



The evolving data center landscape

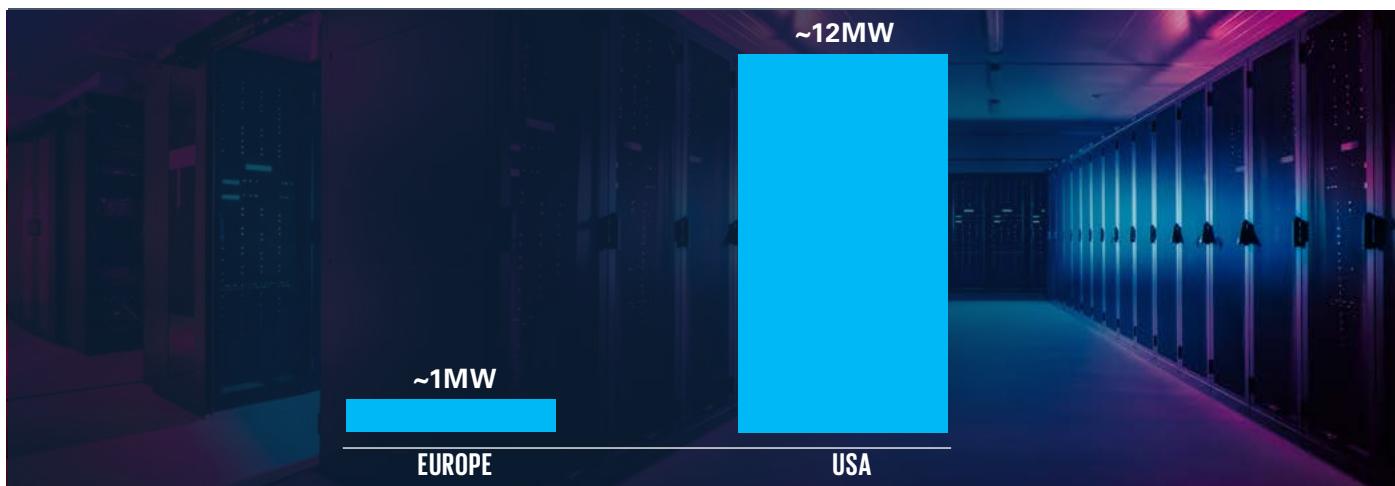
Spotlight on Europe's journey



Europe's DC catch up

When it comes to data center (DC) capacity, European markets still lag the US, betraying a yawning provision gap that is being addressed, but with increasing obstacles. Double digit DC growth over the next decade is required for Europe to ensure data resiliency as sectors such as healthcare, life sciences, government, and education become more data and cloud centric. A key question for stakeholders is how DC investment will evolve in Europe during that period.

Approximate installed MW per 100,000 population today¹



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In Europe, there hasn't been enough supply for some time. Most data centers here are focused on large area tenants and cloud providers. Therefore, most of the capacity is already fully leased before the completion of the data center space. It is getting more difficult for smaller tenants outside the tech industry to find adequate capacity.

Managing Director

*Data center services company,
Frankfurt am Main,
Germany*

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While it is true that some of the hyper-scalers are currently building large, greater than 80MW data centers in Europe, the cold reality of the situation is that capacity still remains really low compared to US and it has become really difficult to build new data centers here.

Data Center Executive,
*Turner & Townsend,
France*

Beyond FLAP

In Europe, major financial centers, being willing to pay for improved latency to high to support high frequency trading platforms, have driven much development of DCs. As such, European DCs have tended to cluster around the so-called FLAP markets: Frankfurt, London, Amsterdam, Paris. However, there is limited scope to expand in these expensive urban locations, due to constraints on:



Space: Development projects often seek sizeable real estate footprints near dense urban centers

Cost: Urban land values

Energy: DCs' outsized energy demands are exceeding plant and grid capacities in existing hotspots

Furthermore, recent actual, threatened, or implied moratoria on DC development to align with Europe's sustainability agenda have also complicated the development of new DC campuses. As the European DC market looks to catch up to the US, new geographies will therefore inevitably come into play. But which ones, and why?

Here we take a closer look at some of the alternative European cities that have become, and with prudent policy decisions can continue to be, leading locations for DC developers over the next decade. We'll examine both Ireland and France, and we will contrast the situation in Europe with what is happening elsewhere in the world. Specifically, we'll look at the market dynamics in Singapore that have enabled the city state to continue to rapidly extend its global DC leadership despite a recent DC moratorium.

DC types

In their relatively short history, DCs have evolved quickly. These days, the term 'data center' is an inadequate descriptor for a spectrum of offerings, including any of the following:

DC TYPE	FEATURES	GOOD FOR
Edge	<ul style="list-style-type: none">Small scale, located near to userLow latencyCustomizable, compact, situated within entity premises	<ul style="list-style-type: none">IoT, AV, VR, AR, edge computing
Enterprise	<ul style="list-style-type: none">Owned and operated by userCan be on-premises or off-siteDeclining share of market	<ul style="list-style-type: none">Privacy and security, companies with unique network requirements
Colocation ('colos')	<ul style="list-style-type: none">Large facilitiesMultiple customers lease space in one locationFlexible and scalable	<ul style="list-style-type: none">Companies without resources to own bespoke DC, companies wanting multiple hardware locations
Hyperscale	<ul style="list-style-type: none">Massive, scalable facilities, housing thousands or millions of serversOwned and operated by user	<ul style="list-style-type: none">Large multi-national corporations and big tech, e.g. Amazon

The DC market: multiple drivers of growth

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The appetite this decade is insatiable. The use of colos and hyperscale may shift from year to year and market to market, but there is already a lot of committed investment in Europe over the next three years and I can't see it slowing much after that.

Former Regional Manager

*Data Center Infrastructure Delivery,
Amazon Web Services,
United Kingdom*

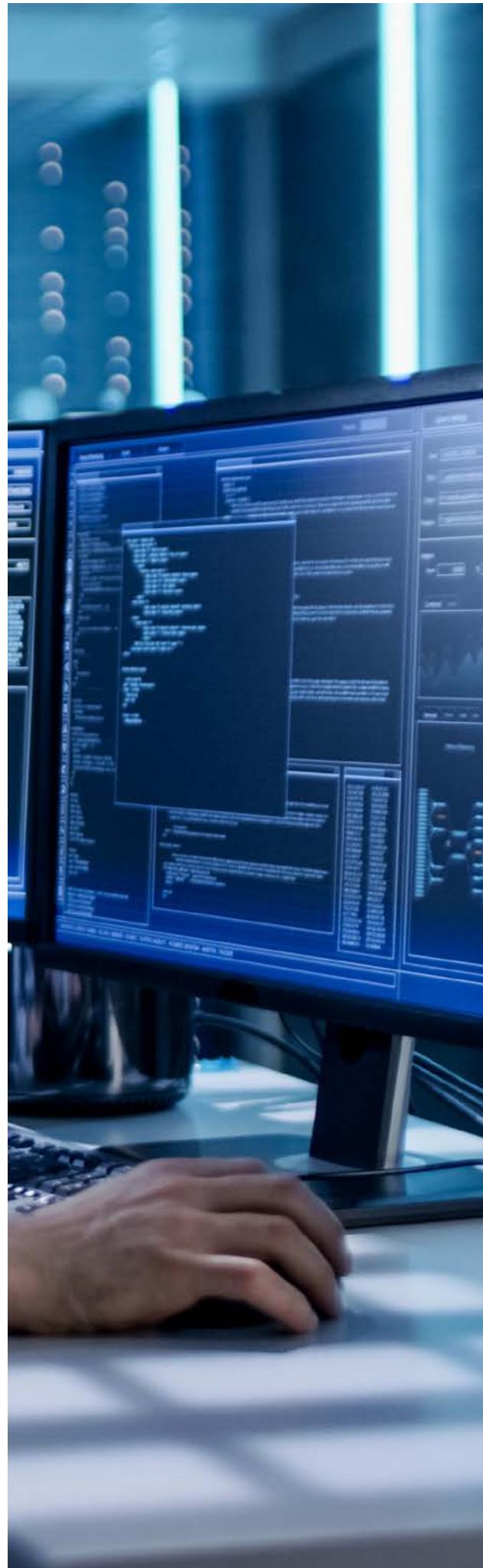
Growth forecasts for DCs are strong, with several robust trends combining to drive demand. Our analysis implies growth of ~15% CAGR for the sector across Europe through to 2025 and ~11% CAGR for the decade, driven in the former years by continued enterprise cloud adoption and data sovereignty requirements, with technologies like internet of things (IoT) and artificial intelligence (AI) along with others such as extended reality (XR), autonomous vehicles (AV) and advanced air mobility (AAM) increasingly driving demand into the latter part of the decade.

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Data center investment will diffuse across Europe. The expansion of 5G mobile edge, AI and machine learning, streaming content and gaming services will require lower latency and therefore demand resources closer to the consumer along with operational savings that can be made in places where power costs are much lower than FLAP locations.

Director of Business Development

*Amazon Web Services,
United Kingdom*



DCs in Europe: new markets, new metros

As the FLAP markets run up against natural constraints, we expect DC construction to move into a range of emerging alternative cities, each with specific attractions such as:

Berlin: Strong data protection, vibrant tech sector

Warsaw: Strong government support

Oslo: Renewable energy availability

Zurich: Strong data protection laws, renewable energy availability

Milan: Business capital, large financial sector

Vienna: Access to Balkans and Central and Eastern Europe

Marseille: Sub-sea cable connectivity to North Africa and the Mediterranean

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The speed, quality and interconnectivity of networks across Europe is world-leading. So, from a latency perspective, companies don't sacrifice much by, for example, putting their DC in the Nordics and providing services into mainland Europe or the UK.

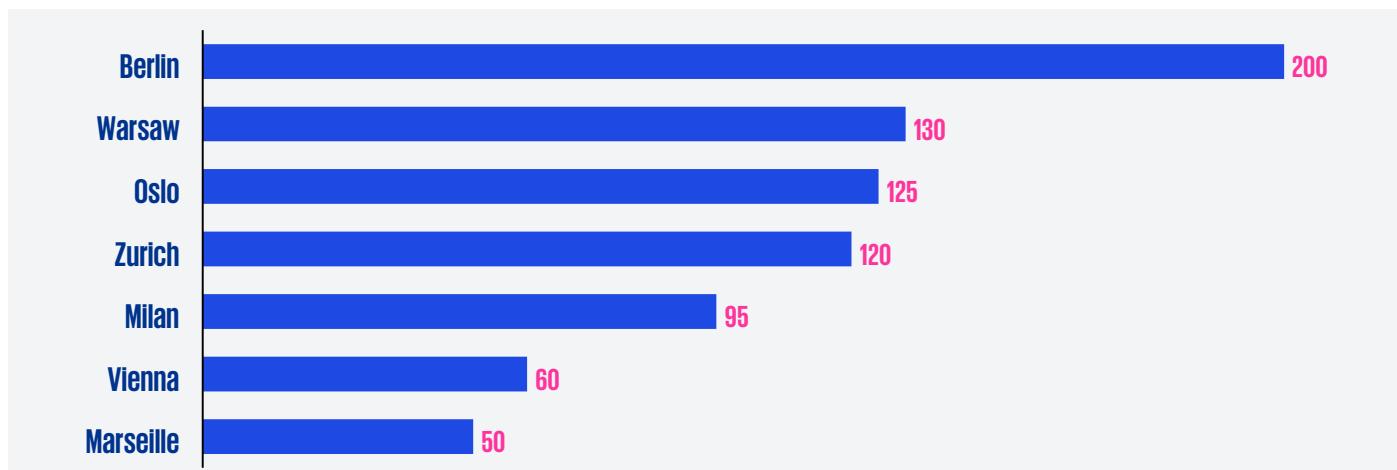
Former Chief Commercial Officer
*Stack Infrastructure,
Norway*

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Customers that do not have low latency requirements are considering co-locating further out from the established more expensive space found in FLAP capitals. If non-traditional hubs can provide good transit links and a pool of qualified workers, it is very likely that we will see a much more distributed data center market emerge in Europe.

Executive
*Digital Realty,
United Kingdom*

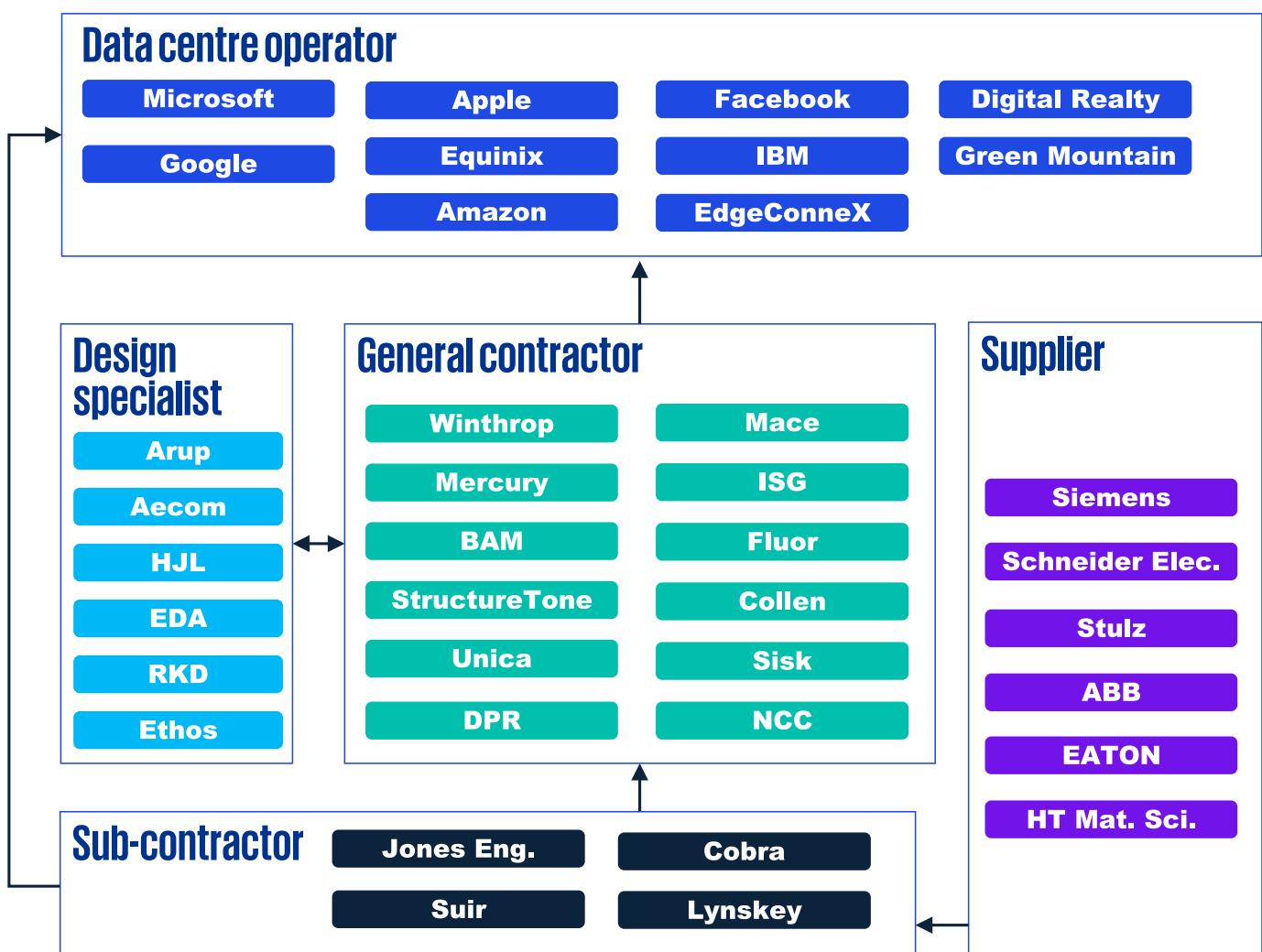
Approximate DC capacity across select European metros (MW)²



Not just DCs: a strong value chain

How and which players benefit from this anticipated demand is nuanced. Some speculators anticipate a shifting balance of power in favor of hyper-scalers that will leave colocation service providers displaced in the DC value-chain.³ Irrespective of which approach comes to dominate over the next decade, growth in the overall sector will continue to support demand throughout a complex regional value chain, including adjacent hardware such as cooling systems, servers, and backup batteries, as well as the supply chain in specialist construction and civil engineering, where UK and Irish engineering firms have developed strength. Investors like private equity firms looking to benefit from the rising tide of DCs can look at the broad gamut of players involved in enabling growth of the sector.

Data center construction value chain (sample of players)



³ Financial Times, "Hedge fund manager Jim Chanos's next 'big short' is data center", June 29 2022, <https://on.ft.com/3Savxy2>

Clouds on the horizon

Of course, no sector is without its challenges. Whilst some jurisdictions are actively concerned to increase their appeal as DC locations, in others, policymakers have a poor understanding of the role DCs play in the modern economy, leading to regulatory scrutiny.



Sustainability

Ballooning DC demand has inevitably increased awareness of the sector's huge energy requirements and resulting emissions impact – roughly similar to aviation (both estimated to account for ~3% of annual global carbon emissions from human activity), another sector that so far is facing louder calls to implement more sustainable operations. This awareness has placed operators under mounting pressure to green the European DC estate. A new European standard for DCs, EN 50600 was published at the end of 2021 as an ISO standard, while the European Commission recently announced an ambition for DCs in the region to achieve carbon neutrality by 2030. Such ambition has lent a certain exceptionalism to the European DC market, which is characterized by smaller and much more efficient builds. But there are limits to how far such design efficiencies can go, making renewable energy availability a real factor in DC sustainability strategies – indeed, many recent hyperscale projects have included their own energy generation capacity or implement circular economy concepts such as returning heat to homes and swimming pools.



Energy availability

DCs' outsized energy demands present other issues aside from their environmental impact.

- In Ireland, it has been noted that DCs could consume 70% of the energy generated by Ireland's national grid by 2030 if left unchecked. This kind of coverage has already invited restrictions in some energy-constrained urban areas. Eirgrid, the state-owned electric power transmission operator in Ireland, has implemented a de facto moratorium on DCs in the Dublin region.⁴
- In Amsterdam, once touted as a nascent DC hub, leaders are now trying to create rules to limit DC demands for both energy and land – moves that are likely to push DC builds to other cities.
- In London, recent DC builds have left no electricity capacity for new housing developments in certain areas of Hillingdon, Ealing, and Hounslow where DCs have sprung up, simply leaving no electrical power for other new significant connections until 2035.



There are likely to be new restrictions on future data centers such as requiring companies to use solutions to address carbon emissions from operations such as PV cells, hydrogen powered backup generators and other carbon capture and reduction techniques to achieve the goal of net zero in Europe by 2050.

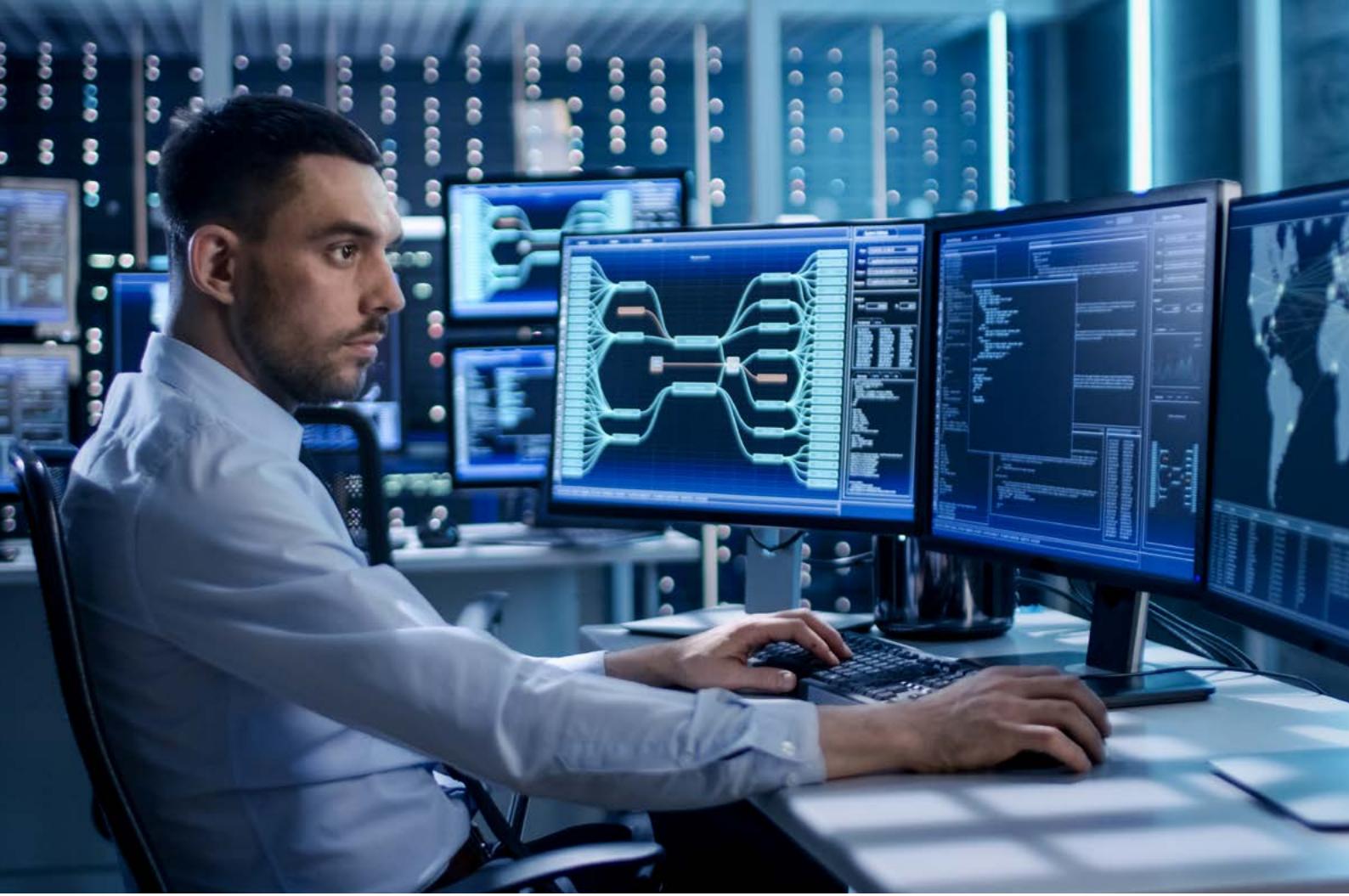
Director of Business Development
Amazon Web Services,
United Kingdom



There are some novel approaches being discussed in the industry, such as the interesting concept of powering data centers with small atomic reactors. It may not be the ultimate or only solution, but it shows that new approaches and outside-the-box thinking are going to be required.

Managing Director
Data Center, Frankfurt am Main,
Germany

⁴ datacentermagazine.com, "Data Centers to consume 70% of Ireland's power by 2030", September 28 2021, <https://bit.ly/3f7TVBP>



Supply chain: Widespread retrofitting of existing facilities to meet growing demand whilst pursuing greater efficiencies of space inside existing facilities is happening alongside new development. This is placing never-before-seen levels of pressure on the DC supply chain which has been impacted by supply chain issues affecting the availability of semi-conductors and fibre-optic cable.



Space: DCs that occupy massive plots in and around metro areas are often as usurpers of prime commercial and living space. In dense European cities, a likely development is that DCs will increasingly be built up instead of out. For example, in early 2021, local magistrates in Frankfurt proposed new regulations on DCs, indicating that facilities should be built taller rather than wider in order to take up less space in this city.



Talent availability: The Uptime Institute has projected that the Europe, Middle East, and Africa region will demand 81,500 net new DC staff by 2025.⁵ An ageing workforce across Europe as the continent transitions to a much older demographic profile, combined with technology advancements on the DC floor outpacing the upskilling of existing labor, will exacerbate a DC workforce talent shortage as demand outpaces supply of talent in the market.

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In the past data center locations mapped neatly to financial services hotspots. Going forward I think we'll see data centers start mapping to renewable power generation hotspots.

Former Chief Commercial Officer

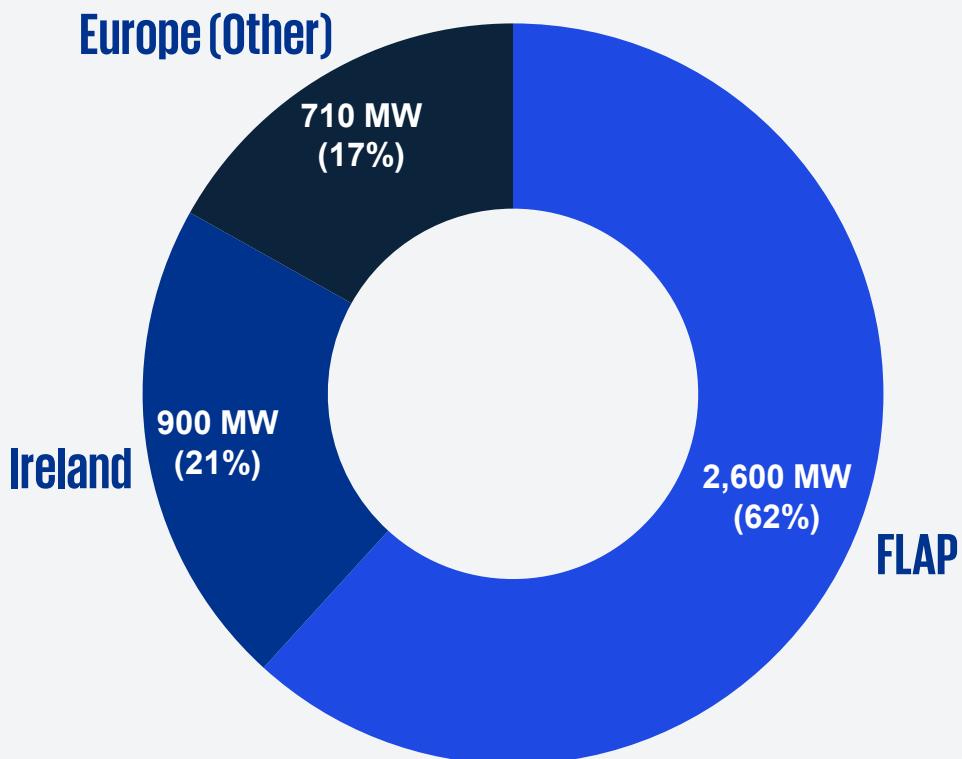
*Stack Infrastructure
Norway*

⁵ Uptime Institute, “The people challenge: Global data center staffing forecast 2021-2025,” April 5 2021
<https://bit.ly/3f3nLY8>

Ireland - a DC leader driven by hyperscale

While colos have grown first in financial centers, hyperscalers are more influenced by existing talent pools, government policy, climate, and the energy grid/generation landscape. These factors have made Dublin one of the largest data center hubs in Europe, given its foreign direct investment role into the EU market, its favorable government support in terms of taxation benefits, and its geographic position – bridging Europe and the UK with subsea cable access to the US.

Installed data center capacity by region, Europe, MW, 2022⁶



Notes: Installed data center capacity by MW for 2020 based on available estimates for FLAP markets (via CBRE), Dublin (via Host for Ireland), and secondary markets (via Cushman and Wakefield). This is likely a conservative market estimate, as it does not include additional hyperscale facilities located in the FLAP markets which were not sized due to data limitations. Installed data center capacity by type based on industry interviews and Host for Ireland. 70% of total hyperscale capacity assumed to be located in colocation facilities according to the Synergy Research Group.

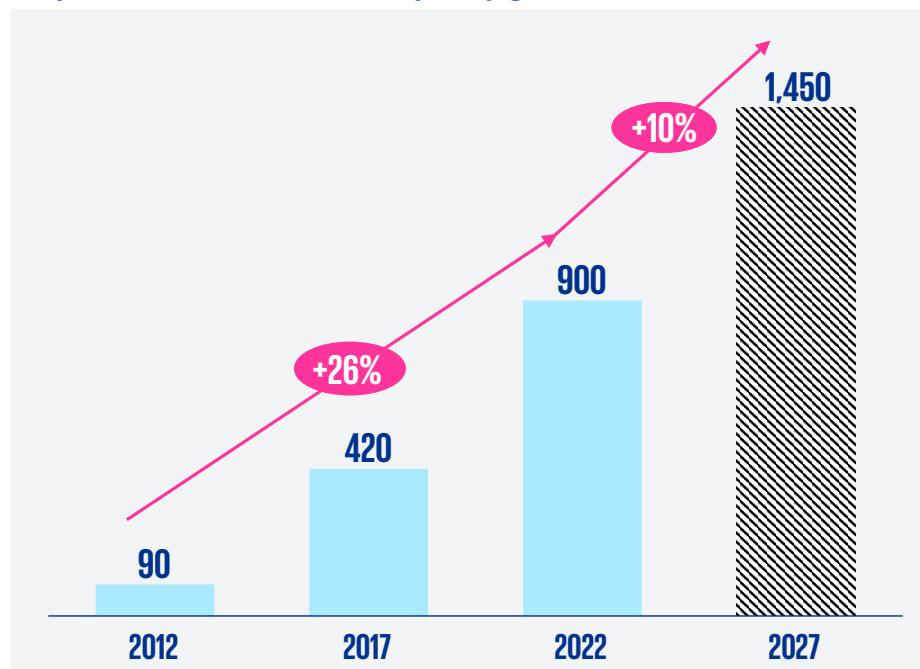
CASE STUDIES

Hyperscale DC investors

Ireland currently has over 70 DCs in operation. Colos account for some 25% of capacity, whilst hyperscalers account for about 74%, with Amazon, Microsoft, Facebook, and Google all represented in Ireland, and interest from Asia-Pacific technology firms looking to expand their DC footprint to Europe (e.g., TikTok, Alibaba and Huawei) further brightening prospects.

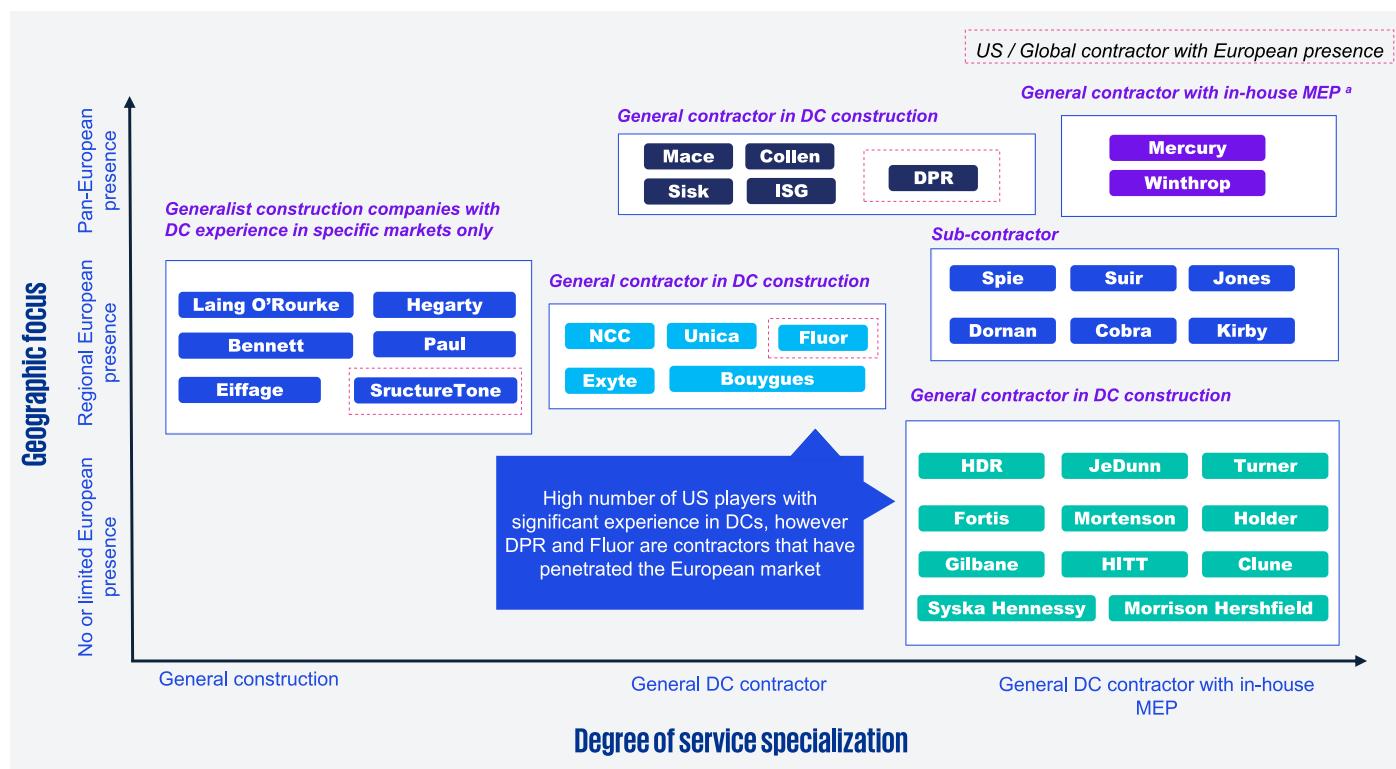
This growth story and the credibility it has lent to the Irish DC construction sector has enabled it to play disproportionately in opportunities across Europe, making the geographic expansion of the sector an exciting opportunity for investors.

Projected Irish data center capacity growth (MW)⁷



The European market is dominated by Irish and UK players, although on a local level there are smaller regional players.

Indicative players in the DC construction value chain.⁸



⁷ KPMG analysis based on Host In Ireland report figures

⁸ KPMG analysis, Notes: (a) Turnkey contractor with in-house mechanical and electrical engineering capability

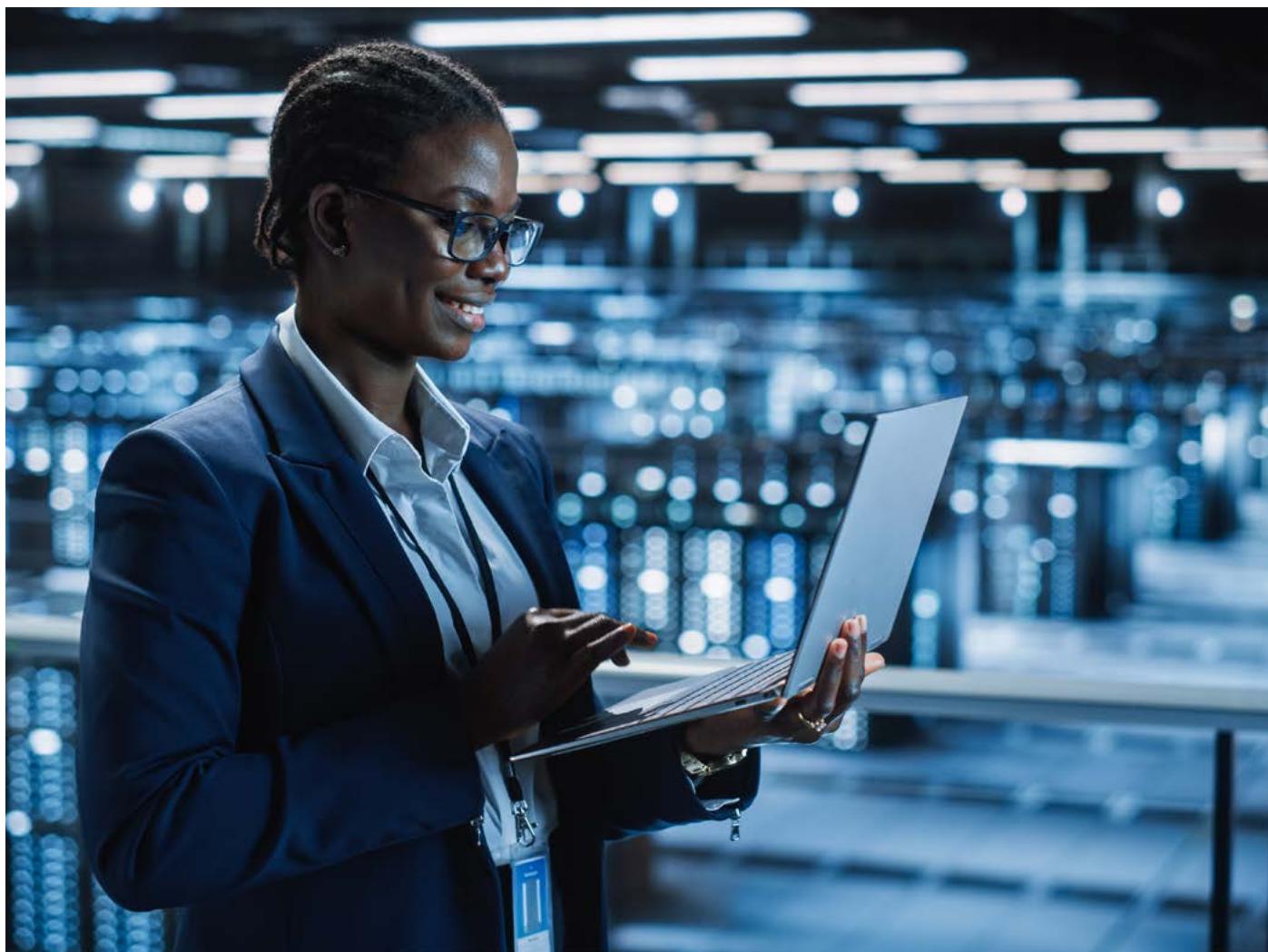
CASE STUDIES

However, there are challenges to overcome – particularly regarding power supply. With data centers accounting for 14% of the country's energy use in 2021 (up from 5% in 2015)⁹, making progress on increased power supply, energy independence and renewables will be key to maintaining an open and competitive market.

The situation prompted the Irish government to issue a statement on the situation in July 2022. "The capacity constraints experienced by our electricity system today, and the binding carbon budgets that require rapid decarbonization of energy use across all sectors, necessarily mean that not all existing demand for data center development can be accommodated."¹⁰

The sector, possibly anticipating a slight shift in tone, is showing its agility by already adapting to change. For example, Bord na Móna, a diversified energy company is developing a massive renewables 'energy park' in Ireland's midland region. The huge project involves a 3,000 hectares site and sits around 40 miles west of Dublin's major cloud campus. The company anticipates that the combination of wind, solar, and hydrogen energy produced on the site, will appeal to heavy energy users like DCs.

This approach of strategically developing renewable power creation campuses adjacent to DCs is likely to be replicated in the established and emerging DC metros of Europe, but will require increased coordination between power suppliers, DC construction firms and hyperscalers.



9 Data Centers Metered Electricity Consumption 2021," May 03 2022, <https://bit.ly/3R97wX0>

10 Government of Ireland, "Government Statement on the Role of Data Centers in Ireland's Enterprise Strategy," July 2022 <https://bit.ly/3R9lzMf>

France

How France is evolving into a more nationally distributed market

DCs in France are being deployed at a steady pace, with the country ranking as the 4th largest DC provider in Europe.

A particular strength of the French market is neutral DCs. A neutral DC is defined as a building managed by a colocation player and hosting DCs of external companies. Since 2012, France has experienced annual growth of 5.7% in its number of neutral DCs, to reach approximately 200 neutral DCs in 2020. France has 3% of the world's neutral DCs, ranking as the 6th largest hosting country in the world, at the same level as countries like Japan and Canada. France has 11% of neutral DCs in Europe, positioning itself as the 4th hosting country Europe behind Germany, the Netherlands, and the United Kingdom.

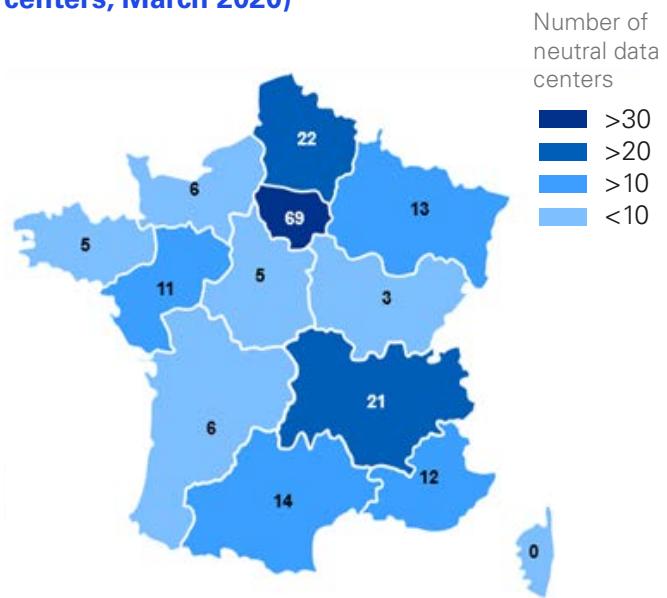
DCs in the country are still largely concentrated in the Île-de-France region surrounding Paris, the area of choice for CIOs because of the density of the electrical and telecommunications networks.

However, like other European countries, energy efficiency is a central issue for the industry. The industry must implement energy improvement levers to meet the Climate Neutrality Pact by 2030 while DC power demands on the energy grid Île-de-France will be a factor in planning new builds in that region. This has been one factor driving DC investment from Paris to Tier 2 locations in the country.

Already, by March 2020, 118 neutral DCs in France were located in the regions (i.e. 63%), while 69 of them were concentrated in Île-de-France (i.e. 37%). However, regionalization of DCs is as much driven by the growing needs of small and medium enterprises (SMEs) as it is by power considerations, in order to:

- Facilitate maintenance and outsourcing operations
- Reduce latency and energy consumption related to data transport
- Anticipate technological trends pushing for localization such as edge computing

Distribution by region of the 187 neutral data centers in France (Number of neutral data centers, March 2020)¹¹



In the regions, competition is intensifying between DC managers, as in the Lyon region with the launch of the largest regional data center "DC Rock" by Jaguar Network, the opening of a second site by the ESN Xefi and the arrival of a newcomer, hosTELyon.

CASE STUDIES

Singapore

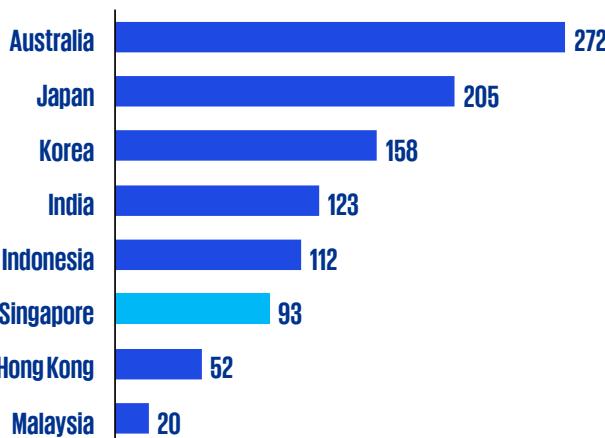
How the city-state is overcoming regulatory and structural impediments to growth by committing to technological innovation

Singapore is widely reputed as a leading DC hub both regionally and internationally. It hosts a significant DC market despite its higher property prices, build-up and operating costs relative to other countries.

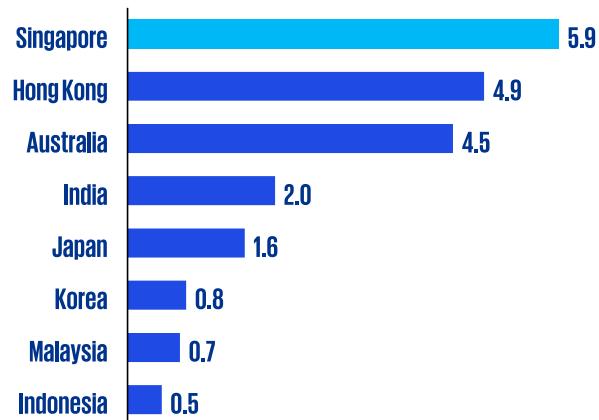
Established as a leading location in Asia Pacific for colocation, US and China headquartered technology companies with hyperscale preference, including Amazon Web Services, Microsoft, Tencent and China Telecom, are increasingly developing their data centers in Singapore.

While Singapore houses fewer data centers relative to other countries in Asia Pacific, its data centers typically have higher processing capacity relative to its counterparts.

Total number of data centers in Asia-Pacific, 2021¹²



2021 Total capacity of data centers in APJ (Rack space, million square feet)¹³



However, there are headwinds to be navigated in Singapore's DC market. These challenges are primarily on the regulatory and operational fronts, driven by greater pushes for sustainability and energy efficiency by local authorities.

Singapore currently relies heavily on natural gas. DCs are projected to consume approximately 12 per cent of Singapore's total energy consumption by 2030. Notably, the state has recently lifted a three-year moratorium on new DCs in January 2022 which aimed to curb the impact of DCs on the energy grid.

The resources that DCs typically consume is amplified in Singapore due to its tropical climate and limited land availability, translating to higher operating costs for data center operators. The cost of cooling is one of the key competitive disadvantages¹⁴ that Singapore faces when hosting DCs as DCs should ideally operate at below 21 degrees Celsius.

12 Sgtech.org.sg, "Driving a Sustainable Data Center Future in Singapore's Digital Economy", May 2022, <https://bit.ly/3Svfg6P>

13 Sgtech.org.sg, "Driving a Sustainable Data Center Future in Singapore's Digital Economy", May 2022, <https://bit.ly/3Svfg6P>

14 The Straits Times, "Data center rents in S'pore set to keep rising amid high demand, limited supply", July 11 2022, <https://bit.ly/3Sazxi2>

CASE STUDIES

Furthermore, land constraints mean that DCs are high-rise buildings, requiring more energy to facilitate cooling and air flow compared to their low-rise counterparts in Europe.

So how has Singapore managed to remain relevant as a Tier 1 DC location? The unique challenges faced by Singapore also position Singapore headquartered data center services companies to capitalize on the evolution of the market by driving innovation. These companies may have a greater incentive to develop novel designs such as floating DCs and more efficient, cost-effective builds. For example, Singapore-based ST Engineering has entered the data center cooling market with cooling technology that aims to achieve 20 per cent energy savings for data center operators in tropical climates.

Singapore's ability to punch above its weight has transformed it into a global powerhouse for technological innovations. Its efforts to overcome its natural resource constraints have spurred it to become an incubator of new ideas and technologies, including those related to data centers.

These characteristics make Singapore a valuable case study for European cities like Dublin seeking similar growth opportunities and solutions to similar pain points as Singapore.

On the whole, Singapore as a case study offers insight into how European cities can manage the deepening social and regulatory scrutiny on data center construction and operation due to their energy intensity.

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Singapore's data center operators and service providers are diverting more resources to technological innovation. Considering Singapore's limited land availability and high cost of cooling, these players can leverage opportunities in floating and underwater data centers in their future ventures.

Gopi Rengasamy,
Director, KPMG Strategy
Singapore



Conclusion

Prospects in Europe's DC sector look robust in the coming decade, but active management is still needed to ensure that looming constraints do not become bottlenecks and Europe is able to deliver the double-digit growth needed to ensure data resilience.

We conclude with some key implications by stakeholder:

PE investors in the value chain

- With widely varying jurisdictional responses to DCs, sober due diligence will be needed when investing in the sector as it expands to new geographies.
- Require detailed business responses to regulatory challenges especially around sustainability and data sovereignty.
- Consider the risk of technological disruption (by e.g., quantum computing) leading to stranded assets.

Engineering and construction

- Next-gen European DC capacity is increasingly outside FLAP locations – but not all local supply chains are equal, don't miss the opportunity for greater consolidation in the European DC construction market.
- Efficiency standards will continue to rise in Europe, and efficiency leadership will be a greater competitive advantage than in other geographies. How much further can design for energy efficiency – including reuse – go?
- Consider whether it is possible to incorporate low-carbon energy production into new DC design plans, and consider the commercial partnership(s) needed to realize this.
- With construction demand running up against supply side constraints, management teams face a tricky balance between the pursuit of growth in new markets and continued quality of service for existing customers.
- Consider development of built-in energy sources and microgrids to boost energy independence.
- An experienced team is the key criteria for operators, with senior team members generally well known within the industry.
- Modular design and construction can further improve build efficiency.

Colocation providers

- With sustainability credentials increasingly critical to business success, consider whether existing stock and new facilities can source low-carbon energy, whether through power purchase agreements, renewable energy certificates, or even bespoke renewable assets. Ability to demonstrate and quantify emissions impact will be increasingly critical to sourcing and retaining business.
- Staffing and up-skilling will be major focus areas for operational strategies. Consider educational initiatives and other upstream interventions to secure the labor force necessary to meet demand.
- Targeted incentives for young people may be necessary, including education, training, flexible working, and other benefits.

Policy makers and regulators

- With the backlash against DCs in some geographies, it may be necessary to educate policymakers on the functions of DCs and their importance to the modern economy.
- DCs are critical infrastructure – ensure that regulation in pursuit of sustainability or other goals is proportionate and sensitive to the industry's growth potential.
- Jurisdictions whose grids and (low carbon) power production capacity – renewable or nuclear – can accommodate DCs in urban centers will be better placed to pitch themselves as DC hubs. Oslo, with its low-cost hydropower, is an example. This needs to be reflected in national or city-level energy strategies.

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Produced by: KPMG's Creative Services. Publication Date: November 2022. (8577)