Green data centres:

Singapore's sustainable data centre opportunity

April 2022

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Background information on research

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This report should be cited as follows: "AlphaBeta (commissioned by Amazon Web Services) 2022, Singapore's sustainable data centre opportunity."

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Insights at a glance

Several key drivers enable the growth of data centres in Singapore. They include the rise of e-commerce and other strategic growth areas such as Artificial Intelligence and Machine Learning, the digital transformation of businesses and the Government as a result of COVID-19 (including significant demands from contact tracing and vaccine operations) and the Government's strategic efforts that rely on data management and analytics (including the "Singapore 2030 Green Plan"). At the same time, government stakeholders have raised concerns about the significant environmental impacts of data centres (with limited direct economic payoffs), which has led to the 2019 imposition of a two-year moratorium on new data centre construction in Singapore.[1] This remained in place until January 2022, when the Government announced plans to pilot a new framework designed to ensure that new data centres be resource-efficient and a contributor to Singapore's economic and strategic objectives.[2]

This research aims to inform the ongoing discourse by providing a precise, fact-based analysis of the current economic and environmental contributions of Singapore's data centres, as well as how the industry could evolve under different scenarios from now until 2030. It also outlines some critical actions required from the Government and the industry to ensure the latter's sustainable, long-term development. The Government plays an essential role in creating an enabling environment conducive to a smooth transition into a green data centre – by establishing new standards (as is called for under the new framework to facilitate the calibrated growth of data centres), by enabling further innovation and by overcoming challenges to clean energy procurement.

Data centres are critical to Singapore's continued economic competitiveness and relevance as a global business hub

> Today, Singapore's data centre industry contributes over **SGD2 billion** to its economy annually.

> **1.6 million jobs** in Singapore are enabled by cloud computing services provided by local data centres.[3] While direct employment by data centre operations is limited (approximately 25,000 jobs), these jobs are highly productive and high paying (35% higher wages and 2.6 times higher labour productivity as compared to the national average).[4]

> Locating data centres in Singapore reduces business costs for Singapore-based businesses due to lower compliance and telecommunication costs. The local data centre infrastructure also enables the lower latency required for data-driven services.

> Around 7,000 multinational corporations (MNCs) have located their base in Singapore, of which 4,200 have regional HQs that are largely dependent on local data centres.[5] Local data centres also help increase data security and resilience by reducing disaster-related and geopolitical risks for businesses located in Singapore. This in turn drives innovation and is a strong motivator for MNCs to base their operations in Singapore.

> Today, cloud data centres in Singapore are already more efficient than on-premise data centres. Moving computing workloads from on-premise data centres to hyperscale cloud facilities in Singapore is estimated to reduce the carbon footprint of businesses and organisations by an average of **at least 78%**.[6]

Our analysis estimates that Singapore customers' use of data services will grow four times by 2030, mainly driven by government policies and plans, further increasing the relevance of local data centres

> Singapore customers' data usage could increase **4 times** by 2030.

> Up to 75% of the country's data demand relates to data where location proximity is crucial.

> A "green growth" scenario in data centre sustainability can lead to over **2.8 times** increase in jobs and **8.9 times** increase in economic contribution. The same scenario may also lead to slower growth in energy consumption and **90%** lower carbon emissions than today's levels.

> Removing hyperscale data centres from Singapore could lead to higher usage of on-premise data centres (due to location proximity required) and a **241%** increase in energy consumption, resulting in carbon emissions.

1. Ministry of Communications and Information, Singapore (2021), "MCI's response to PQ on data on current and expected 2021 total carbon emissions by data centres in Singapore and efforts to reduce emissions for data centres", Available at: https://www.mci.gov.sg/pressroom/news-and-stories/pressroom/2021/7/mci-response-to-pq-on-data-on-current-and-expected-2021-total-carbon-emissions-by-data-centres-in-singapore-and-efforts-to-reduce-emissions-for-data-centres
2. Business Times (2022), "New data centres in Singapore to meet higher standards when moratorium lifts in Q2 2022", Available at: https://www.businesstimes.com.sg/companies-markets/new-data-centres-in-singapore-to-meet-higher-standards-when-moratorium-lifts-in-q2
3. This includes about 25,000 jobs due to presence of physical data centres in Singapore, around 496,000 jobs that involve transition from on premises-based IT environments to cloud environments, and designing and refining new cloud and hybrid architecture patterns (typically in partners/ ICT sectors) and another 1,175,000 jobs that that involve using cloud-based software-as-a-service (SaaS) applications and tools (e.g., finance jobs requiring using cloud tools)
4. This is compared to Singapore's median monthly salary and labour productivity. The median monthly salary for data centre employees is SGD6,128, which is higher than the median of Singapore at SGD4,534. Similarly, labour productivity of data centre workers is estimated at SGD147,000, which more than doubles the national average of SGD56,000.
5. Accounting and Corporate Regulatory Authority (2009), Committee to Develop the Accountancy Sector. Available at: https://www.acra.gov.sg/docs/default-source/default-document-library/legislation/listing-of-consultation-papers/cdas-public-consultation-on-transforming-singapore-into-a-leading-global-accountancy-hub/cdaspublicconsultation_9dec09.pdf
6. Amazon (2021), "AWS Cloud can help lower carbon footprints in Asia Pacific". Available at: https://www.aboutamazon.com/news/aws/aws-cloud-can-help-lower-carbon-footprints-in-asia-pacific

Through a close partnership between the Government and industry, Singapore can become a Sustainable Data Centre Hub without trade-offs between economic or sustainability goals

> Highly ambitious, cross-industry collaborative models from other jurisdictions, such as the European 'Climate Neutral Data Centre Pact'[7], could serve as a model for developing and managing sustainable criteria for data centre expansion in Singapore.

> Combining data centre sustainability criteria with other supporting policies will enable greater access to clean energy procurement options, and remove regulatory blockers to innovation in data centre design, such as in energy, water, and land use.

> Supporting the development of sustainability-related innovation and new approaches for data centres in Singapore (which could be exported across the region) would not only enhance Singapore's status as a regional hub for business development and innovation, but also ensure that the growing neutral demand continues to be met with best-in-class local data centres.

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7.   Climate Neutral Data Centre (n.d.), "Self-Regulatory Initiatives". Available at: https://www.climateneutraldatacentre.net/self-regulatory-initiative

The contribution of data centres

Singapore has become an important regional and international hub for data centres, which has created significant economic and employment benefits locally. The data centre industry in Singapore contributes over SGD2.0 billion in annual Gross Domestic Product (GDP). At the same time, data centres also enable up to 1.6 million jobs across the country.[8] Additionally, the presence of data centres is crucial for the businesses in Singapore, as it ensures reliable access to low latency services for businesses and consumers, enhances disaster resiliency, reduces geopolitical risks, and ensures Singapore's continued status as a regional hub. Data centres also leverage digital technologies which enable decarbonisation of the rest of the economy.

8. This includes about 25,000 jobs due to presence of physical data centres in Singapore, around 496,000 jobs that involve transition from on premises-based IT environments to cloud environments, and designing and refining new cloud and hybrid architecture patterns (typically in partners/ ICT sectors) and another 1,175,000 jobs that that involve using cloud-based software-as-a-service (SaaS) applications and tools (e.g., finance jobs requiring using cloud tools)

Several trends are fuelling the growth of data centres

The number of data centres is expected to rise over the next decade, driven by four key trends:

> **Singapore will continue to witness substantial growth in e-commerce and other digital services.** As a result of the pandemic, restricted travel and social gatherings have significantly reduced footfall to traditional "brick-and-mortar" retail stores. As a result, many businesses have moved their operations online to meet growing consumer demand for online goods and services, such as digital payments and digital platforms for food delivery. According to the e-Conomy SEA 2021 report published by Google, Temasek & Bain, Singapore's Internet economy is projected to increase 16% per annum — from SGD20 billion in 2021 to SGD36 billion in 2025.[9] This annual growth of 16% is significant, representing more than double Singapore's GDP growth rate today.[10] The same study found that consumers surveyed consumed an average of 2.9 times more digital services since the pandemic began, with 99% of them intending to continue using these services going forward. This shift towards e-commerce and digital services will only increase demand for data and low latency services, spurring the growing need for local data centres.

> **Evolving government needs such as smart city initiatives are fast-tracking cloud adoption and usage.** Since 2018, the Singapore Government has been migrating most of its information technology (IT) systems from on-premises data centres to commercial clouds as part of a five-year plan cloud migration plan. This shift aims to speed up the delivery and improve the quality of online services for its citizens and business ecosystem. As of 2020, more than 150 systems have migrated to a commercial cloud, and over SGD870 million of contracts have been awarded in view of doubling the number of systems on commercial clouds. Similarly, Singapore's smart city initiatives rely on growing the usage of advanced technologies, such as smart meters and smart urban mobility, which requires

sizable cloud services. Meanwhile, COVID-19 unexpectedly accelerated the Government's digital transformation and cloud-based needs when Singaporeans became reliant on remote work, home-based learning and various other COVID-19 — responses such as contact tracing and vaccine operations

> **Digital adoption by businesses have taken a quantum leap, bolstered by the pandemic.** Due to the COVID-19 crisis, many businesses have had to accelerate their digitalisation efforts in order to protect employees and better serve customers. According to a McKinsey Global Survey conducted in 2020, companies have accelerated the digitalisation of their supply chain and internal operations by three to four years as a result of the pandemic.[11] Similar trends can be observed across Singapore, where adoption rates of advanced digital technologies by businesses increased by 14% from 2018 to 2020 alone.[12] Additionally, cloud spending in the Asia-Pacific (APAC) region is expected to double from the current 5% to 10% of the average Information Technology (IT) budget by 2023,[13] once again pointing to the ever-increasing need for more data centres.

> **Cost and sustainability considerations increasingly lead businesses from on-premise to cloud data centres.** Cloud data centres can save businesses, on average, 13 to 36% of IT costs based on their higher efficiency, security and sustainable practices.[14] In addition, as corporate responsibility becomes increasingly important, businesses are keen to work with data centre providers to develop reliable sustainability strategies that deliver long-term business value. A recent survey of over 500 enterprises and public sector organisations from across APAC — with more than 100 in Singapore alone — found that the average organisation could expect to reduce its carbon footprint by more than 78% simply by moving the IT workloads from on-premises data centres to the cloud.[15]

9. Google, Temasek, and Bain & Company (2021), *e-Conomy SEA 2021*. Available at: https://services.google.com/fh/files/misc/e_conomy_sea_2021_report.pdf?utm_source=twg&utm_medium=article&utm_campaign=2021

10. Sources include Google, Temasek, and Bain & Company (2021), *e-Conomy SEA 2021*. Available at: https://services.google.com/fh/files/misc/e_conomy_sea_2021_report.pdf?utm_source=twg&utm_medium=article&utm_campaign=2021; and Business Times (2021), "Singapore's growth forecast at 'around 7%' for 2021, 3-5% for 2022". Available at: https://www.businesstimes.com.sg/government-economy/singapores-growth-forecast-at-around-7-for-2021-3-5-for-2022

11. McKinsey (2020), "How COVID-19 has pushed companies over the technology tipping point—and transformed business forever". Available at: https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/how-covid-19-has-pushed-companies-over-the-technology-tipping-point-and-transformed-business-forever

12. Straits Times (2020), "Over half of SMEs in Singapore blame digitalisation delay on coronavirus". Available at: https://www.straitstimes.com/singapore/over-half-of-smes-blame-digitalisation-delay-on-virus

13. BCG (2020), "Businesses in Asia-Pacific Can Find Resilience and Growth in the Cloud". Available at: https://www.bcg.com/publications/2020/businesses-asia-pacific-find-resilience-growth-in-the-cloud

14. S&P Global (2021), "Enterprises are missing out on 24B by not optimizing cloud spending not going multicloud". Available at: https://www.spglobal.com/marketintelligence/en/news-insights/blog/enterprises-are-missing-out-on-24b-by-not-optimizing-cloud-spending-not-going-multicloud

15. Amazon (2021), "AWS Cloud can help lower carbon footprints in Asia Pacific". Available at: https://www.aboutamazon.com/news/aws/aws-cloud-can-help-lower-carbon-footprints-in-asia-pacific

Singapore: Asia and the world's leading data centre hub

Singapore is a leading data centre hub globally due to its efficient digital and power infrastructure, business-friendly environment, highly-skilled workforce and stable political climate.[16] According to Cushman and Wakefield, global financial and innovation hubs such as New York, Silicon Valley and London are also recognised as top data centre markets.[17] Like Singapore, locating data centre regions near these global hubs has been a critical growth driver, affording local businesses easier access to their customers and service providers.[18] New York and London, for example, have at least 60 colocation facilities in each city to meet the already high (and growing) demand for digital services.[19]
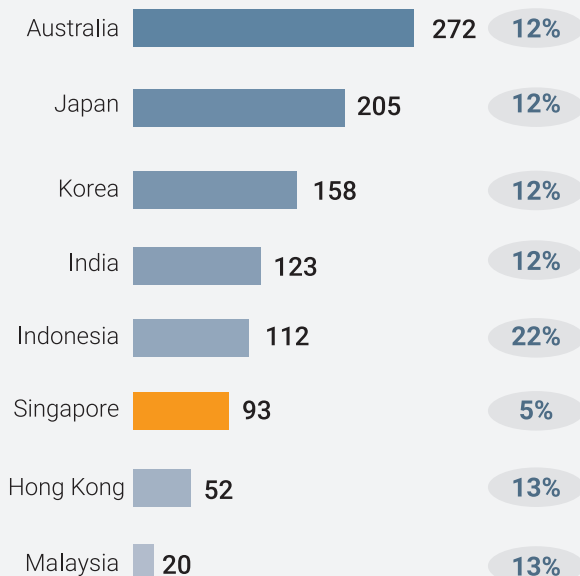
In recent years, demand for data centres in APAC has been increasing steadily, and Singapore, being a key business hub in the region, is no exception. The number of data centres in APAC, such as Australia, Japan, Indonesia, and India, have grown at over ten per cent per annum in the past five years (Exhibit 1). While Singapore homes a smaller number of data centres than other countries in the region, it is a leader in terms of data centre capacity. As of 2021, Singapore's data centres boast close to six million square feet of rack space, exceeding the capacity of countries that have more than double the number of data centre facilities, such as Australia and Japan (Exhibit 1).
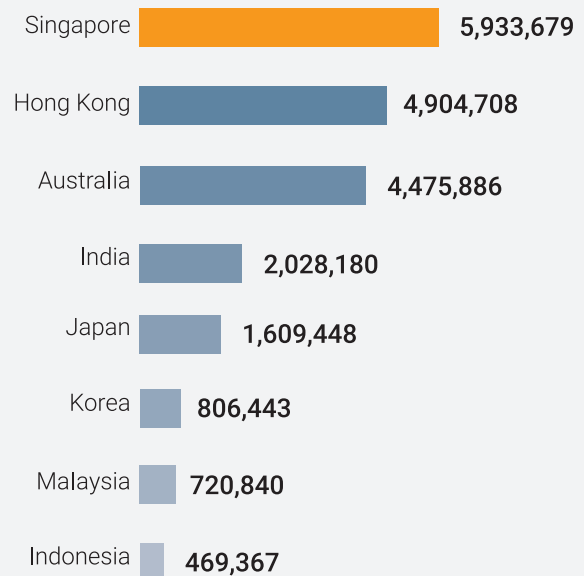
Exhibit 1	**Singapore is a leading data centre hub with higher capacity despite having less data centres**

Number of data centres by country; 2021
Percent annual growth over last 5 years

Country	Number	Growth
Australia	272	12%
Japan	205	12%
Korea	158	12%
India	123	12%
Indonesia	112	22%
Singapore	93	5%
Hong Kong	52	13%
Malaysia	20	13%

Capacity of data centres by country; Rack space, sq. ft, 2021

Country	Rack space
Singapore	5,933,679
Hong Kong	4,904,708
Australia	4,475,886
India	2,028,180
Japan	1,609,448
Korea	806,443
Malaysia	720,840
Indonesia	469,367

Note: The numbers on this slide could include the captive data centres. However, the list of captives covered is not exhaustive.
SOURCE: Statista; Cushman & Wakefield

16. Singtel (n.d.), "9 reasons why Singapore's the ideal DC hub in Asia Pacific". Available at: https://www.singtel.com/business/articles/9-reasons-why-singapore-is-the-ideal-data-centre-hub-in-asia-pac
17. Cushman & Wakefield (2021), *Data Centre Market Comparison*. Available at: https://cushwake.cld.bz/2021-Data-Center-Global-Market-Comparison
18. Sources include AWS (n.d.), "Regions and Availability Zones". Available at: https://aws.amazon.com/about-aws/global-infrastructure/regions_az/; and Equinix (n.d.), "Why choose Silicon Valley data centers?". Available at: https://www.equinix.se/data-centers/americas-colocation/united-states-colocation/silicon-valley-data-centers
19. Sources include Datacenters.com (n.d.), "New York". Available at: https://www.datacenters.com/locations/new-york; and Datacenters.com (n.d.), "London". Available at: https://www.datacenters.com/locations/London
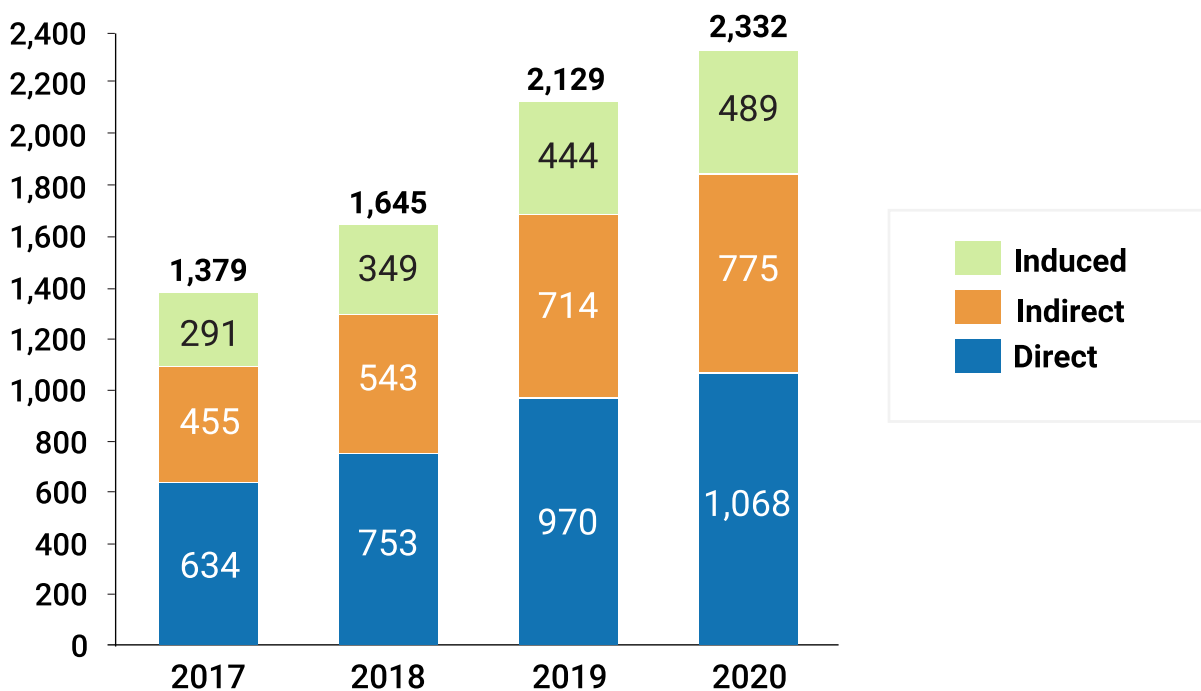
Singapore's data centre industry contributes over SGD2 billion to its economy annually

> The data centre industry creates value via three channels: direct, indirect and induced impact (refer to Box 1). The enabled impact is also noteworthy because it includes the wider economic benefits from businesses such as new revenue opportunities due to low latency data services and lower regulatory costs. For this study, we have quantified the direct, indirect and induced impacts, and have depicted the enabled impact through empirical evidence.

> Direct investments and expenditures on data centres in Singapore has resulted in value-add estimates that swelled from SGD634 million in 2017 to SGD1,068 million in 2020. Similarly, indirect and induced value-add estimates have also increased over the same period and are estimated to be SGD775 million and SGD489 million in 2020, respectively. As a result, the total gross value added (GVA) from data centres has steadily increased over the years, from SGD1.4 billion in 2017 to SGD2.3 billion in 2020 (Exhibit 2), despite the moratorium in 2019.

Exhibit 2 **The SGD2 billion annual contribution of data centres is nearly half the total retail sector and larger than Singapore's entire hospitality sector**

Data centre investment and expenditure on output (GVA) in Singapore;
SGD millions

	2017	2018	2019	2020
Total	1,379	1,645	2,129	2,332
Induced	291	349	444	489
Indirect	455	543	714	775
Direct	634	753	970	1,068

SOURCE: AlphaBeta analysis

Box 1. **The estimated economic impact of data centres in Singapore**

Economic impact analysis provides a rules-based methodology for evaluating the economic significance of data centres to an economy. The economic impact of Singapore's data centres in terms of gross value added and employment was studied at four levels:

1. Direct impact refers to direct spending on data centres, including investment, capital expenditure, and operating expenditure.

2. Indirect impact refers to the supply chain effects that are stimulated from direct spending on data centres. For example, data centre expenditure on domestic providers of construction or utility services will increase output for suppliers of these service providers.

3. Induced impact refers to spending by data centre and supply chain workers across all sectors in the economy.

4. Enabled impact refers to benefits to the economy from businesses having access to lower latency or more secure digital services.

Gross output multipliers and employment multipliers were derived from Singapore's Input-Output (IO) tables to calculate the impact of its data centres on the economy. An IO table shows the relationship between an initial shock (such as investment spending on construction of new data centres) and final output across the whole economy. Both Type I and Type II multipliers were calculated in this study. The Type I multiplier shows the direct and indirect impact along the supply chain, while Type II multiplier factors in the induced impact that arises from workers spending their wages on goods and services. IO tables were obtained from Singapore's national statistics website and aligned with existing literature.[20]

For this study, enabled impacts are depicted using empirical evidence and quantitative assessment (for employment impact).

20. Sources include HIS Markit (2019), *The economic contribution of Facebook data centres in Denmark, Ireland, and Sweden*. Available at: https://tech. fb.com/wp-content/uploads/2019/12/The-economic-contribution-of-Facebook-EU-data-centres-with-cover-image_final.pdf; and Copenhagen Economics (2015), The economic impact of Google's data centre in Belgium. Available at: https://www.copenhageneconomics.com/dyn/resources/Publication/publicationPDF/1/301/1435043322/the-economic-impact-of-googles-data-centre-in-belgium-2.pdf

### While direct employment in data centres is low, data centres enable over 1.6 million jobs in Singapore

Data centres employ around 7,000 people around the country, including technicians and workers, each earning approximately 35% higher median wages with 2.6 times higher labour productivity than the national average.[21] Another 17,000 jobs in Singapore are related to supply chain of data centres. Besides this direct employment, in Singapore, 1.6 million jobs accounting for approximately 70% of the resident labour force, are enabled by the availability of low-latency cloud services. To date, 496,000 cloud implementation jobs (jobs involved in the transition from on premises-based IT environments to cloud environments and/or the designing and refining of new cloud and hybrid architecture patterns), and another 1.2 million cloud-enabled jobs (jobs that use cloud-based, software-as-a-service applications and tools) have been generated as a result of data centres being located in Singapore (all from Exhibit 3).

Exhibit 3 — **While direct employment with data centres may be small, the industry enables over 1.6 million workers in Singapore**

Total number of jobs related to cloud services in Singapore, 2021

Data centre jobs	7,000
Supply chain jobs	17,000
Cloud implementation jobs	496,000
Cloud enabled jobs	1,175,000
Total	1,695,000
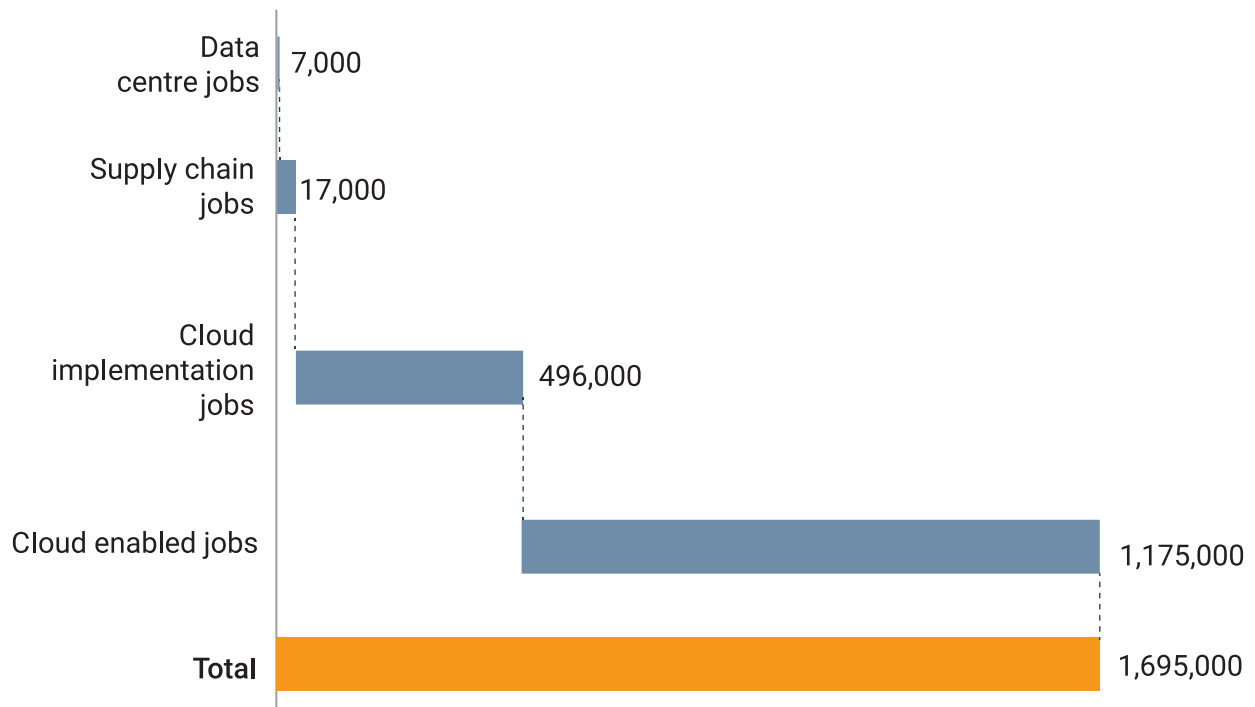
SOURCE: AlphaBeta analysis

21. This is compared to Singapore's median monthly salary and labour productivity. The median monthly salary for data centre employees is SGD6,128, which is higher than the median of Singapore at SGD4,534. Similarly, labour productivity of data centre workers is estimated at SGD147,000, which more than doubles the national average of SGD56,000.
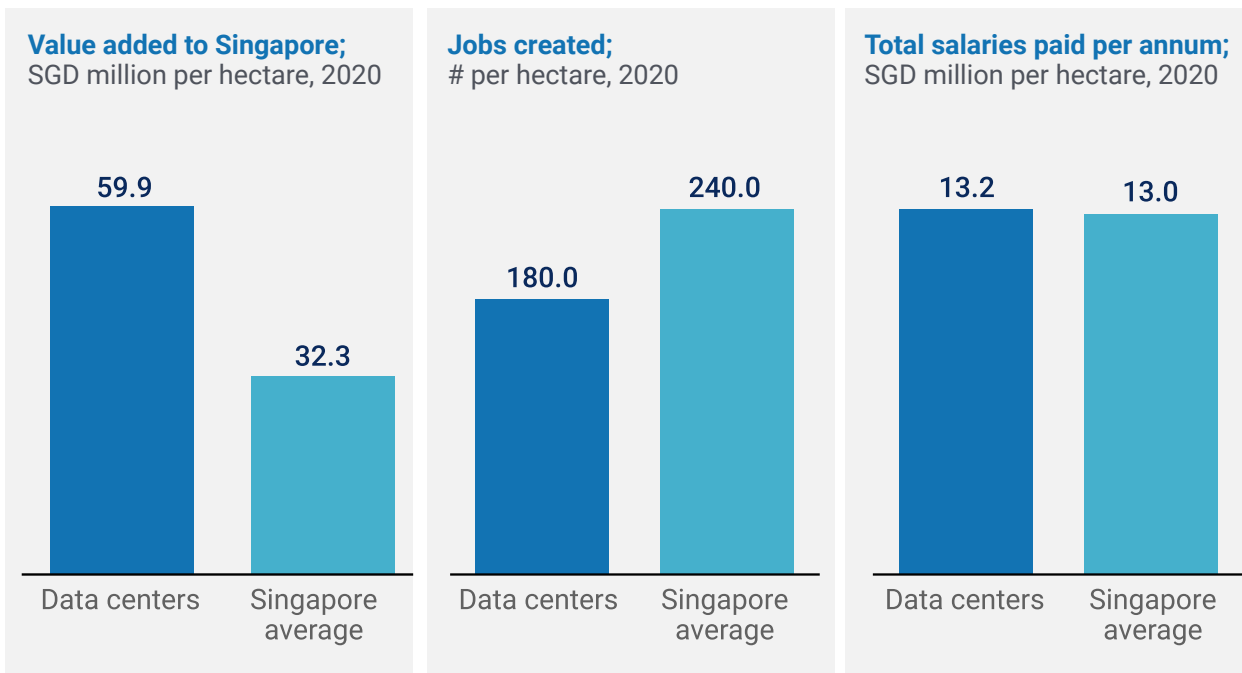
Data centres have 85% higher land productivity than average land use in Singapore which is vital considering its land constraints

The gross value added by the data centre industry to Singapore's economy is an estimated SGD59.9 million per hectare, almost double the national average. In addition, while data centres generate 180 jobs per hectare (lower than the national average of 240 jobs per hectare), the wage contribution of data centres is higher than the national average, at SGD13.2 million per hectare due to the higher wages per employee (Exhibit 4).

Exhibit 4

On a per hectare basis, data centres also deliver more economic value than other sectors in Singapore

Value added to Singapore;
SGD million per hectare, 2020

	Data centers	Singapore average
	59.9	32.3

Jobs created;
per hectare, 2020

	Data centers	Singapore average
	180.0	240.0

Total salaries paid per annum;
SGD million per hectare, 2020

	Data centers	Singapore average
	13.2	13.0

SOURCE: Singapore Statistics; JTC Corporation; AlphaBeta analysis

Local data centres are critical to Singapore's competitiveness as a regional business and technology hub

To reiterate, Singapore-based data centres are crucial for industry competitiveness because they (i) deliver cost reductions for local businesses and supporting innovations; (ii) enhance disaster resiliency; (iii) reduce geopolitical risks; and (iv) encourage multinational firms to locate the regional headquarters in the country.

01 Reducing costs for local businesses and supporting innovations

Having local data centres significantly reduces business costs, including regulatory compliance and telecommunications costs, for many. Not only do overseas data centres incur higher regulatory compliance costs, they often require additional resources so as to comply with regulations across multiple jurisdictions, including data localisation laws and consent requirements. This not only results in restrictive business environments but hinders business growth as well.[22] Mastercard, for instance, spent 35% of its SGD1.4 billion investment in India on localisation compliance alone.[23]

For Singapore to truly become a Smart Nation, local industries must have reliable access to strong network connectivity.[24] Research shows that as the distance to data centres increases, propagation delay between servers will also increase, eventually resulting in more costly telecommunication networks.[25] Local data centres are therefore critical to ensuring Singapore's businesses have reliable access and more affordable telecommunication services.

Increased use of overseas data centres may even result in lost opportunities for Singaporean businesses as a result of higher transaction costs and disruptions or increased latency for high-speed data-driven services. Many sectors rely on fast, dependable and readily available data flow for growth. Take the healthcare sector, for example, which increasingly uses data-intensive telehealth applications like remote patient monitoring and real-time monitoring, while streaming and analysing patient data is reliant on extremely low latency. Similarly, a five millisecond delay in high-frequency trading could lead to a one per cent loss of revenue flow in the financial sector, and a 100-millisecond delay in website load time can lead to a six per cent loss in sales in the e-commerce sector.[26]

02 Enhancing disaster resilience with local data centres

Compared to other data centre hubs, Singapore faces lower disaster risk and higher resilience due to its geographical position and robust infrastructure. Geographically, Singapore is in a low seismic-hazard region and has a low risk of earthquakes and tsunamis.[27] Therefore, if businesses use local data centres rather than those in neighbouring countries with higher disaster risks, such as Indonesia and Malaysia, it is estimated that the businesses could save a considerable SGD7 billion to SGD11 billion, on average, due to lower disaster resilience spending (including insurance premiums).[28]

22. Pideeco (2019), "The rising cost of regulatory compliance for financial institutions". Available at: https://pideeco.be/articles/regulatory-compliance-costs-meaning/
23. ENTRACKR (2019), "Mastercard claiming compliance with RBI norms, begins deleting transactions data stored overseas". Available at: https://entrackr.com/2019/05/mastercard-begins-data-localisation-in-india/
24. The Business Times (2018), "The crucial role of telcos in a Smart Nation". Available at: https://www.businesstimes.com.sg/hub/empowering-enterprise/the-crucial-role-of-telcos-in-a-smart-nation
25. Greenberg, Albert, et al. (2008), "The cost of a cloud: research problems in data center networks.", ACM SIGCOMM computer communication review 39.1 (2008): 68-73. Available at: https://dl.acm.org/doi/abs/10.1145/1496091.1496103
26. Sources include TABB Group (2008), "The Value of a Millisecond: Finding the Optimal Speed of a Trading Infrastructure". Available at: https://research.tabbgroup.com/report/v06-007-value-millisecond-finding-optimal-speed-trading-infrastructure#:~:text=As%20in%20the%20Indy%20500,million%20in%20revenues%20per%20millisecond; and Gigaspaces (2019), "Amazon Found Every 100ms of Latency Cost them 1% in Sales". Available at: https://www.gigaspaces.com/blog/amazon-found-every-100ms-of-latency-cost-them-1-in-sales
27. Lai, Allen Yu-Hung, and Seck L. Tan (2014). Impact of disasters and disaster risk management in Singapore: A case study of Singapore's experience in fighting the SARS epidemic. *Resilience and Recovery in Asian Disasters*. Springer, Tokyo, 2015. 309-336. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7120670/
28. ADB (2020), *Financing Disaster Risk Reduction in Asia and the Pacific*. Available at: https://www.adb.org/sites/default/files/institutional-document/670596/financing-disaster-risk-reduction-asia-pacific.pdf

03 Reducing geopolitical risks

Singapore also has relatively lower geopolitical risks than neighbouring countries including Malaysia, Hong Kong, and Indonesia. According to the Global Innovation Index 2021 by the World Intellectual Property Organization (WIPO), Singapore is a leader in political and operational stability and government effectiveness.[29] Currently, businesses pay an annual political risk premium of SGD32 billion to SGD38 billion across Southeast Asia — which could be significantly reduced if data centres were located in more politically stable environments like Singapore.[30] Furthermore, data localisation requirements from locating data centres in neighbouring countries would negatively impact Singapore firms due to the higher business costs resulting from regulatory restrictions, less efficient technologies and higher risks of being taken over by local governments during a crisis.[31] Therefore, it is strategic for many businesses — and for Singapore — to have a strong contingent of local data centres.

04 Securing Singapore's position as a regional HQ hub for MNCs

Many global institutions cite that access to Info communication and Telecommunication (ICT) and data centre infrastructure is critical to delivering regional business growth. As a result, more international businesses are seeking to locate their regional headquarters (HQs) and regional data centre operations within the same jurisdiction. Out of around 7,000 MNCs in Singapore, 4,200 host their regional headquarters (HQs) here. Companies with regional HQs here are also highly likely to be rely on access to local data centres.[32] A favourable data centre environment will help attract global firms and convince them to locate their regional data centres in Singapore, thereby supporting the expansion of regional technology, and fuelling research and development activities. Without Singapore-based data centres, it could become more challenging for Singapore to secure its regional hub status and attract and retain regional HQs in the country.

29. The Global Innovation Index 2021 captures the innovation ecosystem performance of 132 economies and tracks the most recent global innovation trends. It comprises seven pillars, including institutions, human capital and research, infrastructure, market sophistication, business sophistication knowledge and technology outputs, and creative outputs. Source includes World Intellectual Property Organization (2021), *Global Innovation Index 2021*. Available at: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2021/sg.pdf
30. International Growth Centre (2018), *Political risk insurance and its effectiveness in supporting private sector investment in fragile states.* Available at: https://www.theigc.org/wp-content/uploads/2018/05/Political-risk-insurance.pdf
31. World Economic Forum (2020), "How data residency laws can harm privacy, commerce and innovation - and do little for national security". Available at: https://www.weforum.org/agenda/2020/06/where-data-is-stored-could-impact-privacy-commerce-and-even-national-security-here-s-why/
32. The Business Times (2019), Singapore's hook as a site for corporate treasuries. Available at https://www.businesstimes.com.sg/opinion/singapores-hook-as-a-site-for-corporate-treasuries

Data centre energy efficiencies are improving while carbon footprint has seen relatively slower growth

The share of electricity from renewable sources has remained at a constant 2.8% since 2017, while carbon emissions have grown at a slower pace than Internet demand, as illustrated in the 36% reduction of carbon emissions per unit of Internet capacity from 2017 to 2020.[33] Although the Power Usage Effectiveness (PUE) of data centres in Singapore has improved from 2.00 in 2017 to 1.90 in 2020 (all from Exhibit 5), a considerable 34% of data centres in Singapore continue to register a PUE of over 2.00.[34]

Singapore's data centre industry also comprises energy-efficient hyperscale cloud data centres that boast an average PUE of 1.2 given their higher resource utilisation and sophisticated energy efficiency practices.[35] The average server utilisation rate among Asia Pacific enterprises and public sector organisations is estimated t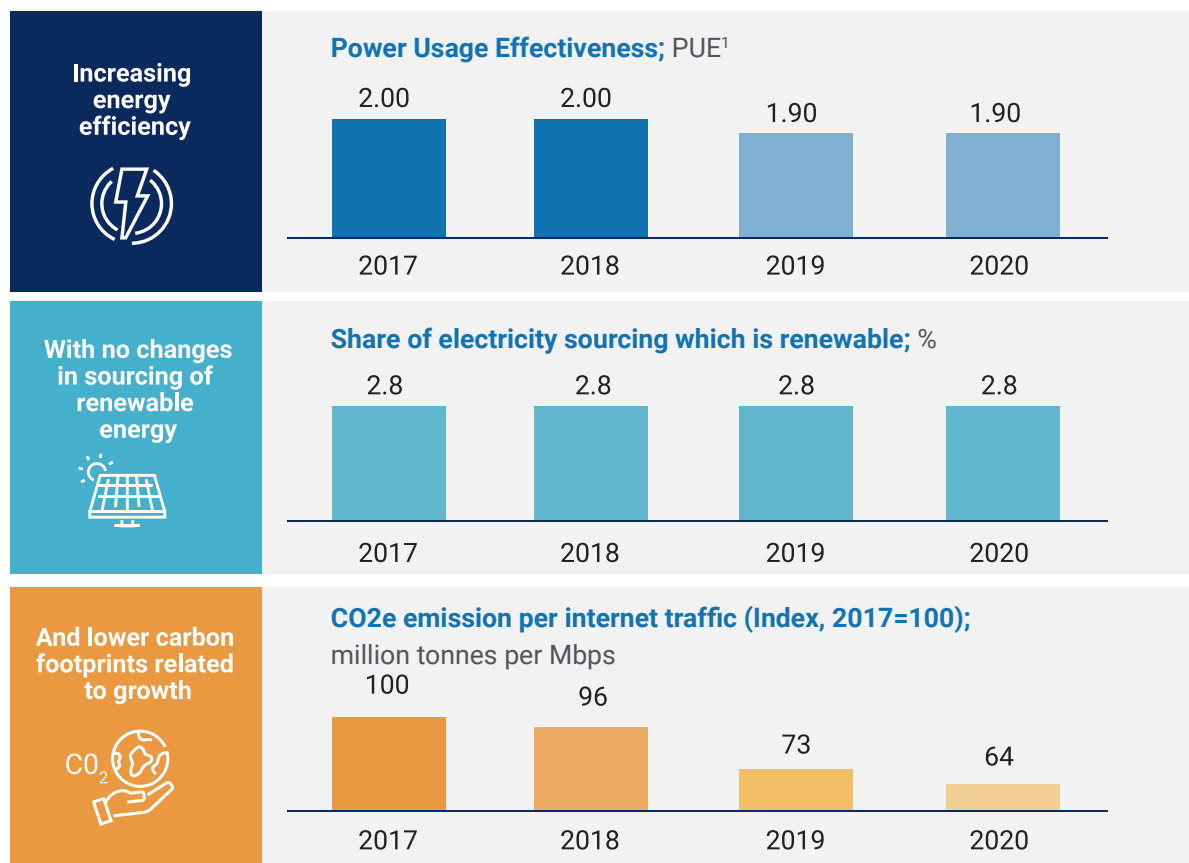o be around just 15%. In contrast, the average server utilisation rate for hyperscale cloud servers begins at 50%.[36] As a result, hyperscale cloud servers can achieve up to 78% reduction in the carbon footprint associated with running IT workloads compared to typical on-premises servers.[37] This comprises 67% due to energy savings and 11% savings from using more efficient power and cooling systems.[38] For Singapore, where there are around 1,300 businesses with more than 250 employees, if just one-quarter of these firms put 1MW of their IT load into the cloud, the energy savings would be equivalent to a year's worth of emissions from over 23,500 Singaporean households' electricity use.[39] It is further estimated that enabling cloud operators to source 100% renewable energy would reduce related emissions by another 15%, which, when combined with the server and facility efficiency gains, could reduce IT infrastructure emissions by up to 93% across APAC.

33. Sources include Infocomm Media Development Authority (2021), "Statistics on Capacity/Bandwidth Services (2015 – 2018)". Available at: https://www.imda.gov.sg/infocomm-media-landscape/research-and-statistics/telecommunications/statistics-on-capacity-bandwidth-services/statistics-on-capacity-bandwidth-services-2015-2018; Energy Market Authority (n.d.), "Singapore Energy Statistics". Available at: https://www.ema.gov.sg/Singapore_Energy_Statistics.aspx; and Infocomm Media Development Authority (2021), "Statistics on Capacity/Bandwidth Services (2019 – 2022)". Available at: https://www.imda.gov.sg/infocomm-media-landscape/research-and-statistics/telecommunications/statistics-on-capacity-bandwidth-services/statistics-on-capacity-bandwidth-services-2019-2022
34. PUE is an indicator that measures the energy efficiency of data centres, and a lower number indicates greater energy efficiency, with the ideal value being one. Source includes AWS (2021), "Meeting Sustainability and Climate Goals with the Cloud". Available at: https://pages.awscloud.com/APAC-public-OE-Meeting-Sustainability-and-Climate-Goals-with-the-Cloud-in-APAC-2021-reg-event.html
35. AWS (2015), "Cloud Computing, Server Utilization, & the Environment". Available at: https://aws.amazon.com/blogs/aws/cloud-computing-server-utilization-the-environment/
36. 451 Research (2021), *The Carbon Reduction Opportunity of Moving to the Cloud for APAC*. Available at: https://d1.awsstatic.com/institute/The%20carbon%20opportunity%20of%20moving%20to%20the%20cloud%20for%20APAC.pdf
37. 451 Research (2021), *The Carbon Reduction Opportunity of Moving to the Cloud for APAC*. Available at: https://d1.awsstatic.com/institute/The%20carbon%20opportunity%20of%20moving%20to%20the%20cloud%20for%20APAC.pdf
38. 451 Research (2021), *The Carbon Reduction Opportunity of Moving to the Cloud for APAC*. Available at: https://d1.awsstatic.com/institute/The%20carbon%20opportunity%20of%20moving%20to%20the%20cloud%20for%20APAC.pdf
39. 451 Research (2021), *The Carbon Reduction Opportunity of Moving to the Cloud for APAC*. Available at: https://d1.awsstatic.com/institute/The%20carbon%20opportunity%20of%20moving%20to%20the%20cloud%20for%20APAC.pdf

Exhibit 5

Energy efficiency of Singapore data centres has increased while their carbon footprint growth has slowed

Increasing energy efficiency

Power Usage Effectiveness; PUE[1]

2017	2018	2019	2020
2.00	2.00	1.90	1.90

With no changes in sourcing of renewable energy

Share of electricity sourcing which is renewable; %

2017	2018	2019	2020
2.8	2.8	2.8	2.8

And lower carbon footprints related to growth

CO_2e emission per internet traffic (Index, 2017=100); million tonnes per Mbps

2017	2018	2019	2020
100	96	73	64

1. Power usage effectiveness (PUE) is a metric used to determine the energy efficiency of a data centre. PUE is determined by dividing the amount of power entering a data centre by the power used to run the computer infrastructure within it. PUE is therefore expressed as a ratio, with overall efficiency improving as the quotient decreases toward 1. A lower number indicates greater efficiency. 34% of respondents in Singapore had PUE of over 2 in a recent survey conducted by 451 research
SOURCE: Structure Research; EMA; IMDA; AlphaBeta analysis

Research has also shown that clouds can create a positive sustainability impact by enabling businesses to accelerate more sustainable outcomes through real-time data insights, improved decision-making and the ability to leverage new business opportunities.[40] Research indicates migration of workloads to the public cloud can reduce global carbon (CO_2) emissions by 59 million tons per year.[41]

TRENDE Inc uses cloud to expand solar power offerings and establish peer-to-peer electricity trading for residential customers in Japan

TRENDE was established in August 2007 as a wholly-owned subsidiary of TEPCO Holdings, on the concept of "changing the world from energy, changing the future with energy". It provides both electricity retail services ("Ashitadenki") for Japanese households, as well as the installation of residential solar power generation systems ("Hotdenki").

All of this was set up in just the span of six months, due to a back-end system built by the company that instantaneously manages massive volumes of data (customer information, power consumption, etc.), with a microservice architecture based on AWS serverless services. This platform was expanded to provide "UtilitySuite" solutions by sequentially adding systems that manage the growing amount of solar power generation that Trende has enabled.

Cloud deployment saved countless upfront capital costs, and greatly enhanced the speed of deployment of Trende's innovative solutions.[42] The company is also driving further innovation and creating further uses for data generated and analysed on the company's platform to create value for Trende's shareholders and its customers, including expanding solar power offerings and establishing a peer-to-peer electricity trading network for Japanese residential customers.

To this point, we have highlighted the significant economic and employment contributions that data centres are already making in Singapore. The next chapter outlines future scenarios for the country's data centre industry.

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40. Forbes (2021), "Realizing The True Value Of The Cloud As An Innovation Catalyst". Available at: https://www.forbes.com/sites/forbestechcouncil/2021/05/24/realizing-the-true-value-of-the-cloud-as-an-innovation-catalyst/?sh=5b63addc6cb6
41. Accenture (2020), "The green behind the cloud". Available at: https://www.accenture.com/us-en/insights/strategy/green-behind-cloud
42. AWS (2019) "TRENDE Inc." Available at: https://aws.amazon.com/jp/solutions/case-studies/trende/

Future pathways for sustainable data centres

There are many development paths that Singapore's data centres could take over the next decade. This chapter outlines those paths and the potential for driving sustainable development in this critical sector. The Singapore Government has already announced its intentions to anchor best-in-class data centres in terms of resource efficiency and their contributions to Singapore's economic and strategic objectives.[43] With the appropriate measures in place, by 2030, data centres in Singapore are looking at delivering a 2.8 times increase in jobs and 8.9 times growth in economic contribution (from 2022 levels). Meanwhile, energy consumption is expected to slow and carbon emissions to drop by up to 90% lower than today's levels.

43. Channel News Asia (2022). "Singapore to be 'more selective' of data centre investments" Available at: https://www.channelnewsasia.com/singapore/singapore-date-centres-more-selective-projects-investments-mti-2429681

Government policies are expected to grow Singapore's data needs 4 times by 2030

Singapore-based businesses' use of data services is expected to grow by four times, from SGD3.1 billion in 2021 to SGD13.0 billion in 2030 (Exhibit 6). Out of all the sectors analysed, the finance and insurance sector and the health and social services sector are expected to see the largest annual increase in cloud demand, at 23% (Exhibit 6). This is a conservative estimate, however, considering the significant growth in financial technology (FinTech) and regulatory technology (RegTech), as well as advancements in Artificial Intelligence (AI) and Machine Learning (ML) applications in the finance sector in recent years.[44] Similarly, a fast-growing focus on telemedicine, AI-enabled medical devices, and blockchain electronic health records has stimulated the demand for cloud services in the health and social services sector.[45] As industries increase their pace of digitalisation and demand for data-driven services, existing data centre capacity will soon no longer suffice and new builds will be required to meet the growing needs.

This expected increase in data needs is largely driven by key policy objectives, which support greater technology adoption. Singapore's public cloud strength is critical to evolving the nation's into an advanced economy with digitalised and high-tech industries. In recent years, the Government has introduced initiatives such as the "Singapore 2030 Green Plan," "Industry 4.0" and the "Services and Digital Economy Technology Roadmap" — that will exponentially increase the need for highly scalable digital technologies as well as low-cost, low-latency data storage, networking, computing and database capabilities.

Take, for instance, the "Singapore 2030 Green Plan" which was designed to meet the "UN 2030 Agenda for Sustainable Development" and the "Paris Agreement" targets.[46] As part of the plan, the Government is looking to develop energy-efficient and cost-effective green technologies, invest in desalination and water treatment technologies (i.e., electrochemical desalination), and double the number of national electric vehicle (EV) charging points from 28,000 to 60,000 charging points by 2030.[47] Similarly, the Infocomm Media Development Authority launched the "Services and Digital Economy Technology Roadmap" in 2018, outlining its efforts to help domestic businesses better leverage advanced digital technologies such as immersive media, AI and blockchain.[48] To further enhance the effort, the Government also aims to facilitate the rapid adoption of the Internet of Things and contribute to the Cloud Native Architecture ecosystem in view of realising its "Hub for Services 4.0" vision.[49]

44. Nasir, Adeel, et al (2021), Trends and Directions of Financial Technology (Fintech) in Society and Environment: A Bibliometric Study. *Applied Sciences* 11.21 (2021): 10353. Available at: https://www.researchgate.net/publication/355809218_Trends_and_Directions_of_Financial_Technology_Fintech_in_Society_and_Environment_A_Bibliometric_Study

45. Mobidev (2021), "Healthcare Technology Trends and Digital Innovations in 2022". Available at: https://mobidev.biz/blog/technology-trends-healthcare-digital-transformation

46. Enviliance Asia (2021), "Launch of Singapore Green Plan 2030 for sustainable development". Available at: https://enviliance.com/regions/southeast-asia/sg/report_3943

47. Green Plan (2021), *Initiatives and Targets under the Singapore Green Plan 2030.* Available at: https://www.greenplan.gov.sg/files/resources/media-release-annex.pdf
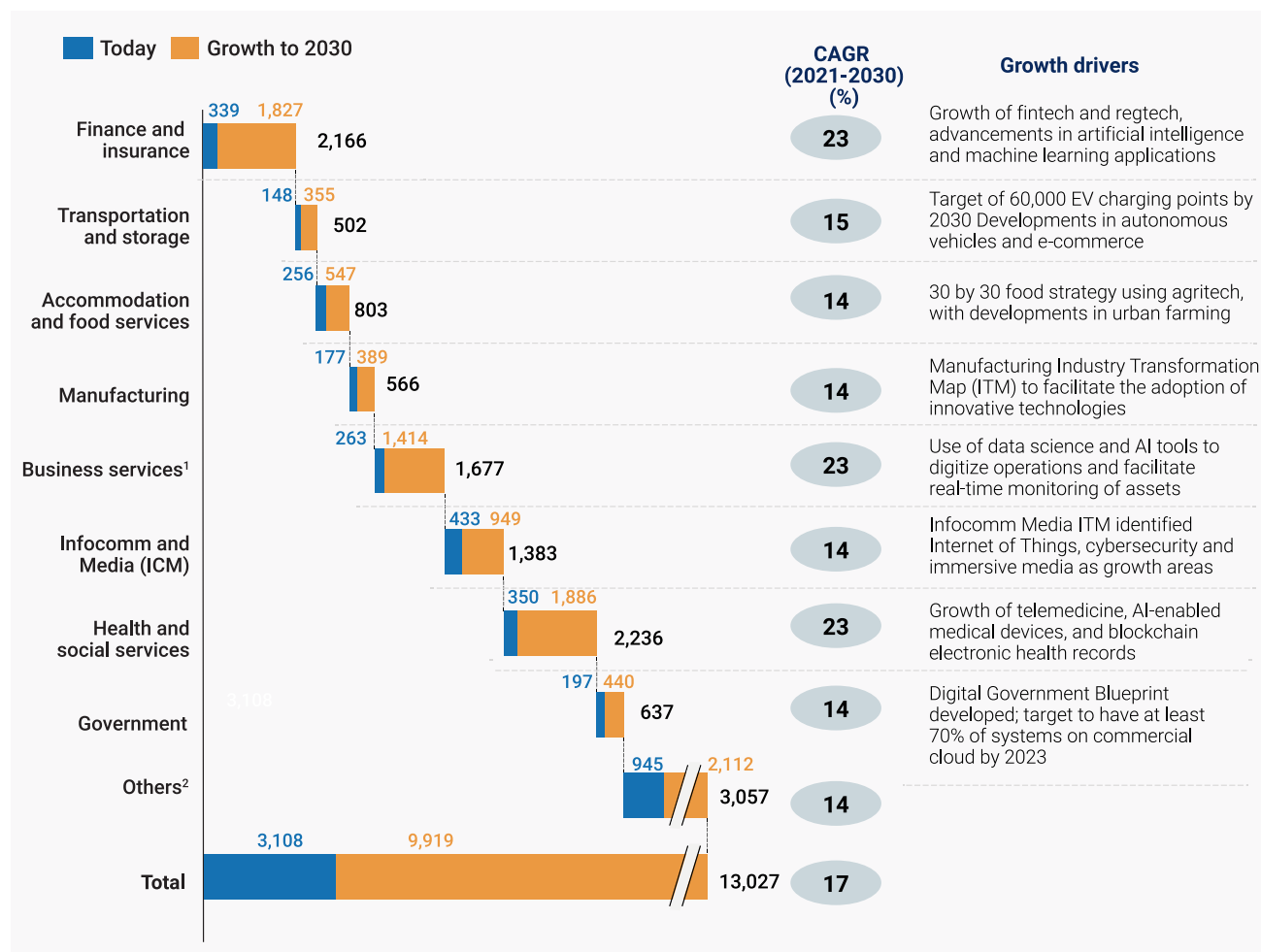
48. Straits Times (2018), "IMDA rolls out new measures to help infocomm media sector ride on emerging tech trends". Available at: https://www.straitstimes.com/business/economy/imda-rolls-out-new-measures-to-help-infocomm-media-sector-ride-on-emerging-tech

49. Infocomm Media Development Authority (2018), *Annex A-1: Future Communications and Internet-of-Things.* Available at: https://www.imda.gov.sg/-/media/Imda/Files/Industry-Development/Infrastructure/Technology/Technology-Roadmap/WG1-Executive-Summary-for-Future-Communications-and-IoT.pdf

Exhibit 6

Singapore's use of data services is expected to grow by 4 times , mainly driven by government policies

Market size of public cloud in Singapore, by sector; SGD millions

Sector	Today	Growth to 2030	Total	CAGR (2021-2030) (%)	Growth drivers
Finance and insurance	339	1,827	2,166	23	Growth of fintech and regtech, advancements in artificial intelligence and machine learning applications
Transportation and storage	148	355	502	15	Target of 60,000 EV charging points by 2030 Developments in autonomous vehicles and e-commerce
Accommodation and food services	256	547	803	14	30 by 30 food strategy using agritech, with developments in urban farming
Manufacturing	177	389	566	14	Manufacturing Industry Transformation Map (ITM) to facilitate the adoption of innovative technologies
Business services[1]	263	1,414	1,677	23	Use of data science and AI tools to digitize operations and facilitate real-time monitoring of assets
Infocomm and Media (ICM)	433	949	1,383	14	Infocomm Media ITM identified Internet of Things, cybersecurity and immersive media as growth areas
Health and social services	350	1,886	2,236	23	Growth of telemedicine, AI-enabled medical devices, and blockchain electronic health records
Government	197	440	637	14	Digital Government Blueprint developed; target to have at least 70% of systems on commercial cloud by 2023
Others[2]	945	2,112	3,057	14	
Total	3,108	9,919	13,027	17	

1. Business services include real estate, professional services, scientific and technical activities, environmental services, security, other administrative and support services, employment activities, and travel agencies.
2. Others include wholesale and retail trade sector, construction sector and other goods and services sectors which includes personal and household services not elsewhere classified such as hairdressing shops, beauty salons, and spas, repair and maintenance of motor vehicles, activities of other membership organizations such as churches, country clubs, and charity organizations.

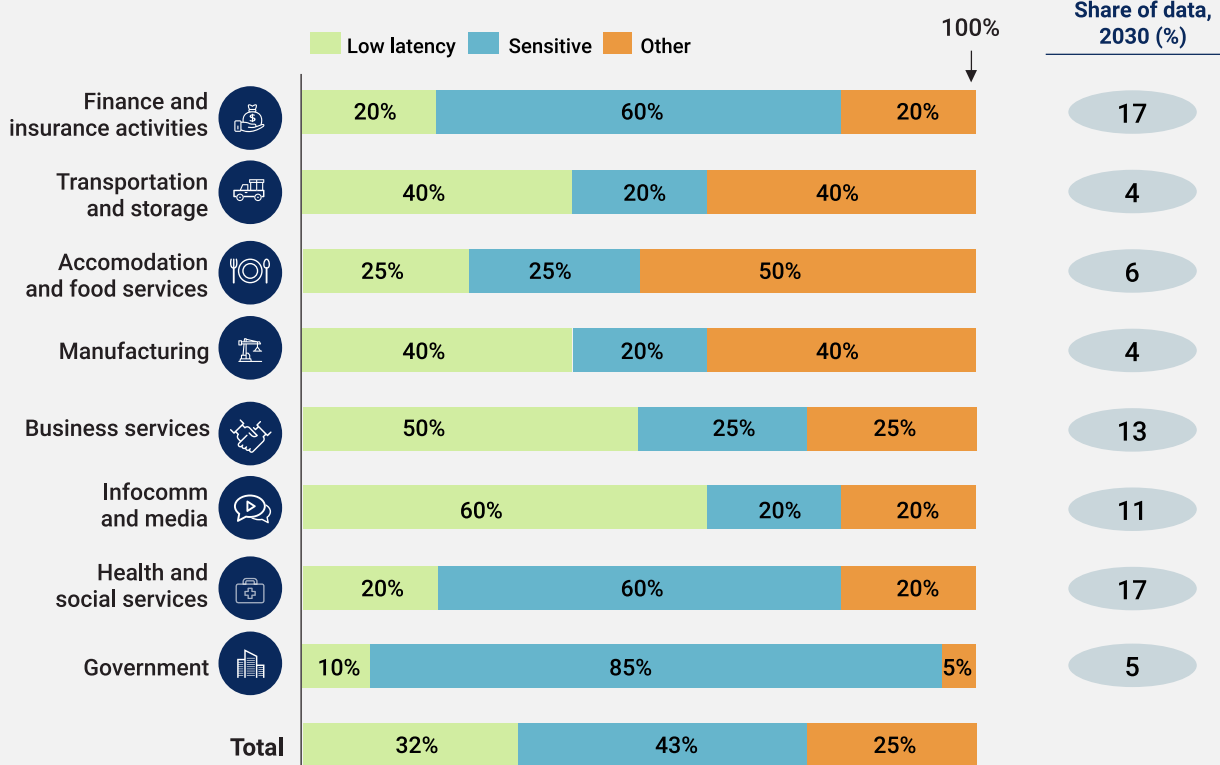SOURCE: IMDA; Statista; IBM; BCG; AlphaBeta analysis

It is not just data needs that are growing — by 2030, 75% of Singapore's data needs by industries will require low latency services or be location sensitive. The share of data requiring low latency or that is location-sensitive is the highest in the government sector (at 95%), followed by the finance and insurance sectors and the infocomm and media sectors (at 85% each) (Exhibit 7). Given that these sectors will likely process significant volumes of classified and commercially-sensitive information and consumer personal data, it is all the more crucial for local data centres to act as key drivers.

Exhibit 7 **75% of data required by 2030 will require low latency or will be location sensitive**

Share of data requiring low latency or location sensitive; %

	Low latency	Sensitive	Other	Share of data, 2030 (%)
Finance and insurance activities	20%	60%	20%	17
Transportation and storage	40%	20%	40%	4
Accomodation and food services	25%	25%	50%	6
Manufacturing	40%	20%	40%	4
Business services	50%	25%	25%	13
Infocomm and media	60%	20%	20%	11
Health and social services	20%	60%	20%	17
Government	10%	85%	5%	5
Total	**32%**	**43%**	**25%**	

100%

SOURCE: AlphaBeta analysis

Future of data centres in Singapore: Four scenarios for development

Four scenarios have been modelled to illustrate the trajectories of Singapore's data centre industry in the approach towards 2030 (Exhibit 8):

1. **"Green growth" scenario:** In this scenario, the number of data centres grow, most with high server utilisation rates and high degrees of energy efficiency at both the server and facility level, similar to hyperscale cloud data centres. In this scenario, data centre operators are encouraged to place a stronger focus on sustainability performance (i.e. better compute power, lower PUE, more energy-efficient approaches such as liquid cooling and the sourcing of 100% renewable energy).

2. **"Green but small" scenario:** In this scenario, the growth in the number of data centres in Singapore is constrained. However, local data centres adopt

sustainability measures with higher utilisation rates, comparable to that of hyperscale cloud data centres.[50] Data centres are assumed to have higher compute power (from increased server efficiency), lower PUE, complete renewable energy sourcing, and reduced power needs from the use of liquid cooling.

3. **"Business-as-usual" scenario:** In this scenario, there is rapid growth in data centres, with no particular focus on improving sustainability performance. As a result, carbon emissions, energy and water use would rise significantly as Singapore added more data centres.

50. In practice, such solutions would require sufficient scale to be economically viable. However, for the sake of simplicity, we have assumed that these solutions are adopted even in a smaller data centre market.

4. **"Dual collapse" scenario:** In this scenario, the number of data centres in Singapore is constrained, combined with a varying degree of sustainability measures across existing data centres — some will adopt best-in-class sustainability measures while others will have poor sustainability performance. This scenario takes into account an increased use of energy-inefficient and less sustainable on-premise data centres.

The four scenarios vary by pace of sustainability and economic growth.

<table>
<tr><td>**Exhibit 8**</td><td>**Four future scenarios of Singapore's data centre industry by 2030**</td></tr>
</table>

"Green but small" scenario

Data centres adopt sustainability measures with utilisation rates comparable to hyperscale cloud, but constraints on their growth mean industry does not expand significantly.

"Green Growth" scenario

Strong expansion of data centres, with utilisation rates comparable to hyperscale cloud providers coupled with focus on energy efficiency and 100% renewable energy sourcing.

Sustainability of growth

High

Low

Pace of expansion

Low — High

"Dual collapse" scenario

Singapore restricts growth in data centres which leads to few leading operators and just the "laggards" with weak sustainability performance remaining. Greater use of inefficient on-site premises.

"Business as usual" scenario

Rapid growth in data centres, but lack of focus on sustainability means that carbon emissions and water footprint rise significantly.

SOURCE: AlphaBeta analysis

Exhibit 9   Assumptions used for the four scenarios related to sustainability measures and economic growth

Assumptions	Scenario			
	Green but small	**Green growth**	**Dual collapse**	**Business as usual**
Compute power efficiency	20% reduction in compute power due to server efficiency (based on industry input)	20% reduction in compute power due to server efficiency	Same as today	Same as today
PUE	1.3 by 2030 (based on industry input)	1.3 by 2030	1.9 (same as today)	1.9 (same as today)
Renewable share	100% renewable energy by 2030	100% renewable energy by 2030	2.8% (as in the grid today)	2.8% (as in the grid today)
Cooling efficiency	Liquid cooling reduces power further by 20%	Liquid cooling reduces power further by 20%	Same as today	Same as today
Social cost of carbon	A social cost of carbon will reduce GVA by SGD$69 per tonne of carbon emitted			
Data centre builds	Only the confirmed builds till 2025 and slower pace from 2026 to 2030 (same pace as 2021-2025)	Data centre build continues at the same pace as between 2017-2020	Only the confirmed builds till 2025 and slower pace from 2026 to 2030 (same pace as 2021-2025)	Data centre build continues at the same pace as between 2017-2020

SOURCE: AlphaBeta analysis, Scientific American

"Green growth" is key to economic and sustainability benefits – and is most beneficial to Singapore

The "green growth" scenario shows a possible pathway to achieving economic success without compromising on sustainability goals. The scenario can lead to a surge in jobs and rise in economic contribution, while keeping energy consumption levels steady, and reducing carbon emissions by a significant amount (Exhibit 10). It provides a viable way for Singapore to achieve economic growth and reduce carbon emissions at the same time.

In the "business as usual" (BAU) scenario, while economic output and jobs generated increase by more than eight times and two times, respectively, compared to today's levels, the amount of carbon emissions and energy demanded are also estimated to increase significantly. This would lead to economic growth being pursued at a considerable cost to the environment. Similar trends can be observed in the "dual collapse" scenario, where an erosion of Singapore's hub status is possible, as businesses start to consider basing their operations in

other developed countries around the region, such as Japan.

The "green but small" scenario is estimated to result in a smaller environmental impact than the BAU scenario by forgoing the economic impact. This scenario limits the number of new builds in Singapore, resulting in larger workloads taking place on inefficient on-premise data centres. Compared to the "dual collapse" scenario, "green but small" is likely to result in better environmental outcomes (45% lower energy demand by 2030). While this seems to be a possible scenario for Singapore to pursue, this will result in Singapore losing out in terms of cloud-enabled innovation and sustainability performance. As mentioned above, hyperscale cloud servers could achieve up to 78% reduction in carbon footprint compared to on-site premises.[51]

Exhibit 10 "Green growth" shows a possible pathway to achieving economic success without compromising on sustainability goals

Legend: Today | Business as usual | Dual collapse | Green but small | Green growth

Carbon emissions related to data centres;
Million tonnes of CO2e, 2030
- 2.2
- 9.9
- 3.8
- 0.1
- 0.2

Economic output related to data centres;
GVA, SGD billions 2030
- 2.3
- 20.1
- 12.6
- 12.9
- 20.7

Energy demand;
TWh, 2030
- 3.4
- 17.1
- 6.5
- 2.9
- 7.5

Direct jobs related to data centres;
'000jobs, 2030
- 7.2
- 20.1
- 12.4
- 12.4
- 20.1

Green growth scenario

2.8x higher direct jobs as compared to today

8.9x higher GVA as compared to today

90% lower CO2 emissions as compared to today

2x higher energy demand as compared to today *(but 2x lower than business as usual scenario*

0% dependence on grid as compared to 100% today

Note: Under the "Green growth" and "Green but Small" scenario, it is assumed that there is 5% of carbon emissions from other data centre processes such as cooling. The energy demand assumes that the mix of data centres (i.e., between hyperscale vs. onsite) doesn't change significantly as compared to today
SOURCE: AlphaBeta analysis

51. 451 Research (2021), *The Carbon Reduction Opportunity of Moving to the Cloud for APAC.* Available at: https://d1.awsstatic.com/institute/The%20carbon%20opportunity%20of%20moving%20to%20the%20cloud%20for%20APAC.pdf

## Curtailing hyperscale cloud data centres could lead to more carbon emissions

Counter-intuitively, limiting hyperscale cloud data centres in Singapore could lead to higher on-premise usage and larger carbon emissions. Given Singapore's future data needs and the considerable difference in energy efficiency between on-premise data centres and hyperscale cloud data centres, reducing the presence of hyperscale cloud data centres will result in significant opportunity costs for Singapore. As indicated earlier in the chapter, 75% of the data required by Singapore industries will require low-latency services or those

that are location-sensitive by 2030. Research has also shown that moving computing workloads from on-premise data centres to hyperscale cloud facilities in the APAC region can reduce carbon footprint by over 78% on average.[52] Assuming that a conservative estimate of 75% of Singapore's 2030 data requirements would be met by local data centres, energy demand in the case where there are no hyperscale data centres in Singapore would be 25.6 TWh (Exhibit 11).

| **Exhibit 11** | **Removing hyperscale cloud data centres from Singapore could lead to more on-premise usage and higher carbon emissions** |

Location and latency sensitive data
2030
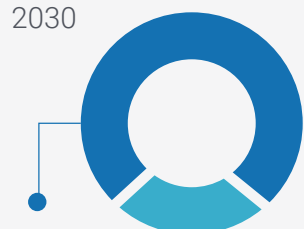
75% of data required by 2030 will require low latency or be location sensitive

Energy efficiency comparison

78%

0%

On-premise data centres — Hyperscale data centres
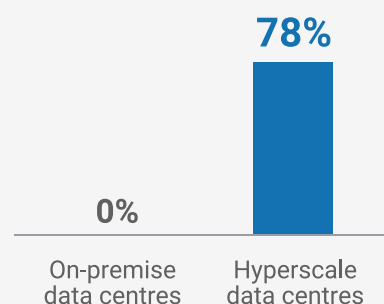
Energy demand, in green growth and in case no hyperscale data centres are allowed in Singapore
TWh; 2030

25.6

+241%

7.5

2030 (green growth scenario) — 2030 (no hyperscale data centres in Singapore)
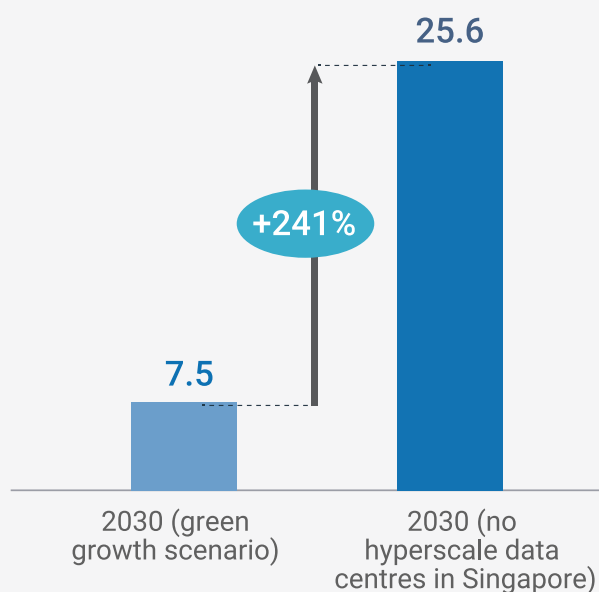
Note: Assuming that 75% of the data requirement in 2030 shifts to on-premise data centres, and the remaining 25% shifts off-shore (outside Singapore).
SOURCE: AlphaBeta analysis

This chapter explained how a green growth scenario could lead to substantial economic and sustainability contributions. The next chapter explores an action plan to implement the "green growth" scenario.

52. Amazon (2021), "AWS Cloud can help lower carbon footprints in Asia Pacific". Available at: https://www.aboutamazon.com/news/aws/aws-cloud-can-help-lower-carbon-footprints-in-asia-pacific

Capturing the green data centre opportunity

Industry alone cannot make this happen; government and industry players need to work hand-in-hand to create the right environment to enable a transition to green data centres.

Essential green data centre lessons from around the world

The "Climate Neutral Data Centre Pact" is a pledge by industry players and trade associations of cloud infrastructure services and data centres in Europe to achieve climate neutrality by 2030.[53] The European Commission supports the pact, and since its launch in January 2021, the pact now represents 90% of Europe's cloud and data centre sector, with 54 members and 22 trade associations.[54] Such public-private partnerships ensures that a standardised approach is applied to green cloud procurement. Established goals developed by both public and private sector players will further

accelerate Europe's decarbonisation efforts and reduce the propagation of different sustainability standards that can lead to inefficient outcomes and additional costs for data centre operators.[55]

The "Climate Neutral Data Centre Pact" outlines targets in five broad areas: energy efficiency, clean energy, water efficiency, circular energy and circular economy (Exhibit 12).[56] To ensure the pact's success, members have committed to its overall aims: to use energy efficiently, boost renewable energy production, encourage water

| Exhibit 13 | Europe's "Climate Neutral Data Centre Pact" lays out a strong vision for sustainability |

Area	Goals and targets
Energy efficiency	• By January 1, 2025 new data centres operating at full capacity will meet an annual PUE target of 1.4 for warmer climates and 1.3 for colder climates; existing data centres will achieve these same targets by January 1, 2030 • These targets apply to all data centres with an IT power demand larger than 50KW
Clean energy	• Data centre electricity demand will be met by 75% renewable energy or hourly carbon-free energy by December 31, 2025 and 100% by December 31, 2030
Water efficiency	• By 2022, data centre operators will set an annual target for water usage effectiveness (WUE), or another water conservation metric, which will be met by new data centres by 2025 and by existing data centres by 2030 • The water metric target may vary depending on the data centre design specifications
Circular energy	• Data centre operators will explore possibilities of interconnecting district heating systems and other heat users to determine whether feeding captured heat from new data centres into nearby systems are practical, environmentally sound and cost effective
Circular economy	• Data centres will assess their used server equipment are suitable for reuse, repair, or recycling 100% • Data centre operators will increase the quantity of server materials that are repaired or reused and will create a target percentage for repair and reuse by 2025

SOURCE: Climate Neutral Data Centre

53. Climate Neutral Data Centre (n.d.), "Governance". Available at: https://www.climateneutraldatacentre.net/governance/
54. Data Center Dynamics (2021), "Europe's Climate Neutral Data Centre Pact takes proposals to the EU". Available at: https://www.datacenterdynamics.com/en/news/eus-climate-neutral-data-centre-pact-takes-proposals-to-the-eu/
55. Climate Neutral Data Centre (2021), *Climate Neutral Data Centre Pact Self-Regulatory Initiative Policy Proposal.* Available at: https://www.climateneutraldatacentre.net/wp-content/uploads/2021/06/CNDCP-Policy-Paper_FINAL.pdf
56. Climate Neutral Data Centre (n.d.), "Self-Regulatory Initiative". Available at: https://www.climateneutraldatacentre.net/self-regulatory-initiative/

conservation, promote the reuse and repair of servers and explore ways to reuse waste heat while promoting a circular economy for natural resources.[57]

Japan presents another example of government support, where a SGD9.8 billion initiative was rolled out in 2020 to encourage green innovations and reduce the data centre's environmental impacts.[58] The initiative included 50 % subsidies on building costs for zero carbon-emissions data centres.[59]

In China, the National Development and Reform Commission has recently announced its intentions to construct four mega clusters of data centres in view of

supporting the data needs of Beijing and other major coastal centres, which indicates that clustering leads to greater efficiencies as well.[60]

Another area the industry and various governments are exploring includes alternative energy sources. Germany, for instance, is home to a research partnership between T-Systems, a digital service provider, and Fraunhofer Institute for Factory Operation and Automation, a research institute, to explore the relationships between renewable energy, creative storage solutions and flexible customer usage in order to create a fully functional, sustainable data centre.[61]

◢ The Singapore opportunity

For Singapore to meet its sustainability goals, a minimum efficiency standard should be set for all local data centres to ensure the efficient use of scarce resources like energy and water. One option is to develop a "Climate Neutral Data Centre Pact" for Singapore, similar to the cross-industry collaborative model seen in Europe. Adopting such a framework would facilitate Singapore's industry and economic growth in an environmentally friendly and resource-efficient manner. Moreover, these innovations could be exported overseas, securing Singapore's status as an innovation hub regionally and globally.

Any proposed goals in Singapore's Pact should consider the local industry landscape and environment, including ambitious PUE targets, the shift to liquid cooling, as well as the introduction of hydrogen fuel cells as an energy source, among others. There is a fast-growing need for the government and industry to jointly develop standards and set aspirational targets on energy and water efficiencies, the circular economy and clean energy — use that will help Singapore's data centres achieve their sustainability goals.

57. Data Center Dynamics (2021), "Europe's Climate Neutral Data Centre Pact takes proposals to the EU". Available at: https://www.datacenterdynamics.com/en/news/eus-climate-neutral-data-centre-pact-takes-proposals-to-the-eu/
58. DataCentre (2020), "Japan's data centres go green". Available at: https://datacentremagazine.com/data-centres/japans-data-centres-go-green
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How the Singapore Government can help enable further innovation

The Singapore Government plays a key role in creating a regulatory environment that spurs sustainable industry growth. To facilitate innovation and overcome challenges to clean energy procurement, the Government should consider adopting the following measures:

> **Encourage building innovation through efficient energy and water use:** The Government can incentivise building innovations by offering tax rebates or subsidies on initiatives such as lowering greenhouse gas emissions or reducing energy and water use. By reducing the cost of engaging in green innovation activities, the overall carbon footprint will drop as well. Beyond encouraging a greater usage of renewable energy, the government and the industry could also work together to secure access to renewable resources produced domestically and imported from neighbouring countries.

> **Land allocation linked to specifically designed data centre clusters:** The Government can develop dedicated clusters for data centres as it is more energy-efficient and generates lower carbon emissions than standalone data centres. Additionally, for new data centres, the Singapore Government can also consider helping identify land for a data centre park that could be sourced entirely by renewable energy. This has been seen in China, homes to specially created economic zones for data centres. Apart from such clusters, the Singapore Government can provide financial

support to facilitate research on renewable and clean energy sources, such as green hydrogen. These research efforts would not only reduce data centres' dependence on the national grids, but the country's carbon footprint as well – a significant step towards achieving its sustainability goals.

> **Invest in land innovation:** Due to land, water and energy constraints, the Government, together, with local companies, have started investing more in research and development activities to develop underground, offshore and underwater data centres in an effort to meet the increasing data demand. This is evidenced by the collaborative research effort to assess the feasibility of underground and floating data centres and the deployment of high-rise green data centres with energy-efficient technologies.[62] Moving forward, the Government can ramp up on research and development efforts that further the development of alternatives to conventional above-ground data centres. Additionally, they can consider re-evaluating land plans to ensure that there is sufficient land for the growing number of data centres and the necessary energy infrastructure.

We strongly support the Singapore Government's intent to facilitate new capacity allocation in a sustainable manner, which will be crucial to raising the overall efficiency of the data centre industry as a whole, all while contributing to Singapore's overarching economic and strategic objectives. We also support the Government's recently announced goal of reaching net-zero carbon by or around 2050. We believe that data-driven, cloud-enabled solutions will be vital in helping to meet this goal, on top of scaled, direct investments in decarbonising technologies by Singapore's cloud service providers and in clean energy.

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