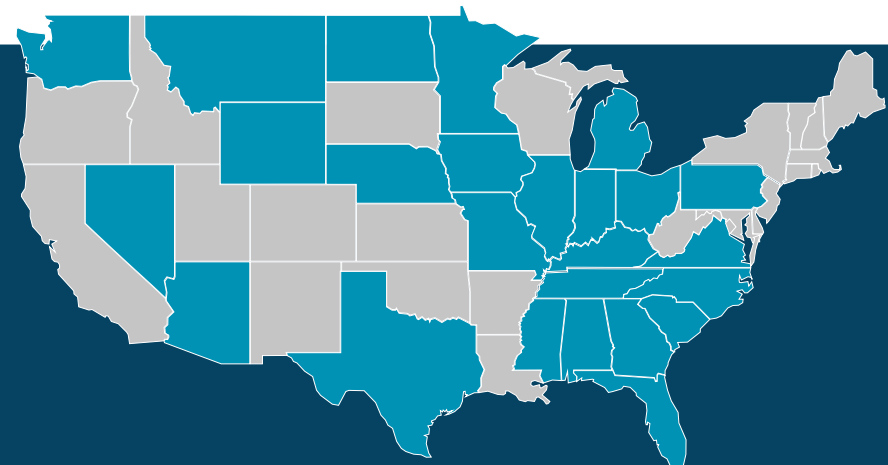
ATLANTA

Georgia incentives launched in 2018 to great fanfare thanks to a strong push from the data center industry.

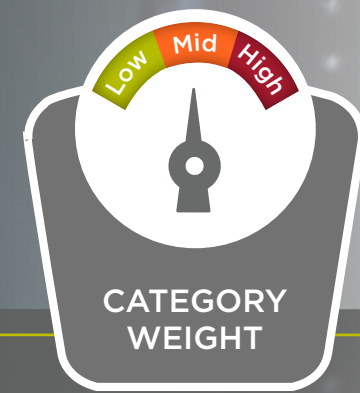


FAST FACT

Several states throughout the U.S. have enacted specific incentives for the data center sector, usually based around sales or property tax abatements. Illinois and Indiana area are among the most recent to launch.



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.

The markets that scored highest in political stability are those that have longstanding democratic forms of government, high standards of living, and are well integrated into the world economy. Canada scored favorably, reflecting well on key data center markets Toronto and Montreal, but also on the smaller market of Vancouver. Several locations in Western Europe both minor and major scored highly (Zurich, Amsterdam, Frankfurt, Dublin), as did Singapore and cities in Australia.

POLITICAL AND REGULATORY REVIEW

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 SIX IN POLITICAL STABILITY



ZURICH

Centuries of direct democracy and strong institutions place Zurich at the top of the list.



TORONTO

The financial and business hub of Canada remains highly stable.



MONTREAL

Cleanliness and cost effectiveness also applies to government in Montreal.



AMSTERDAM

An important business, trading, and IT hub in the heart of the EU.



SYDNEY

The leading city for Australian business and biggest national data center market.



MELBOURNE

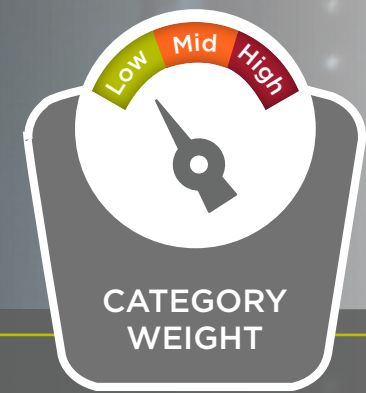
Often ranked as the world's most livable city by the Economist Intelligence Unit.



FAST FACT

Canada, Germany and Australia all score highly on the Freedom House "Freedom on the Net" scoring methodology, measuring freedom on internet access and content. Not surprisingly, these markets also scored well by the World Bank for political stability.

POWER COST



Building a data center to run today's resource-heavy applications requires considerable capital during construction, particularly if attempting to offset this by aiming for a low power usage effectiveness (PUE). A variety of techniques can be used to achieve a low PUE, including locating in cooler climates for air cooling and higher utilization to offset losses. Once complete, one major, continuous cost becomes a reality: power.

Market power costs are derived from a variety of factors. Renewable power lowers the cost, particularly where hydropower is common, with this source having the lowest lifetime cost of energy. Taxes play a part, as power is taxed differently across areas depending on amount used and type of utilization. Maintaining a power grid is complex (particularly in areas with multiple types of power generated) and local utilities' decision to structure as a for-profit or non-profit entity leads to differing levels of responsiveness to the data center industry. Certain utilities have worked to attract data center development, with Hydro Quebec, Silicon Valley Power, Tennessee Valley Authority, Dominion Energy notably willing to assist in the planning process.

A survey of power costs shows that those markets that can generate hydropower consistently appear among the low-cost leaders. Montreal leads the way at three U.S. cents/kWh. Several other markets in the Western and Southern U.S. including Salt Lake City, Dallas and Atlanta also have heavy industrial use pricing below six cents/kWh. Johannesburg in South Africa has the most affordable power of markets reviewed outside North America, albeit with an occasionally inconsistent supply.



FAST FACT

A recent study by the International Renewable Energy Agency indicates one-third of global energy is now being generated by renewables. This will only benefit the data center industry, as those markets that make good use of renewables such as hydropower rank among the top finishers in the lowest power cost rankings.

POLITICAL AND REGULATORY REVIEW

Power is one of the main cost drivers of a data center, with individual large data centers using as much power as a small city. Cities with the lowest cost power thus offer a tantalizing opportunity for data center operators, potentially allowing for higher margin on operations.

THE TOP FIVE IN POWER COST

MONTREAL

The lowest cost power in North America is also the greenest thanks to the abundance of hydroelectricity.

JOHANNESBURG

Johannesburg's pricing competes on a global scale but issues exist in maintaining grid uptime.

PORTLAND

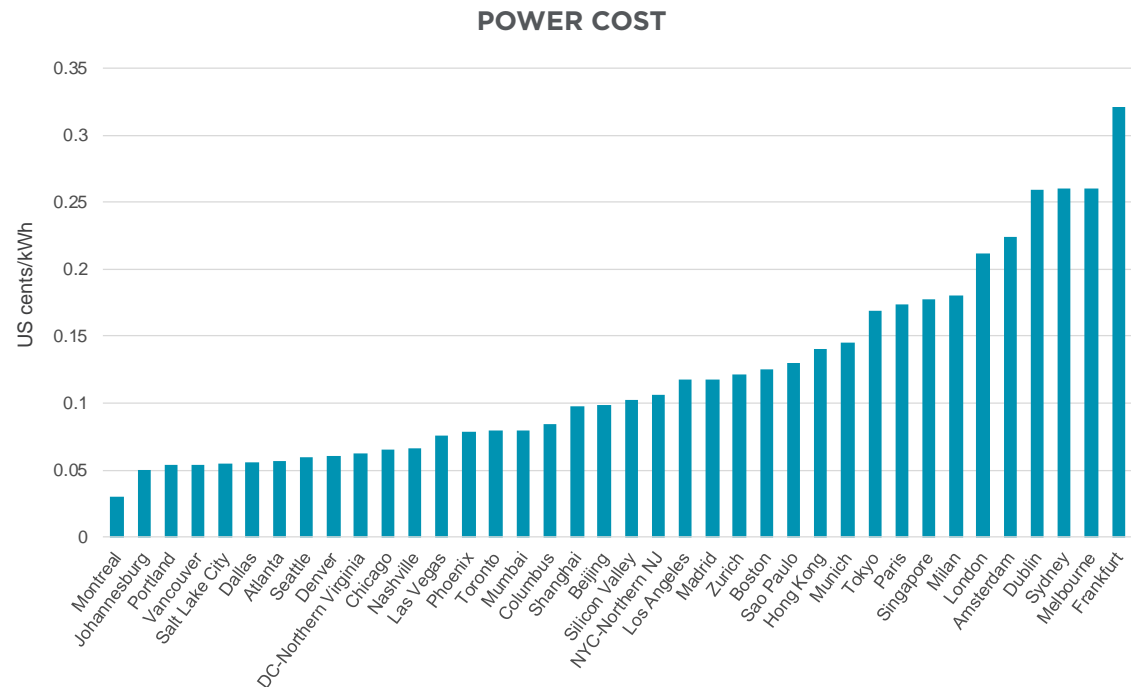
Portland is one more example of a key hub for cost-effective hydroelectric power.

VANCOUVER

Hydroelectricity works well throughout the Northwest corner of the Americas, and Vancouver is no exception.

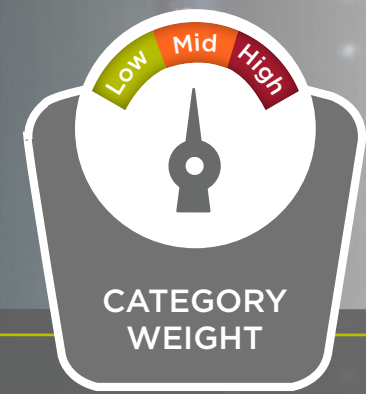
SALT LAKE CITY

Power is available at low cost in Salt Lake City, largely from non-renewable sources.



Source: Cushman & Wakefield Research

TAXES



For data center projects in areas that do not offer government-related incentive packages, sales taxes or value-added taxes come into play when acquiring equipment and materials. A sales tax is a payment to the government for any good or service sold, while a value-added tax is paid by the end user of the value chain. With costs for large data center builds pushing into nine and ten figures over multiple phases, a market with lower tax rates can save millions of dollars over the life of a facility.

Two markets studied, Portland and Hong Kong, have neither of these taxes, thus providing an incentive as compelling as any exemptions given. Hong Kong has long been a pro-business, global center of commerce, and Portland's home state of Oregon taxes income and property instead.

Several other U.S. markets have sales tax rates from four to six percent, including Northern Virginia, Boston, Seattle and Northern New Jersey. Singapore's goods and services tax will remain at a low seven percent for at least another two years. On the opposite end of the scale, most large European markets have rates triple that of the lowest tax regimes, with rates hovering close to 20 percent.



FAST FACT

While incentives may be assigned to a specific project and not exist for the entire data center sector in each market, sales or value-added taxes are much clearer to understand. High-tax jurisdictions throughout Europe have rates double or triple their competition in other parts of the world.

POLITICAL AND REGULATORY REVIEW

For those projects that are not large enough to qualify for specific data center-related incentives, a lower tax rate on equipment purchases can be incentive enough. While these jurisdictions may have other taxes to compensate, initial development or expansion can be more attractive.

THE TOP FIVE LOWEST TAXES

HONG KONG

A main site for global business that has no value-added tax.

PORTLAND

The only U.S. market studied that has no sales tax, creating a compelling incentive by itself.

NORTHERN VIRGINIA

Very low sales taxes are another key reason for locating in Northern Virginia.

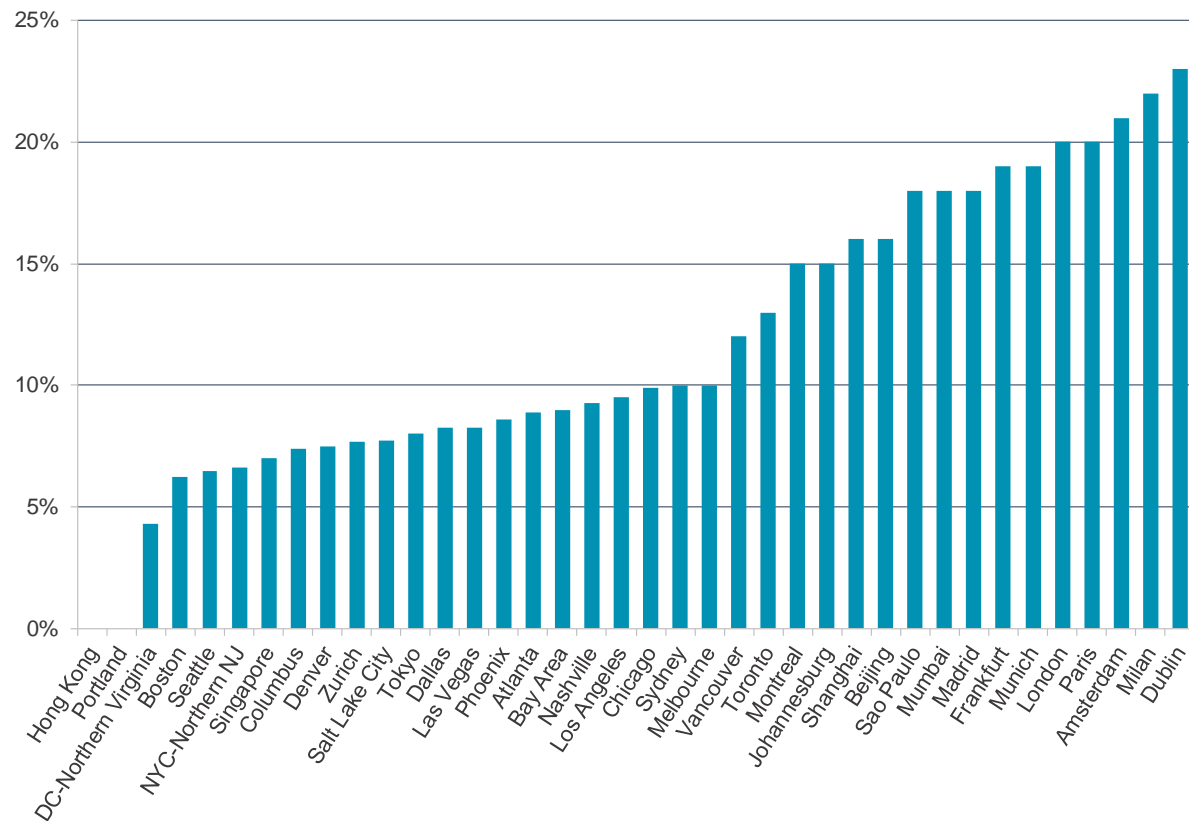
BOSTON

Boston's low taxes offset the high power costs in-market.

SEATTLE

Low sales taxes on equipment in Seattle are an additional benefit to the existing incentives and low-cost power.

SALES TAX/VALUE ADDED TAX



Source: Cushman & Wakefield Research

OVERALL RANKINGS





1



NORTHERN VIRGINIA

2



SILICON VALLEY

3



DALLAS

4



CHICAGO

5



NEW YORK / NEW JERSEY

6



SINGAPORE

7



AMSTERDAM

8



LOS ANGELES

9



SEATTLE

10



LONDON

SYDNEY



OVERALL RANKINGS

With all factors taken into consideration, it will come as no surprise that Northern Virginia finished in first place. The combination of large market size, robust fiber, strong cloud availability, deep development pipeline, and low vacancy propelled the current and longtime largest data center market to the top. This was followed by a succession of other well-established U.S. markets for similar reasons, including Silicon Valley, Dallas, Chicago and New York-New Jersey.

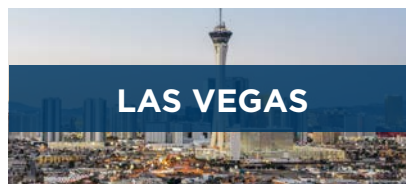
Singapore, Amsterdam and Los Angeles follow as robust data center markets, albeit each with their own challenges around permitting and development. All three markets are in constant demand and have limited physical room for additional construction. Seattle and London round out the top ten. It is crucial to note that although the top three markets had considerably higher scores than fourth place, the next twelve markets were separated by a final score of less than ten percent.

This close placement represents a new shift toward key secondary areas fast becoming primary markets around the globe. Several markets throughout Europe have received continued interest from international operators, with the continent becoming a new hyperscale target where power is available. Large sites have sold recently in emerging U.S. markets such as Portland, Phoenix and Atlanta, with these areas potentially saving investment significant over

locating in California or Northern Virginia. Additional markets in Asia are also expecting considerable growth in the next two to three years, with demand for greater connectivity and need for modernization of older assets required. The top 15 global markets will thus remain extremely competitive for the foreseeable future.

Understanding where to locate a data center comes from a careful review of factors dependent on the needs of each

WHAT TO WATCH: EMERGING MARKETS



organization. Phoenix's emergence in the past year for hyperscale builds makes sense; incentives are available from a low base, land costs are among the lowest in this study, and the market has very low vacancy. By utilizing the cost savings on offer, operators and major cloud services providers are choosing to look to Phoenix as their new hub for servicing U.S. West Coast markets that are individually far more expensive to develop in. Taking this a step further, we anticipate Salt Lake City as a similar destination: land is even cheaper, vacancy even tighter, power is more affordable, sales taxes are lower, and fiber is denser throughout current offerings. Portland land pricing is nearly on par with Phoenix. The green power on offer is cheaper, and the absence of sales taxes provides a keen incentive on its own. Portland also falls into availability zones for all three major cloud services.

Sydney has also made headlines as a data center market to watch. A recent Gartner study indicates a 20 percent increase in public cloud spend over the past year by Australian companies, with similar large increases predicted in the

next two years. This is faster than the global average, and indicates a desire by local firms to modernize their computing capabilities. Sydney has thus enjoyed massive growth throughout the data center sector, although this is tempered by recent wildfires that have caused considerable property damage.

For those smaller deployments that are absolutely mission critical, an interesting comparison comes among markets that fall under areas low in environmental risk with the highest political stability. Dublin (already drawing considerable interest for large deployments) finishes highly in both categories, with the far smaller and tighter Vancouver market a compelling choice alongside. Both offer the rare combination of coastal cities with data centers located outside of floodplains and minimal chance of political disruption. Land costs in Vancouver remain far higher than in Dublin, though the green power on offer is a small fraction of any pricing throughout anywhere in Europe.

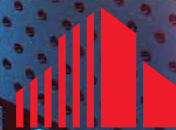
There are also markets that fall under the "What If?" category, that could be highly attractive with the right circumstances.

Denver finishes among the leaders with a low cost of power, inexpensive land, low sales taxes, and low environmental risk yet the market remains largely undeveloped. While many operators with a current or potential presence in the market are hoping for an incentive package to stimulate interest, Denver might be worth investigating on the merits of these other factors alone. Las Vegas offers a strong incentive package, low land and power costs, low sales taxes, and renewable energy from solar power yet remains the home of just one large operator.

The top finishing markets are those that provide the greatest number of options to the greatest number of perspectives. While one size sometimes does fit all, for certain specializations it is imperative to review and understand those factors most important to the specific requirement at hand and aim accordingly. Combined with those markets that have been overlooked and underutilized, there is great potential for niche development across the globe.

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 and Data Center operators and end 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. Beyond the specialized expertise of the real estate, we lend additional value through our understanding of global dynamics and their impact on local markets.



**CUSHMAN &
WAKEFIELD**

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 and Data Center operators and end 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. Beyond the specialized expertise of the real estate, we lend additional value through our understanding of global dynamics and their impact on local markets.

CONTACT

Dave Fanning

Executive Managing Director
Data Center Advisory Group Leader
+1 303 818 7376
dave.fanning@cushwake.com

Kevin Imboden

Director of Research
Data Center Advisory Group
+1 408 436 3622
kevin.imboden@cushwake.com



**CUSHMAN &
WAKEFIELD**