STRUCTURE RESEARCH

ESG REPORT SERIES

2023 STATE OF ENVIRONMENTAL IMPACT

Data Centre Providers & Hyperscale Platforms

JANUARY 2024

Executive Summary

The data centre industry has always exhibited high levels of demand for energy and resources to support the building and operation of this infrastructure. With the increased reliance on data centres, there is growing concern about its environmental impact, especially as capacity requirements continue to expand, driven by cloud adoption, and going to another level with AI and HPC. The data centre industry is increasingly aware of the environmental concerns, especially in the wake of climate change, and the majority of companies are actively transforming their businesses to be more environmentally friendly. This includes the use of renewable and carbon-neutral energy, implementing more energy efficient equipment, mitigating carbon emissions, waste heat reuse, and water conservation techniques. Enterprise environmental efforts are consolidated and reported in annual Environmental, Social, and Governance (ESG) reports, which provide a detailed look at a company's energy use and greenhouse gas (GHG) GHG emissions, as well as plans for mitigating and adapting to climate change.

Although ESG reporting has existed since the early 2000s, transparency and reporting have still been major challenges in the data centre industry. However in 2019, the Sustainable Finance Disclosure Regulation (SFDR) was introduced in Europe and required companies to report a wide range of ESG metrics (European Commission, 2019). Since then, data centre companies have been making strides to report their ESG metrics, and many clients and investors have also cited the importance of ESG metrics in their buying decisions and strategic decision-making.

As of 2022, we have identified 28 data centre providers and 9 hyperscale platforms that have published at least one ESG report since 2019, and using those publicly available reports, we have consolidated an overview of the environmental impact of the data centre and hyperscale cloud industry.

Overall, carbon emissions and consumption of resources have continued to increase since 2019 due to the expanding need for IT infrastructure. In 2022, the data centre and hyperscale industry produced a total of 62.8 million metric tons of CO_2e, an increase of 30.3% since 2019. In terms of energy consumption, in 2022, the global data centre and hyperscale industry consumed 242.0 TWh of energy which accounts for about 0.96% of the total global energy consumption. Water consumption in the industry has also increased, by 4.6% from 2019 to 2022.

With the increase in emissions and consumption, there have been corresponding improvements in operational efficiency and adoption of renewable energy. When looking at the rate of CO_2e emissions by GWh of energy consumption, there was a steady decrease between 2019 to 2022, suggesting that data centres may be able to continue increasing workloads while working towards sustainability goals. Renewable energy use in the industry has also increased significantly, with a 30.8% growth in renewable energy usage between 2019 and 2022. Hyperscalers have been utilizing a larger proportion of the renewables, and about 82% of the energy consumption of hyperscalers is attributed to renewable energy in 2022.

The data centre and hyperscale cloud industry will continue to grow and further intensify resource use and emissions. Overall, however, with clear focus and investment on energy efficiency and sustainability, it is possible for many in the industry to hit net-zero emissions targets. Structure Research's inaugural 2023 State of Environmental Impact: Hyperscale Cloud & Data Centres aims to provide a global view of the impact of the data centre industry on climate change, focusing on GHG, energy and water consumption.

Key Takeaways

1. Total data centre energy consumption represented just under 1% of the global energy consumption in 2022.
2. Data centre ESG Leaders represent about 50% of the total market IT capacity.
3. Total data centre emissions have grown by 10.6% between 2019 and 2022, but the average emissions per GWh of energy consumption has decreased from 397.4 mtCO2e/GWh in 2019 to 343.0 mtCO2e/GWh in 2022.
4. Energy usage by ESG Leaders has grown by 19.2% over 3 years but renewable energy use has also grown considerably faster, at 30.8% over the same period.
5. Hyperscale PUEs are on average 14.4% lower each year than data centre providers average PUEs.
6. Data centre water usage grew by 4.6% in 3 years.

Disclaimer: Some companies only produce one enterprise-wide ESG report which does not separate out the company's data centre-specific ESG values. These companies include Iron Mountain, Amazon, Alibaba, Tencent, Oracle, and Microsoft. In such cases, Structure Research provided estimates for the company's data centre values using our benchmarking analysis.

METHODOLOGY

Structure Research extracted environmental data from 27 data centre providers and 9 hyperscale platforms with publicly available ESG reports between 2019 and 2022. Key data parameters captured include:

- **Total Operational Data Centre IT capacity (MW)**
- **Greenhouse gas emissions (metric ton of CO_2e)**
  - Scope 1
  - Scope 2 (Market- and Location-Based)
  - Scope 3
- **Total energy usage (in GWh)**
- **Renewable energy Usage**
- **Power Usage Effectiveness (PUE)**
  - Annual operating average
  - Design PUE
- **Total water usage (m^3)**

Definitions

ESG LEADER
Structure Research defines an ESG Leader as a data centre operator or hyperscale platform which has published a sustainability/ESG report with reported metrics on the organization's carbon emissions, energy usage, and/or water consumption.

GREENHOUSE GAS EMISSIONS
Metric ton CO_2 equivalent (mtCO_2e): The universal unit of measurement to indicate the global warming potential (GWP) of each greenhouse gas, expressed in terms of the GWP of one unit of carbon dioxide. It is used to evaluate releasing (or avoiding releasing) different greenhouse gases against a common basis.

SCOPE 1 EMISSIONS (SOURCE: EPA)
Direct greenhouse gas emissions from sources that are controlled/owned by the organization. Examples include fuel combustion for generators, vehicles, boilers.

SCOPE 2 EMISSIONS (SOURCE: EPA)
Indirect greenhouse gas emissions associated with the purchase of electricity, steam, heat, or cooling and are often the result of the organization's energy use. Scope 2 emissions can be measured by either location-based or market-based:

- **Location-based scope 2 emissions** are emissions based on the energy generation defined by the location of the energy consumption area.
- **Market-based scope 2 emissions** are based on the emissions of the energy generation that the organization has purchased. Market-based emissions are often lower than location-based emissions if the organization has purchased carbon-free energy sources.

SCOPE 3 EMISSIONS (SOURCE: EPA)
All indirect emissions that occur in the value chain of the organization from assets not controlled or owned by the reporting organization including both upstream and downstream activities.

- Examples include transportation/distribution of products and assets, employee commuting, and end-of-life treatment of sold products.

POWER USAGE EFFECTIVENESS (PUE)
A metric to determine the energy efficiency of a data centre. PUE is calculated by: data centre electricity consumption / IT equipment electricity consumption.

WATER USAGE EFFECTIVENESS (WUE)
A metric to determine the water efficiency of a data centre. WUE is calculated by: data centre water consumption / IT equipment electricity consumption.

RENEWABLE ENERGY
Energy from sources that are inexhaustible. This includes solar, wind, water, geothermal, and biofuels.

CARBON-FREE ENERGY
Energy from sources that do not use fossil fuels or emit carbon. Nuclear energy is the key component that differentiates carbon-free energy from renewable energy. Biofuels are not included in this category as they emit carbon.

ESG Leaders

DC PROVIDERS

- 21Vianet
- AirTrunk
- Chindata
- Cologix
- Colt Data Centre Services
- CoreSite
- CyrusOne
- Data4
- Databank
- Digital Edge
- Digital Realty
- EdgeConneX
- Equinix
- Flexential
- GDS
- Global Switch
- Green Mountain
- Involta
- Iron Mountain Data Centers
- Kao Data
- Keppel DC REIT
- NEXTDC
- Princeton Digital Group
- QTS Data Centers
- Sabey Data Centers
- ST Telemedia Global Data Centres (STT GDC)
- SUNeVision (iAdvantage)
- Vantage Data Centers

HYPERSCALE PLATFORMS

- Alibaba
- Amazon
- Apple
- Google
- Kingsoft Cloud
- Meta
- Microsoft
- Oracle
- Tencent

Data Centre Providers: Environmental Data Reporting by Segment

	CARBON EMISSIONS			ENERGY CONSUMPTION			WATER
Company	Scope 1	Scope 2 (Location)	Scope 2 (Market)	Total Usage	Renewable Usage	PUE	Total Usage
世纪互联 VNET	✓	✓		✓	✓		✓
AIRTRUNK	✓	✓	✓			✓	
CHINDATA GROUP	✓		✓	✓	✓	✓	✓
cologix	✓	✓		✓	✓		
colt Data Centre Services	✓	✓	✓	✓	✓		✓
CORESITE	✓	✓		✓		✓	
CyrusOne	✓	✓	✓	✓	✓	✓	✓
Data4	✓	✓	✓				
DATABANK	✓	✓	✓	✓	✓	✓	✓

Data Centre Providers: Environmental Data Reporting by Segment (Cont.)

	CARBON EMISSIONS			ENERGY CONSUMPTION			WATER
Company	Scope 1	Scope 2 (Location)	Scope 2 (Market)	Total Usage	Renewable Usage	PUE	Total Usage
Digital Edge DC	✓	✓			✓	✓	✓
Digital Realty	✓	✓	✓	✓	✓		✓
edgeconnex	✓	✓	✓	✓	✓	✓	✓
Equinix	✓	✓	✓	✓	✓	✓	
Flexential	✓		✓	✓	✓	✓	
GDS 万国数据	✓		✓	✓	✓	✓	✓
Global Switch	✓	✓	✓	✓	✓		✓
Green Mountain	✓		✓	✓		✓	✓
Involta				✓	✓	✓	✓

Data Centre Providers: Environmental Data Reporting by Segment (Cont.)

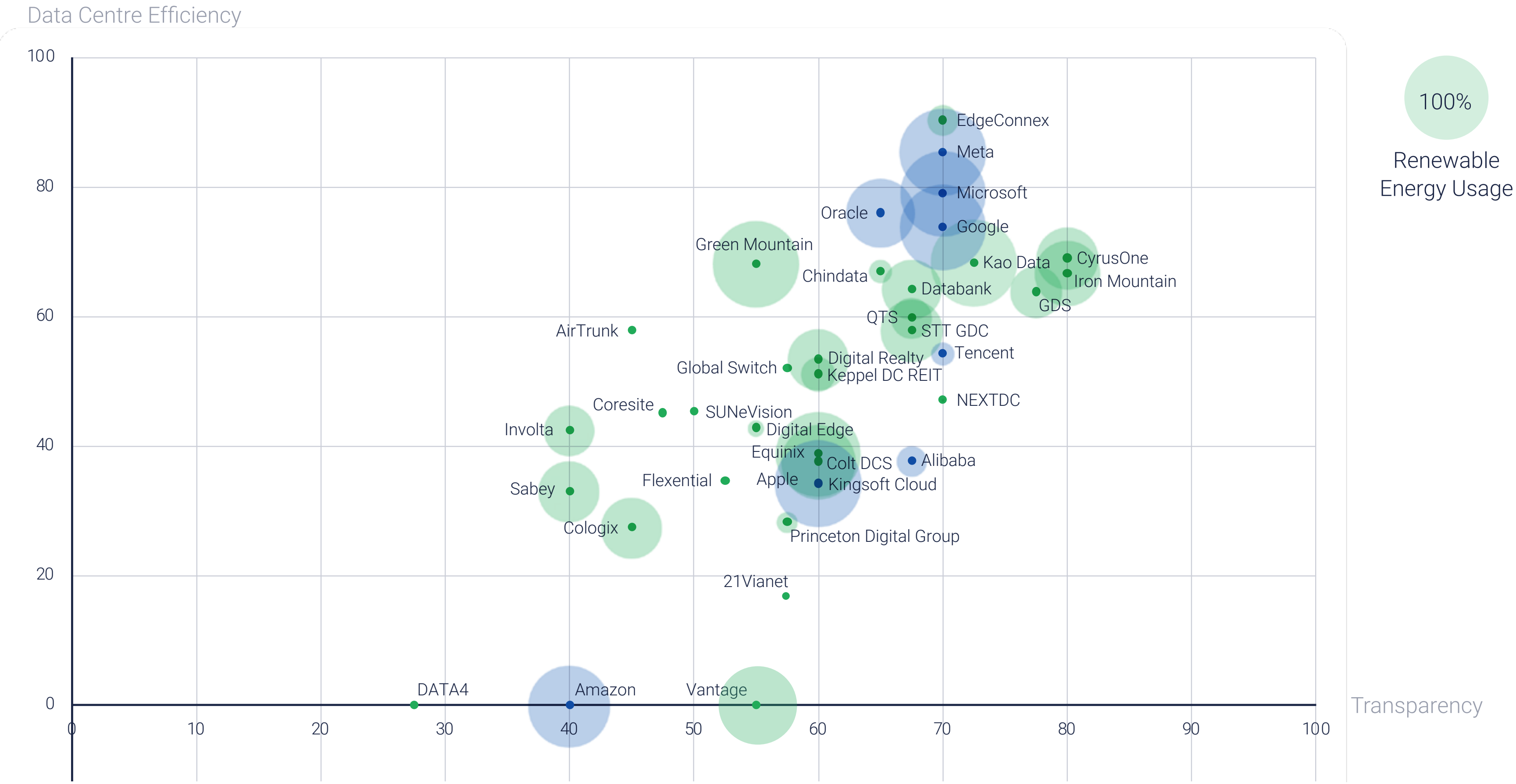
	CARBON EMISSIONS			ENERGY CONSUMPTION			WATER
Company	Scope 1	Scope 2 (Location)	Scope 2 (Market)	Total Usage	Renewable Usage	PUE	Total Usage
Iron Mountain Data Centers	✓	✓	✓	✓	✓	✓	✓
Kao Data	✓	✓		✓	✓	✓	✓
Keppel DC REIT	✓		✓	✓	✓		✓
NEXTDC	✓		✓	✓	✓	✓	✓
PDG	✓	✓	✓	✓	✓	✓	
QTS	✓	✓	✓	✓	✓	✓	✓
Sabey Data Centers	✓	✓	✓	✓			
STTelemedia Global Data Centres	✓	✓	✓	✓	✓	✓	✓
SUNeVision	✓		✓	✓			✓
Vantage Data Centers	✓		✓		✓	✓	✓

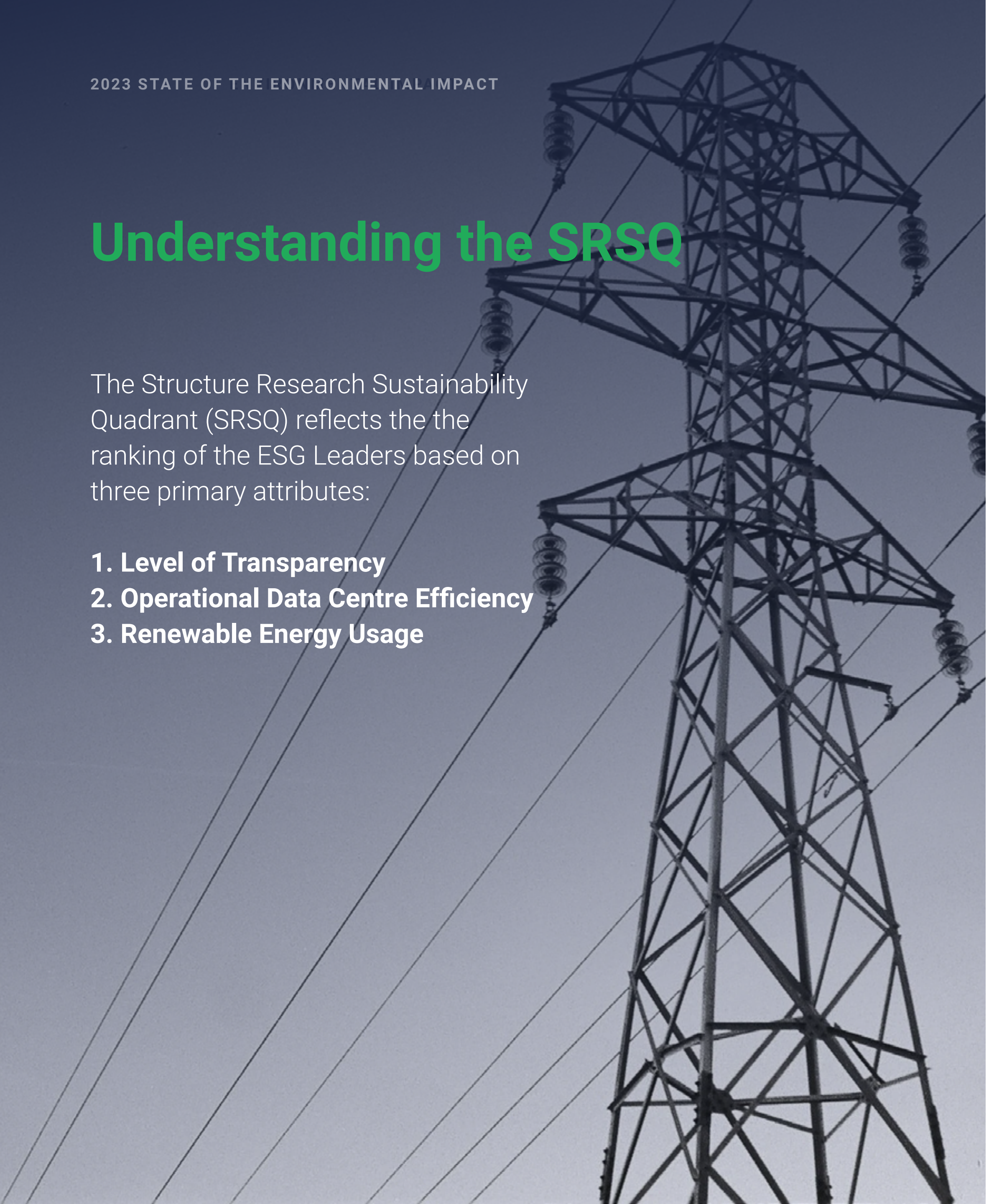
Hyperscale Providers: Environmental Data Reporting by Segment

	CARBON EMISSIONS				ENERGY CONSUMPTION			WATER
Company	Scope 1	Scope 2 (Location)	Scope 2 (Market)	Scope 3	Total Usage	Renewable Usage	PUE	Total Usage
amazon	✓	✓	✓	✓		✓		
Alibaba	✓	✓	✓	✓	✓	✓	✓	✓
Apple	✓	✓	✓		✓	✓		✓
Google	✓	✓	✓	✓	✓	✓	✓	✓
Kingsoft Cloud	✓	✓			✓		✓	✓
Meta	✓	✓	✓	✓	✓	✓	✓	✓
Microsoft	✓	✓	✓	✓	✓	✓	✓	✓
ORACLE	✓	✓	✓	✓	✓	✓	✓	✓
Tencent	✓	✓		✓	✓	✓	✓	✓

SR Sustainability Quadrant

Data Centre Providers   Hyperscale Platforms





Understanding the SRSQ

The Structure Research Sustainability Quadrant (SRSQ) reflects the the ranking of the ESG Leaders based on three primary attributes:

1. Level of Transparency
2. Operational Data Centre Efficiency
3. Renewable Energy Usage

1. TRANSPARENCY

While we applaud all of our ESG Leaders for being trailblazers at producing this first wave of ESG reports, it is also striking the amount of variance in terms of reported data within the ESG leader group. Some have disclosed more environmental parameters compared to others, and the goal of placing Transparency as a pillar of SRSQ is to incentivize and encourage the current group of ESG Leaders, as well as future providers that are in the process of producing their first ESG report, to prioritize transparency over only reporting data that reflects positively on a company's operating metrics.

Scoring: Providers are scored on the below categories of reported environmental data. Points were awarded for each category reported as well as how many historical years of data were reported (regardless of how many ESG reports were published during the span of 2019-2022). The data sets in this report are from years 2019 to 2022.

Understanding the SRSQ (Cont.)

2. OPERATIONAL DATA CENTRE EFFICIENCY

This category measures data centre operating efficiency across three main segments:

Annual Average Operating PUE (AAO-PUE)

- AAO-PUE = Total Energy Usage / Total Energy Used by the IT Equipment.
- The AAO-PUE is a metric used to measure the actual energy efficiency of a data centre that incorporates a time series element to arrive at the annual operative average. This is different and a more accurate measure of data centre efficiency compared to the "Design PUE" metric which only reflects the theoretical optimal PUE of the facility when running at full load.
- A PUE of 1.0 would be ideal, as it would indicate that all of the energy used by the data center is being used to power the IT equipment. However, in reality, most modern colocation and hyperscale facilities have PUEs between 1.2 to 1.8, due to losses in the data center infrastructure, such as cooling systems, power distribution systems, and lighting.
- The lower the provider's AAO-PUE, the higher their score will be for this category.

Carbon Intensity (CI) = (Scope 1 + Scope 2 Emissions) / Total Energy Usage

- The CI metric reflects the amount of carbon emissions generated relative to the total energy usage of the provider. The lower the provider's CI, the higher their score will be for this category.

Water Intensity (WI) = Total Water Usage / Total Energy Usage

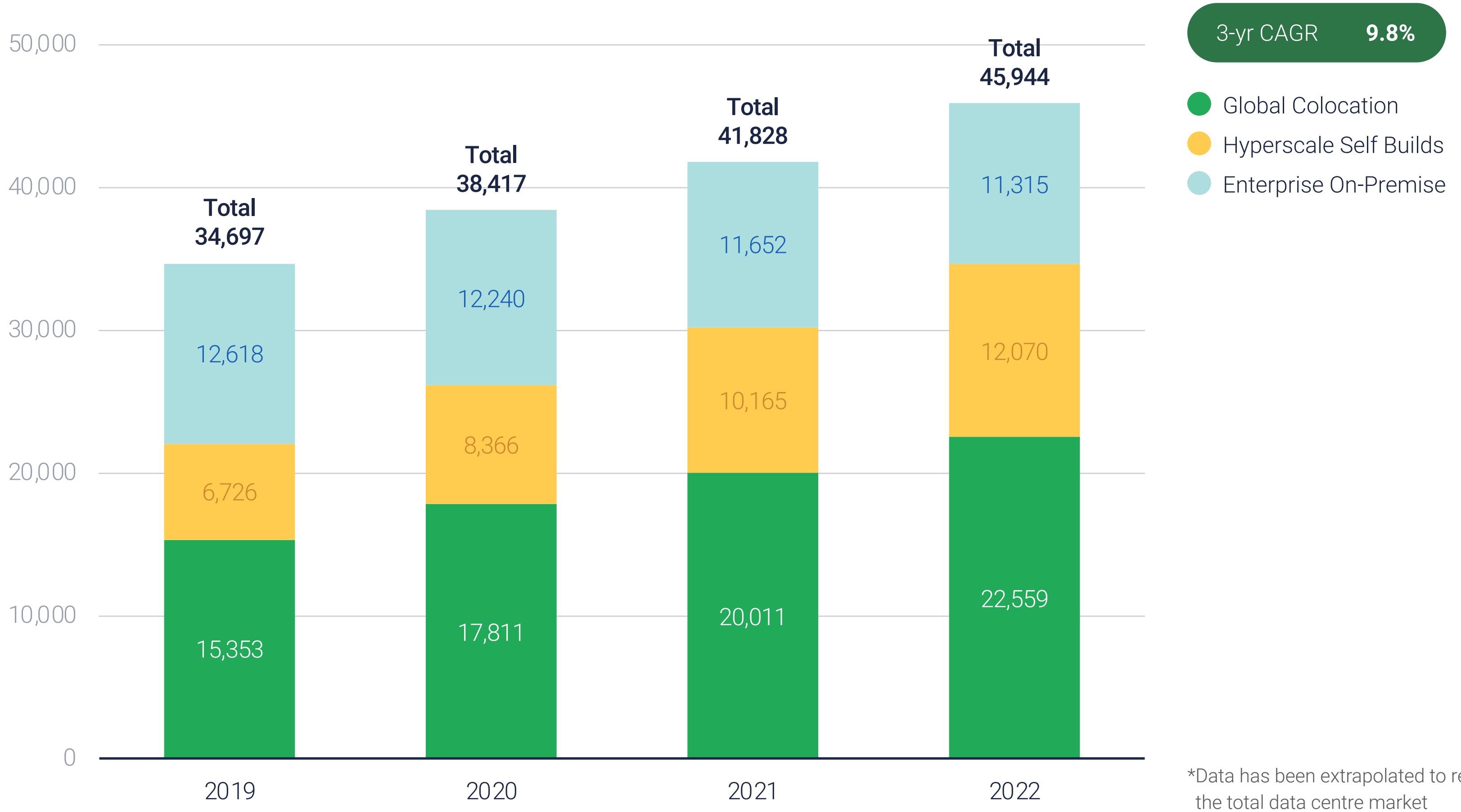
- The WI metric reflects the amount of water used within the provider's data centre footprint relative to the total energy used within the data centre. The lower the provider's WI, the higher their score will be for this category.

Scoring: Providers are given a normalized score between 0-100 for each category. As long as a provider has reported data for these respective categories they are awarded points regardless of how "good or bad" their reported data may be relative to their ESG leader peer group. Providers that did not report data for a category received a score of 0 for it. All categories are then added together and further normalized such that the final data centre efficiency score falls within a range of 0-100.

3. RENEWABLE ENERGY

This category measures the relative percentage of renewable energy used relative to the total energy usage of a provider's data centre footprint. The higher the % of renewable energy used, the higher the provider's score will be. The renewable energy % score is reflected in the size of the bubble surrounding each provider's company name in the SRSQ chart.

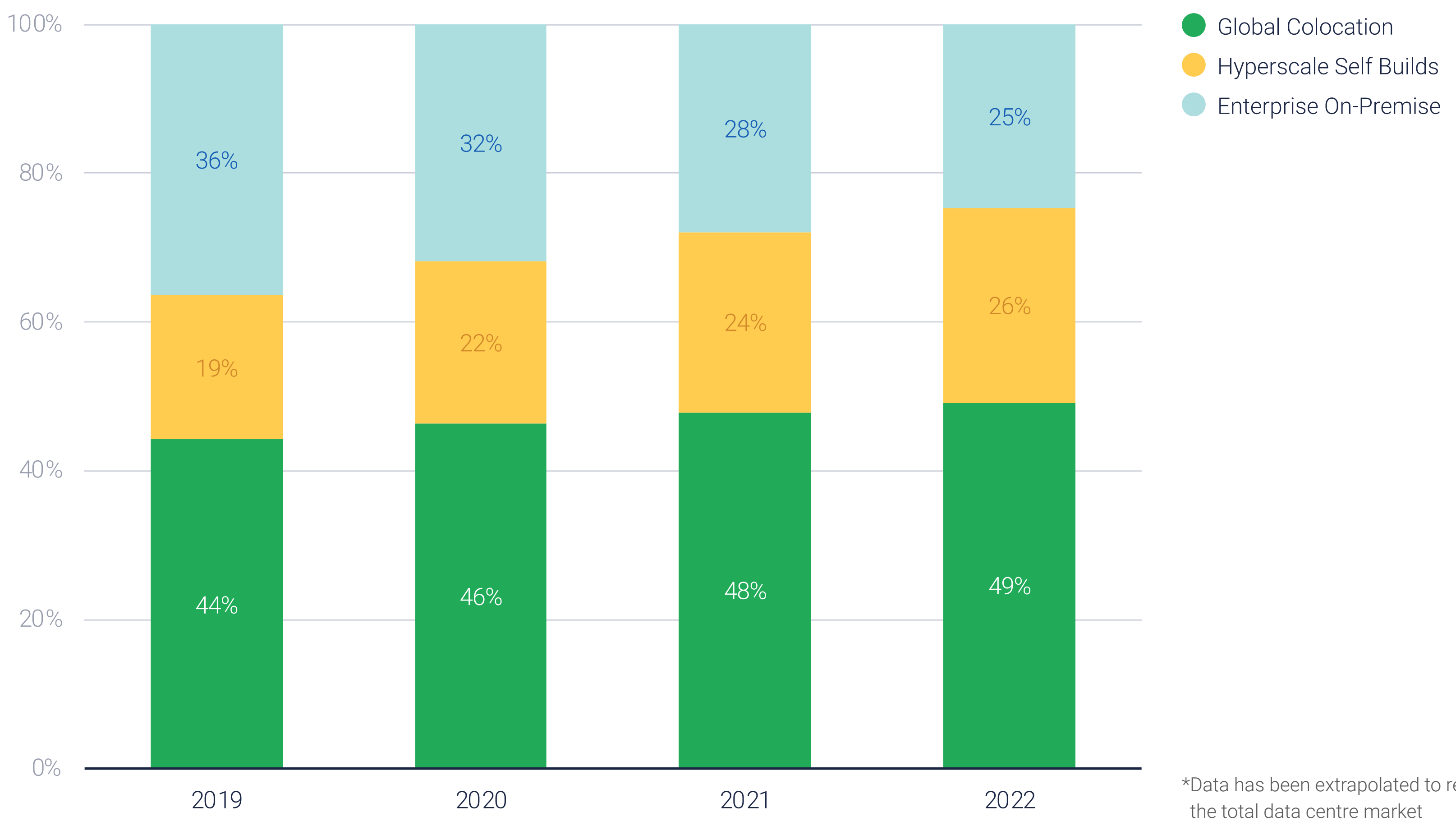
Total Data Centre Market: Operational IT Capacity (MW)



*Data has been extrapolated to represent the total data centre market

Total Data Centre Market: Operational IT Capacity

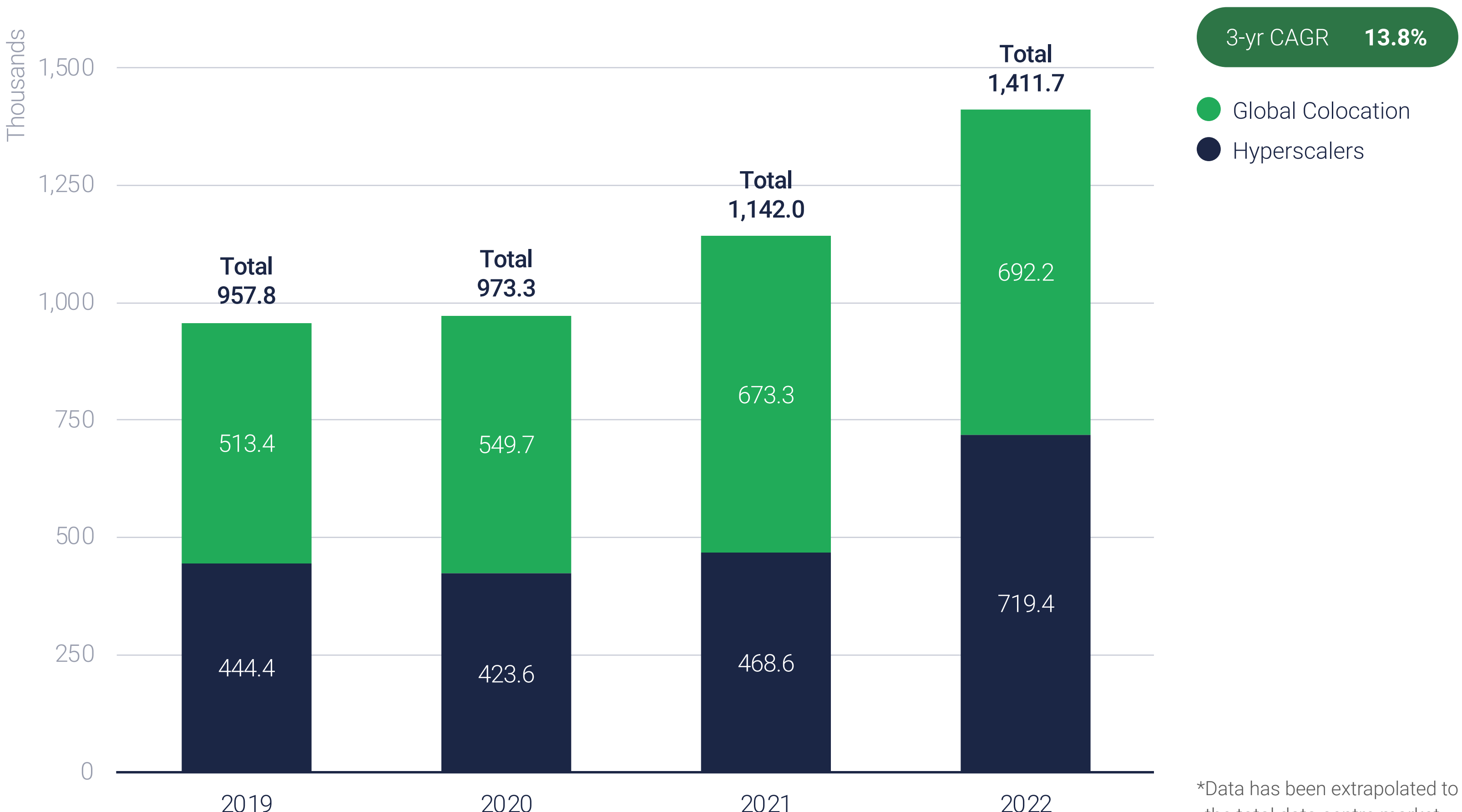
SEGMENT % SHARE



*Data has been extrapolated to represent the total data centre market

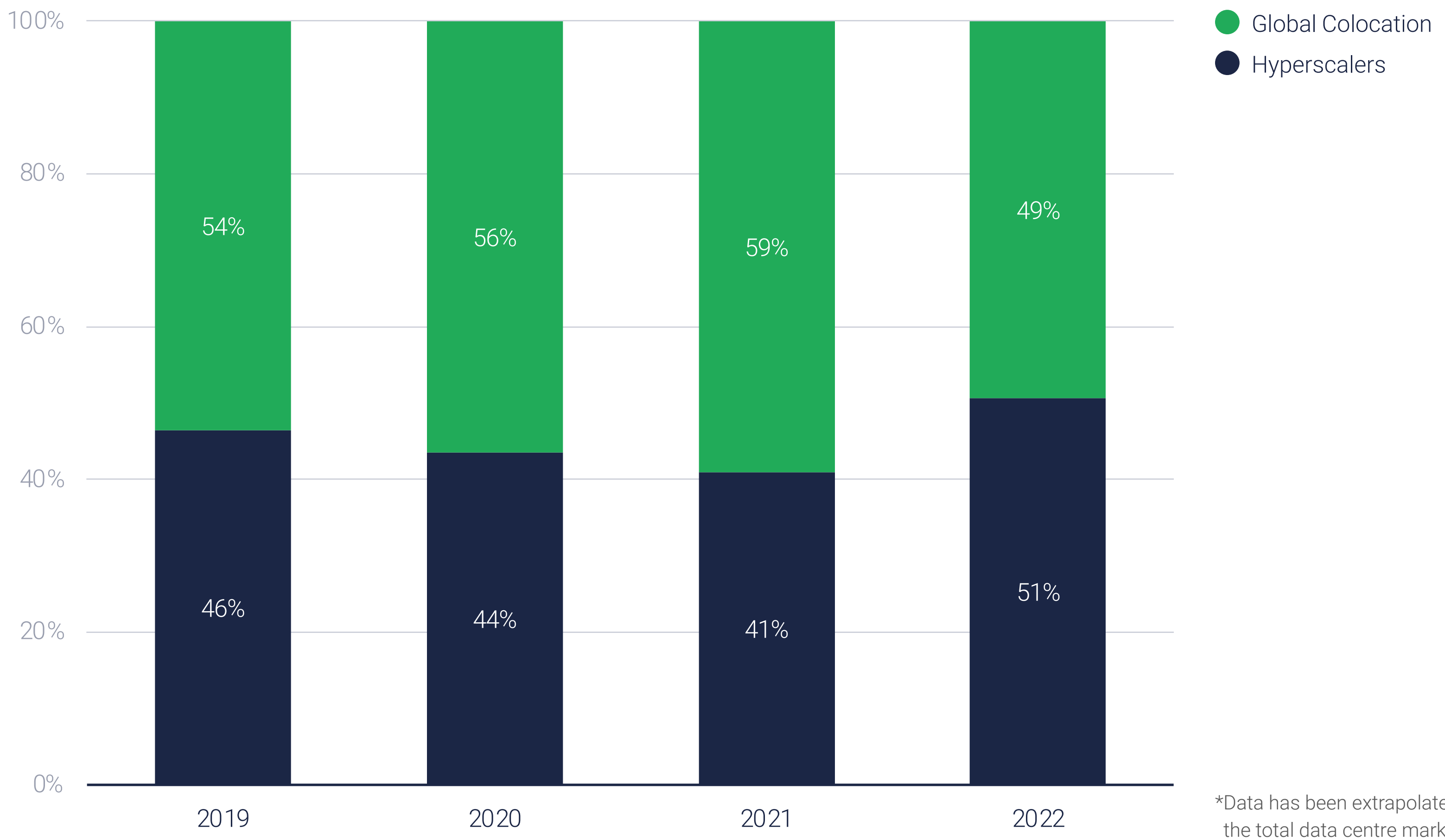
Scope 1 Emissions

In thousands $mtCO_2e$



*Data has been extrapolated to represent the total data centre market

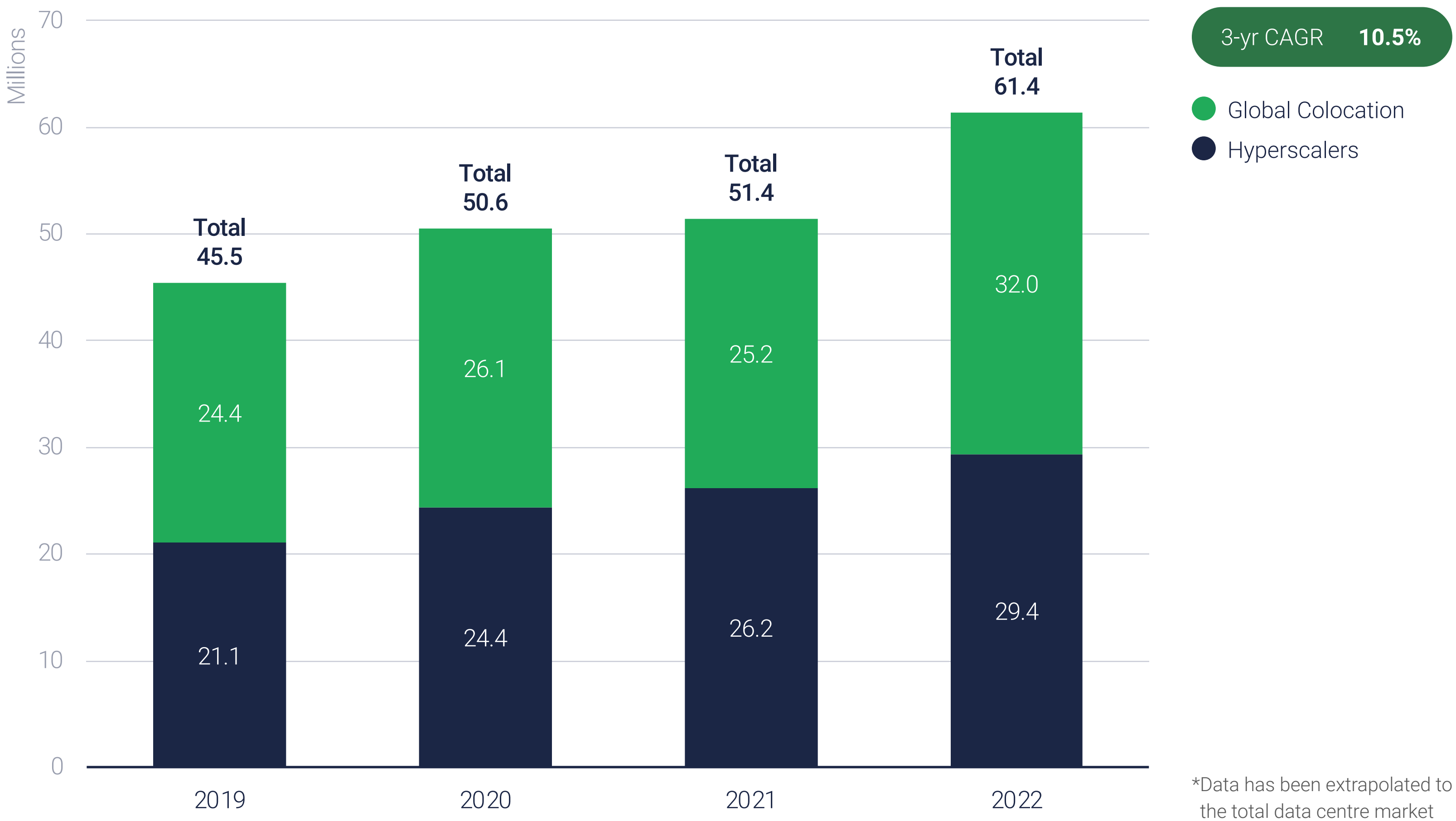
Scope 1 Emissions (%)



*Data has been extrapolated to represent the total data centre market

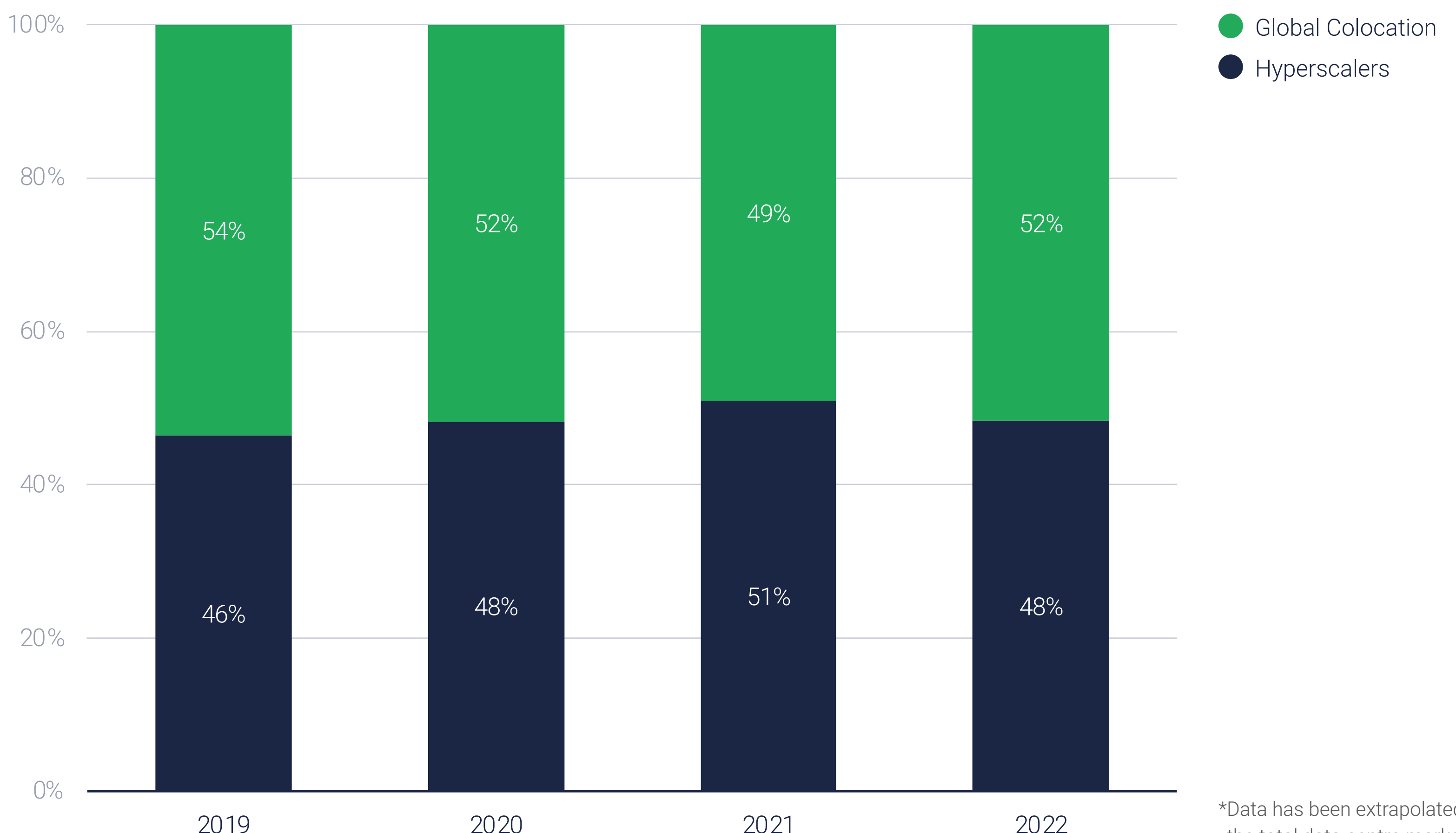
Scope 2 (Location-Based) Emissions

In millions $mtCO_2e$



*Data has been extrapolated to represent the total data centre market

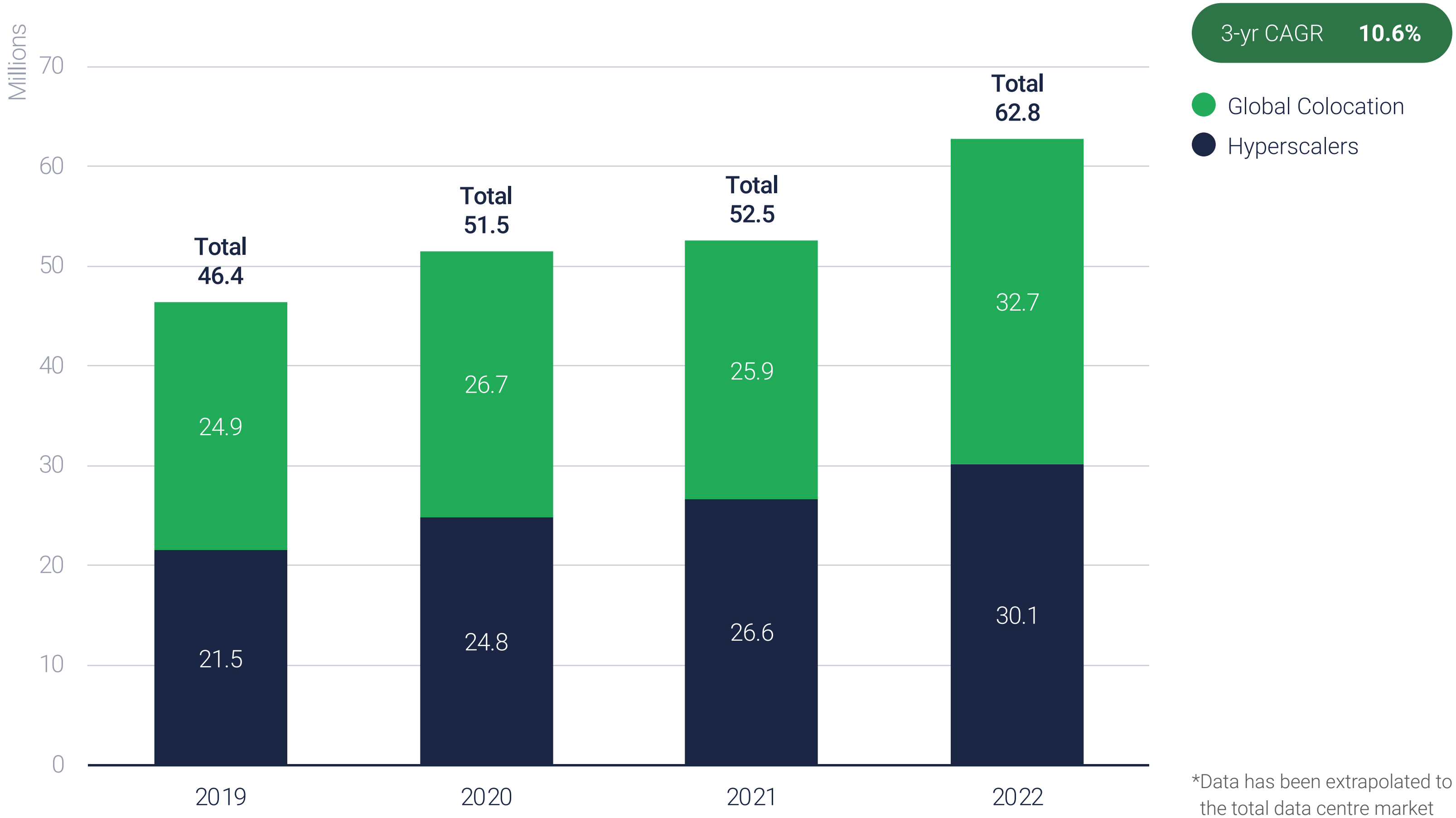
Scope 2 (Location-Based) Emissions (%)



*Data has been extrapolated to represent the total data centre market

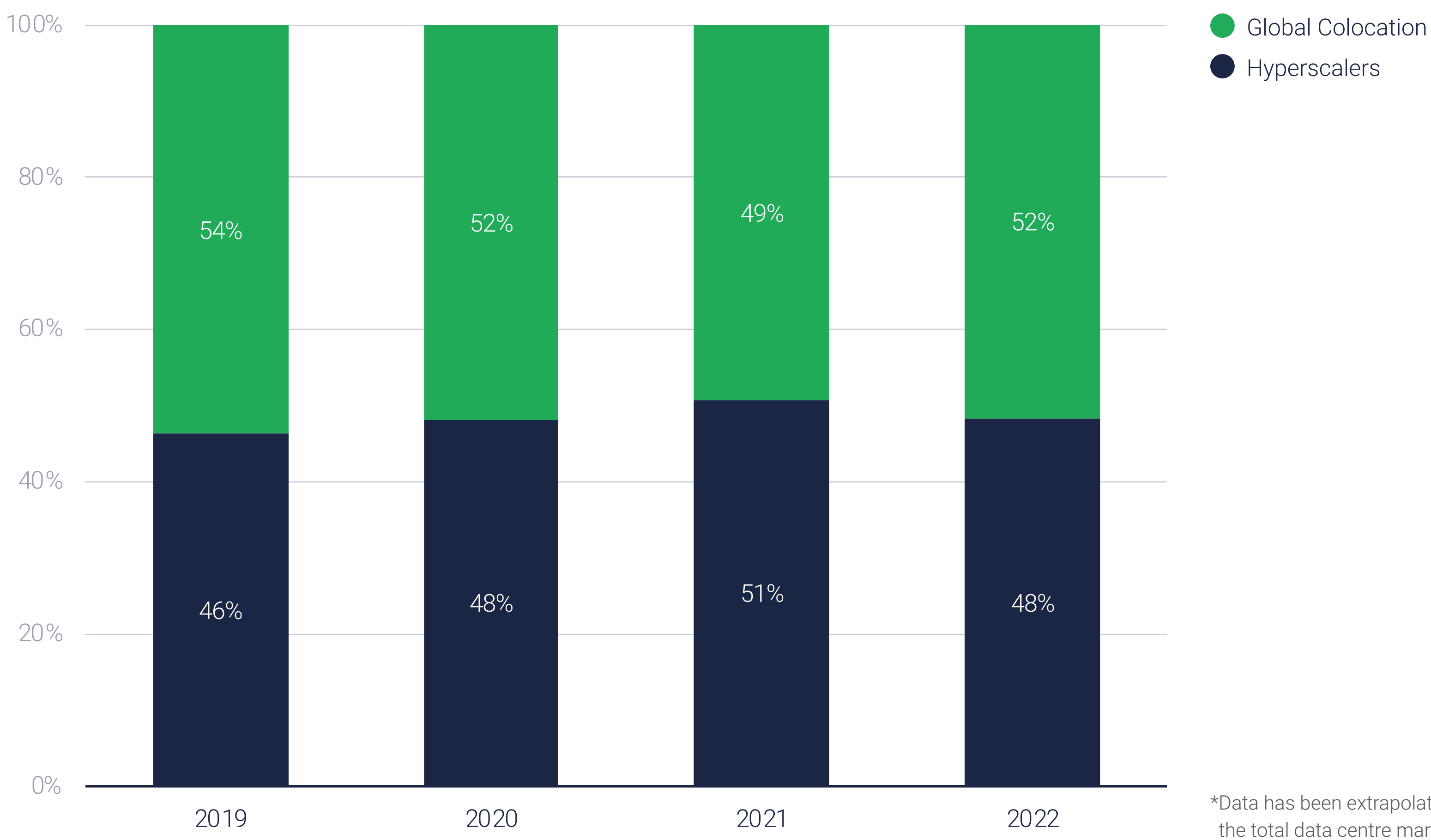
Total Scope 1 + Scope 2 (Location-Based) Emissions

In millions $mtCO_2e$



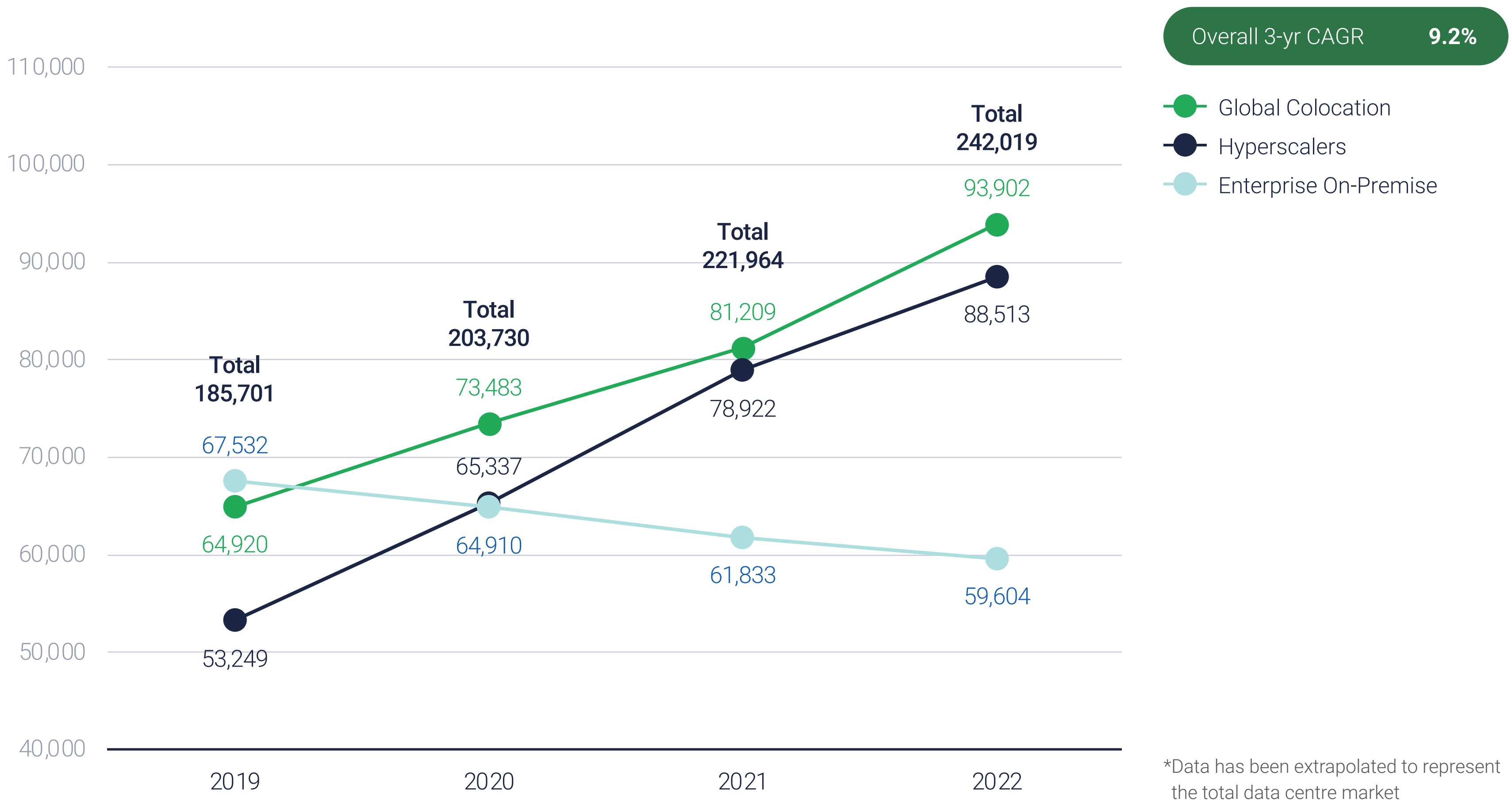
*Data has been extrapolated to represent the total data centre market

Total Scope 1 + Scope 2 (Location-Based) Emissions (%)



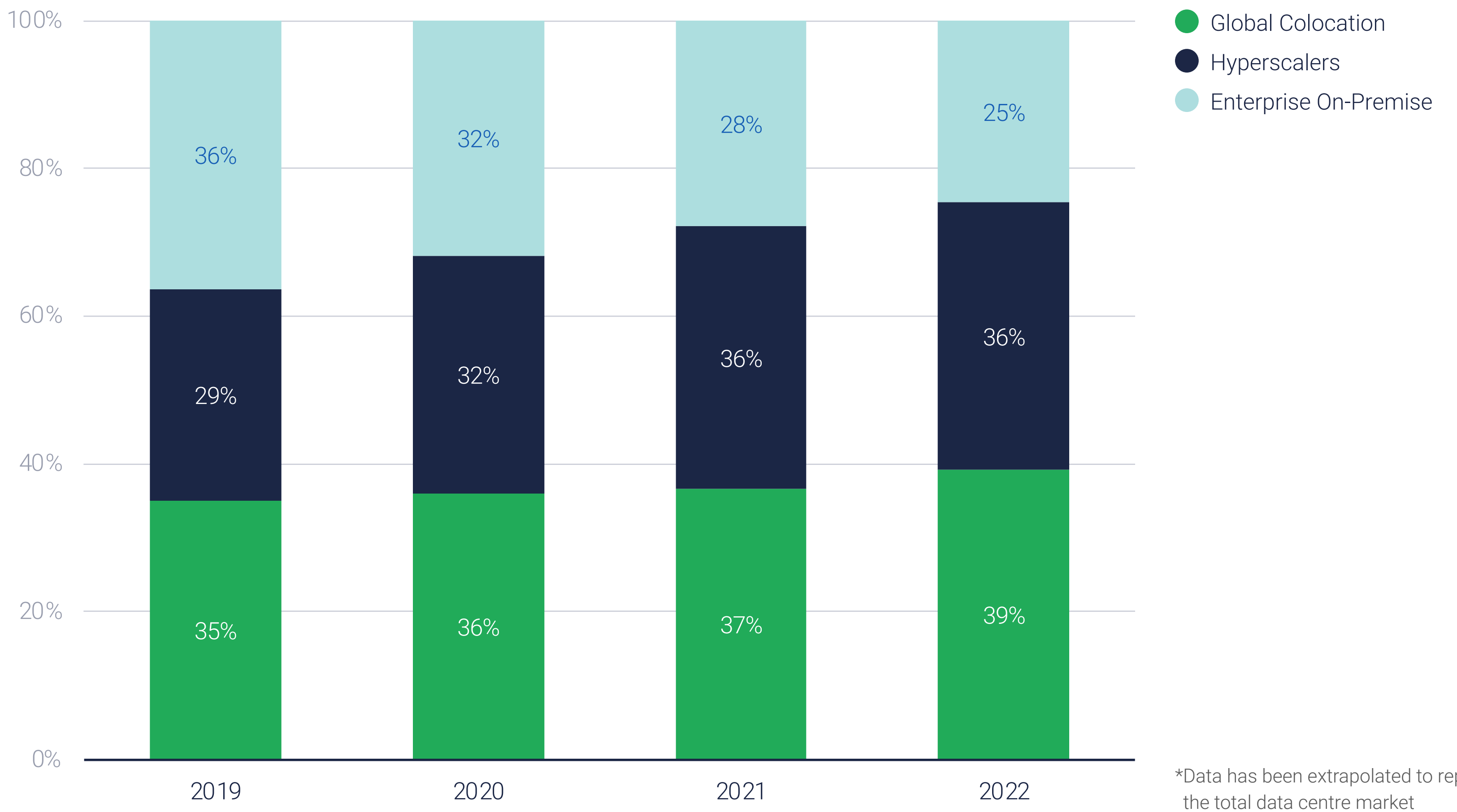
*Data has been extrapolated to represent the total data centre market

Total Energy Consumption (GWh)



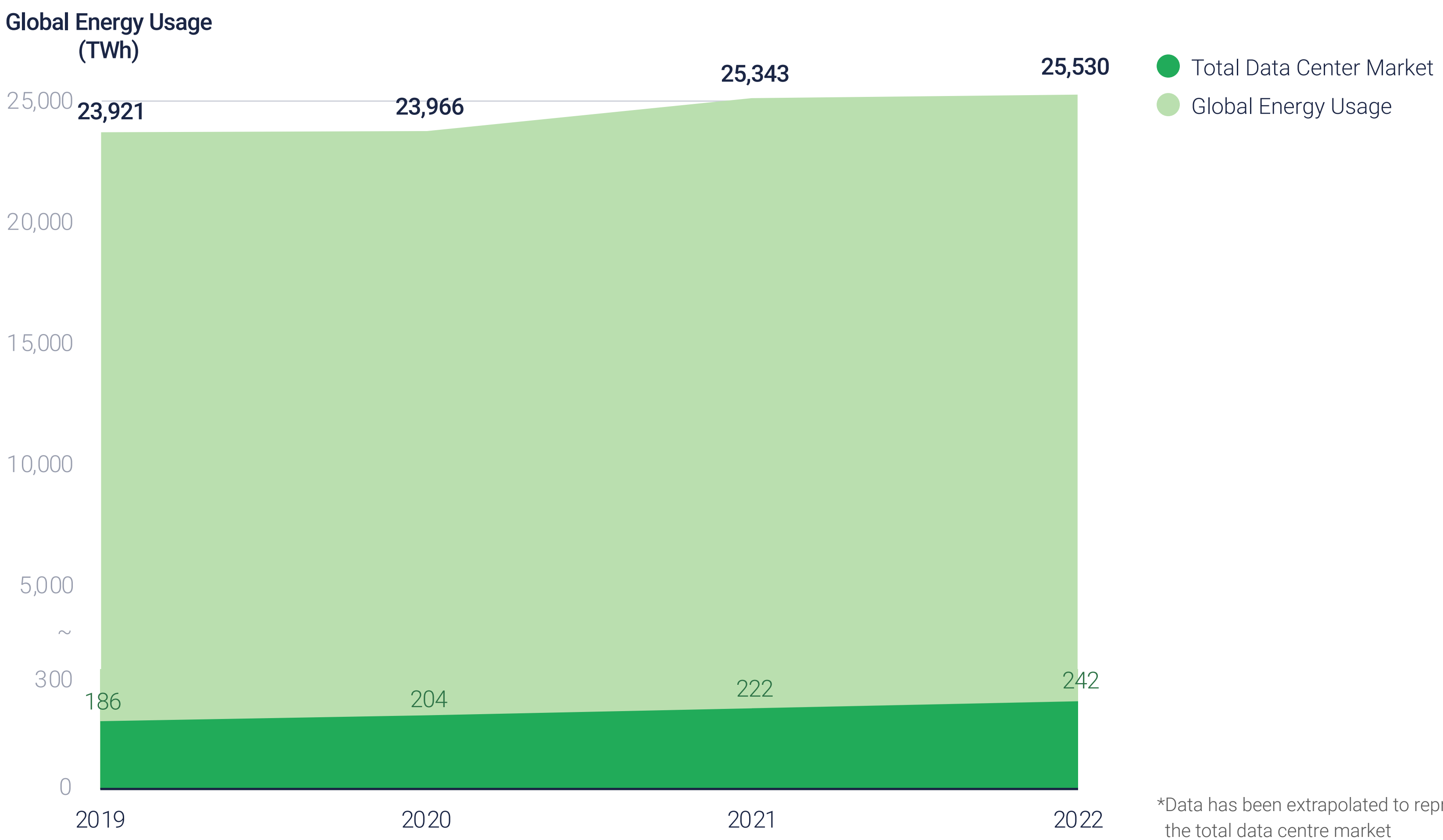
*Data has been extrapolated to represent the total data centre market

Total Energy Consumption (%)



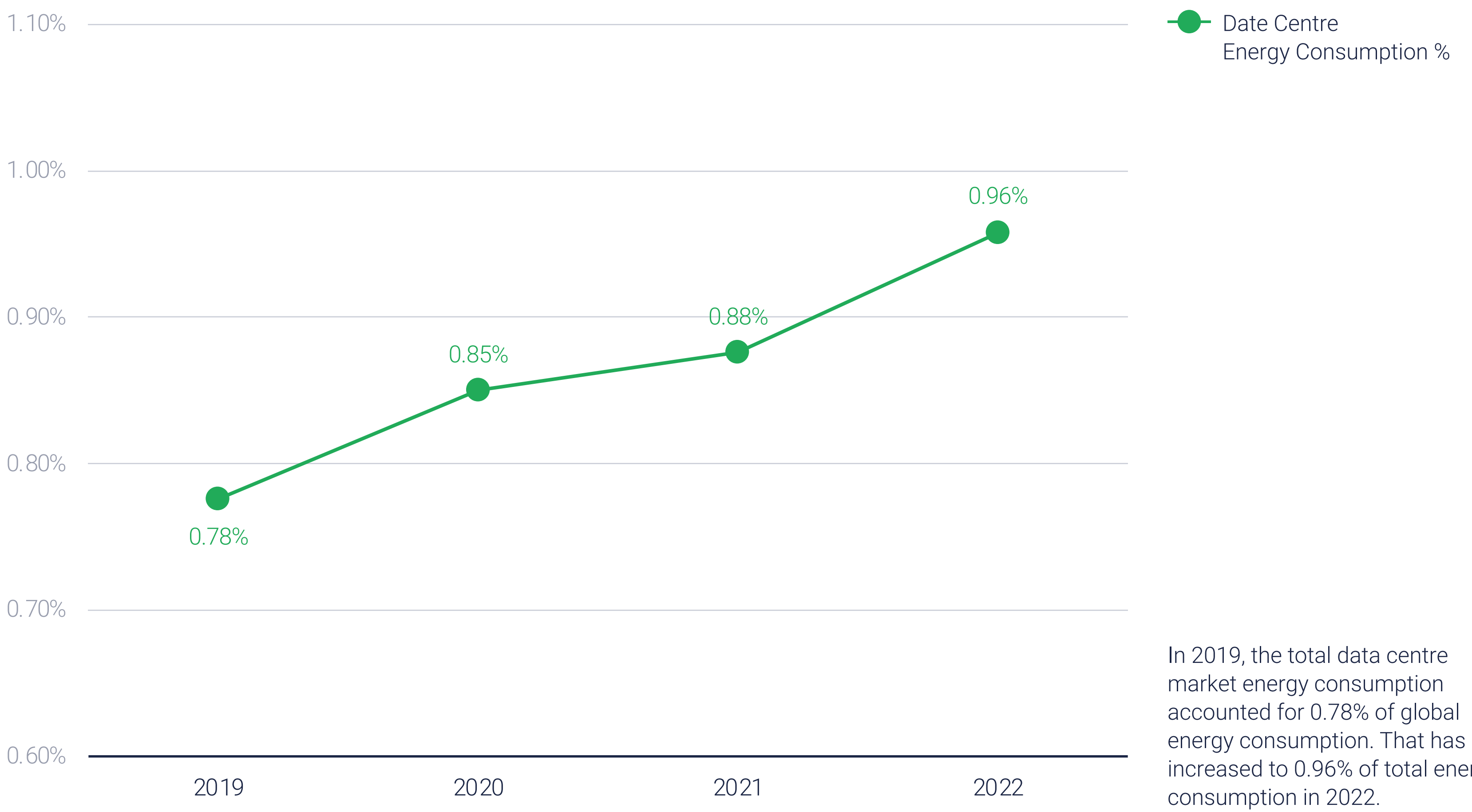
*Data has been extrapolated to represent the total data centre market

Total Data Center Market vs. Global Energy Usage (TWh)



*Data has been extrapolated to represent the total data centre market

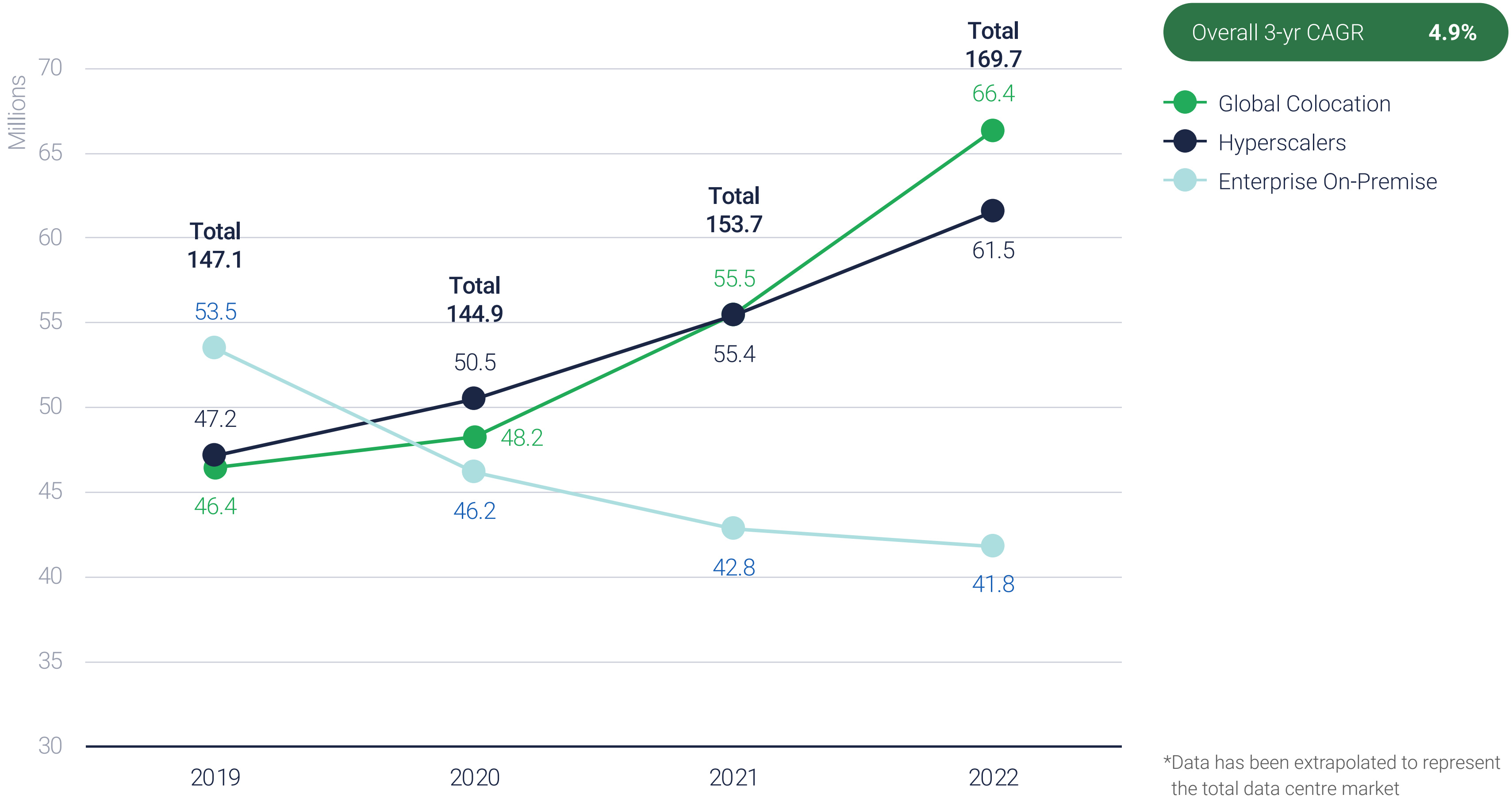
Data Centre vs. Global Energy Consumption (%)



In 2019, the total data centre market energy consumption accounted for 0.78% of global energy consumption. That has increased to 0.96% of total energy consumption in 2022.

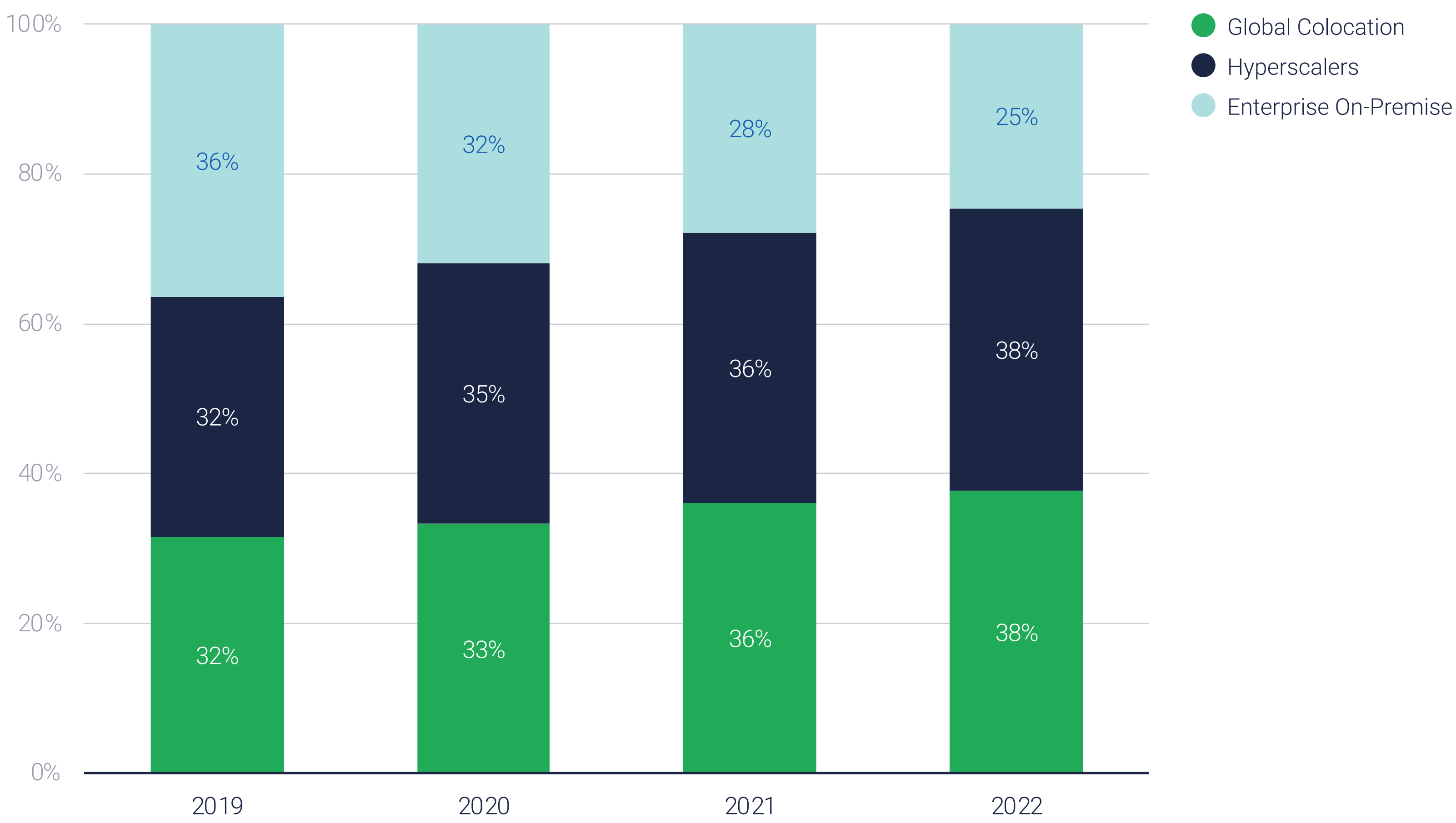
Total Water Consumption

In millions m^3



*Data has been extrapolated to represent the total data centre market

Total Water Consumption (%)



Global Market Insights

OPERATIONAL IT CAPACITY

- Total operational IT capacity has increased from 34,697 MW in 2019 to 45,944 MW in 2022 (approximately a 32.4% increase).
- The global colocation market makes up 49% of this share in 2022, up from 44% in 2019.
- Hyperscale self builds had the most significant growth in IT capacity between 2019 to 2022, going from taking up 19% of the share in 2019 to 26% in 2022.
- Enterprise on-premise capacity has gradually decreased during this period, with 12,618 MW of operational capacity in 2019 and declining to 11,315 MW in 2022.
- With this overall increase in global IT capacity, it holds that total resource utilization by the data centre industry will also increase as more resources are needed to support the new IT demands.

TOTAL CARBON EMISSIONS

- Global colocation providers account for approximately 49-59% of the scope 1 (i.e. direct) emissions each year.
- When looking at the scope 2 emissions, the split is more even between hyperscalers and the global colocation market, with colocation providers representing 49-54% of the emissions each year.
- Combined, total data centre emissions increased from 46.4 million metric tonnes in 2019 to 62.8 million in 2022:
  - Between 2019 to 2020 and 2021 to 2022, total emissions rose by 11.0% and 19.5% respectively, while the growth of emissions between 2020 and 2021 comparatively lower at 2.0%.
  - While emissions did increase between 2020 and 2021, the global pandemic likely slowed the volume of emissions during this period.

Global Market Insights (Cont.)

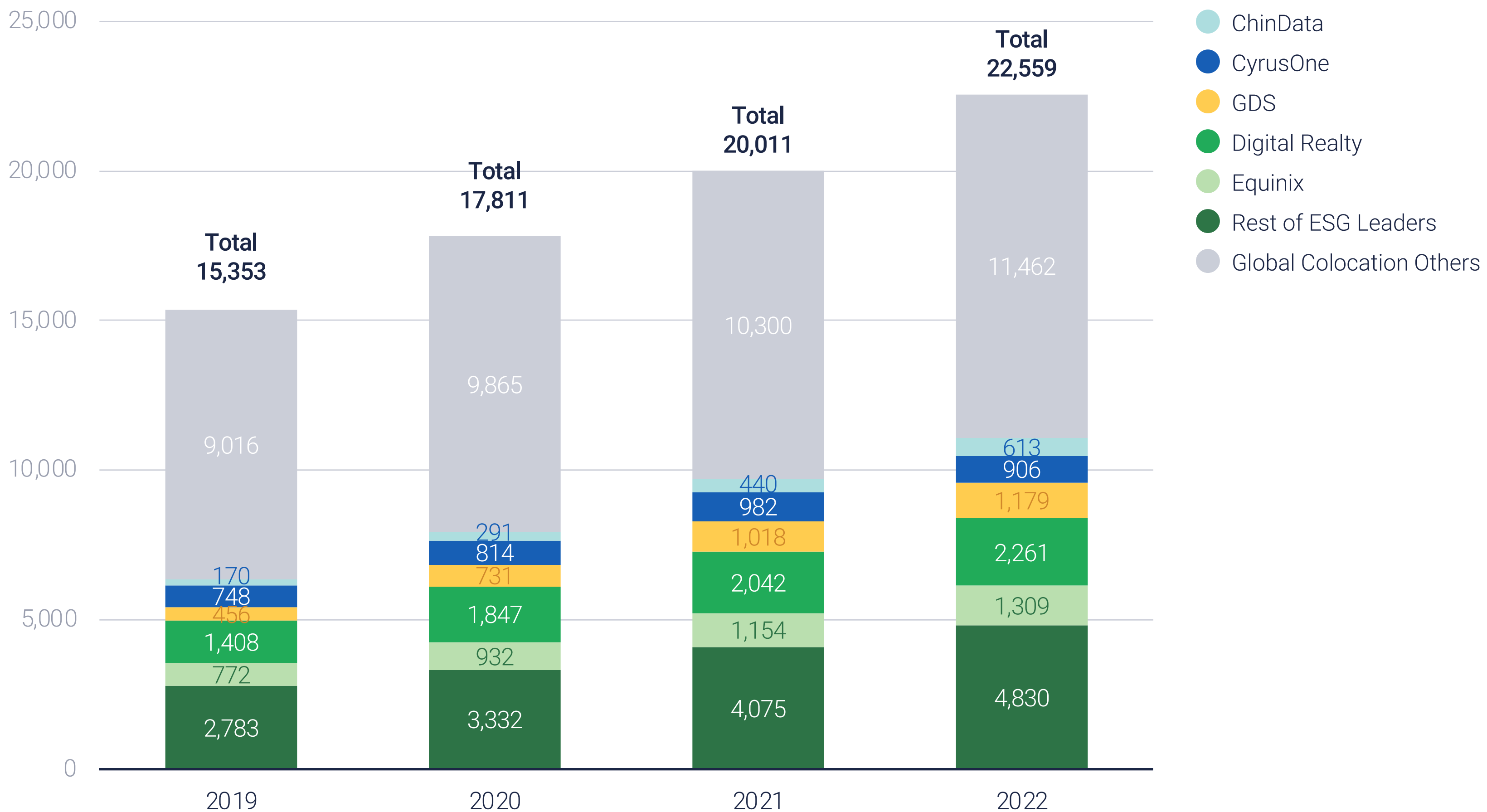
TOTAL ENERGY CONSUMPTION

- Energy consumption has increased each year for colocation and hyperscalers, while enterprise on-premise consumption has decreased each year, in line with growth/decline in the amount of data centre capacity.
- The proportion of energy consumption taken up by enterprise on-premise, hyperscalers, and global colocation providers has changed over the 2019-2022 timeframe:
  - About 35-39% of the consumption has been generated by global colocation providers, increasing about 1% a year.
  - The hyperscale segment has seen the most growth in energy consumption, going from 29% of the total in 2019 to 36% in 2022.
  - The increase in the proportions of energy consumption by hyperscalers and global colocation has resulted in a decrease in the proportion of enterprise on-premise energy consumption. In 2019, enterprise on-premise energy consumption made up about 36% of the total but has declined to about 25% of the total consumption in 2022.
- Data centre energy consumption accounts for almost 1% of it in 2022, up from 0.78% in 2019.

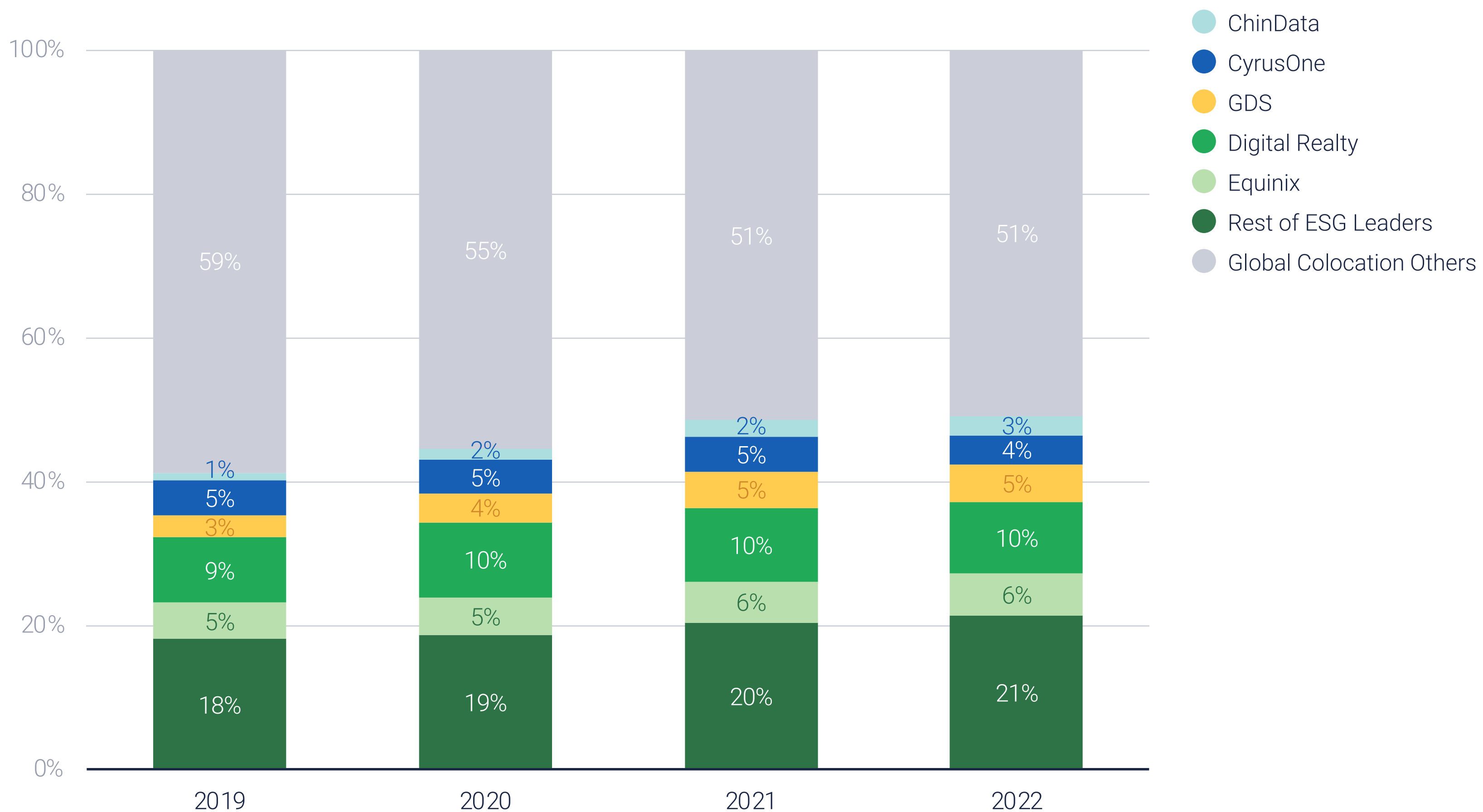
TOTAL WATER CONSUMPTION

- Water is used in data centres for efficient water cooling, but it is still consumed in high volumes. The volume of water consumption has increased every year since 2019.
- Water consumption has increased by 15.4% between 2019 to 2022. Combined, the data centre market consumed about 169.7 million m3 of water in 2022.

Total Operational Data Centre Critical IT Capacity (MW)



ESG Leaders (Data Centre Providers) by % Share of Global Capacity



Total Operational IT Capacity

The previous charts show the global colocation IT capacity with representation for the ESG Leaders included in this report. Between 2019 and 2022, the total proportion of IT capacity from ESG Leaders has risen, with ESG Leaders outside of the top 5 showing the largest increase.

ESG colocation leaders representing the 5 largest entities by IT capacity include ChinData, CyrusOne, GDS, Digital Realty, and Equinix, and are shown separated out from the rest of the colocation ESG Leaders.

For a comparison, the total IT capacity of colocation providers not included as an ESG leader is also included. In 2022, the ESG Leaders combined represent approximately 49% of the total colocation capacity.

22,559 MW

The total operational colocation capacity in 2022

49%

The proportion of colocation capacity represented by ESG Leaders in 2022

5 largest entities by IT capacity

CHINDATA GROUP

CyrusOne

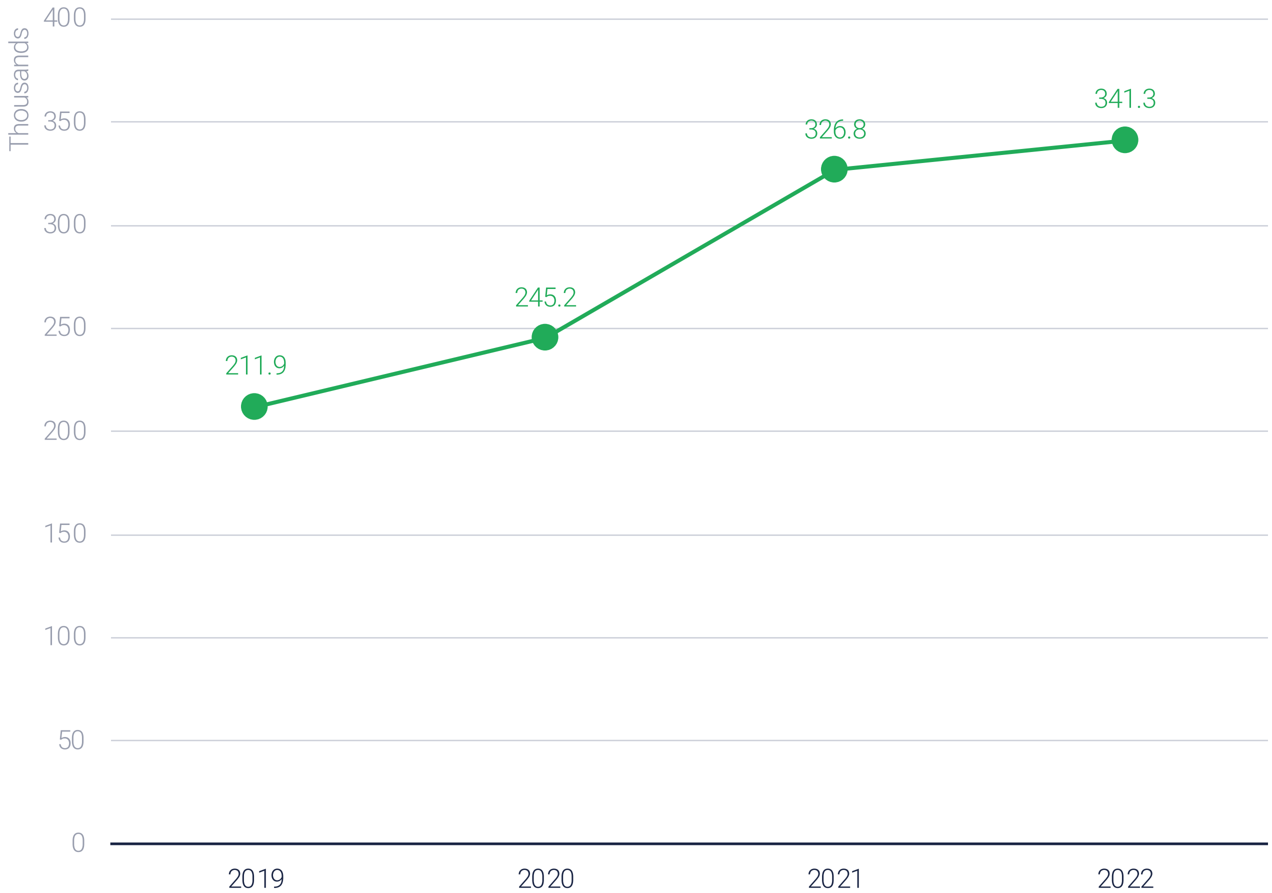
GDS万国数据

DIGITAL REALTY

EQUINIX

Scope 1 Emissions: Data Centre Providers

In thousands $mtCO_2e$

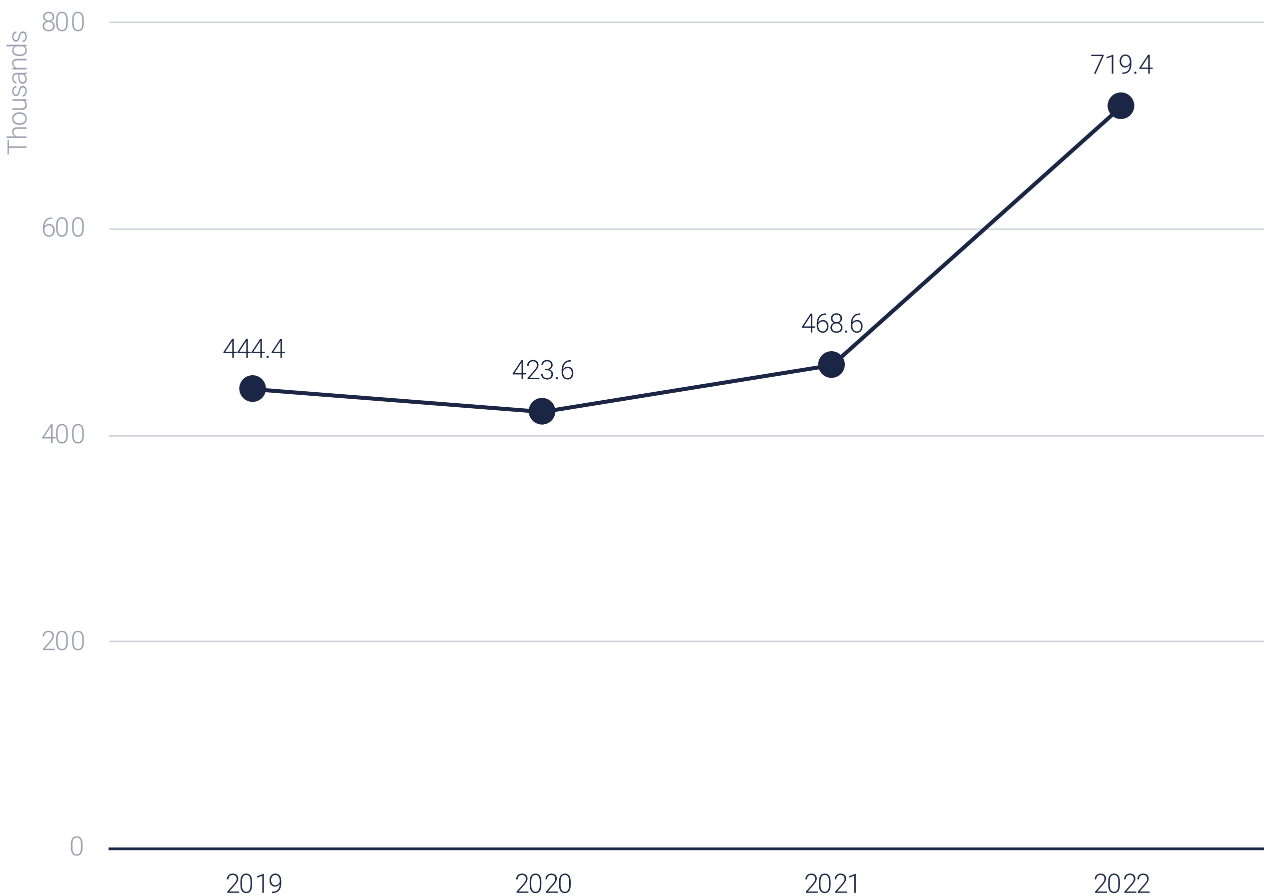


3-yr CAGR **17.2%**

*Values represent data from ESG Leaders only

Scope 1 Emissions: Hyperscale Platforms

In thousands mtCO_2e

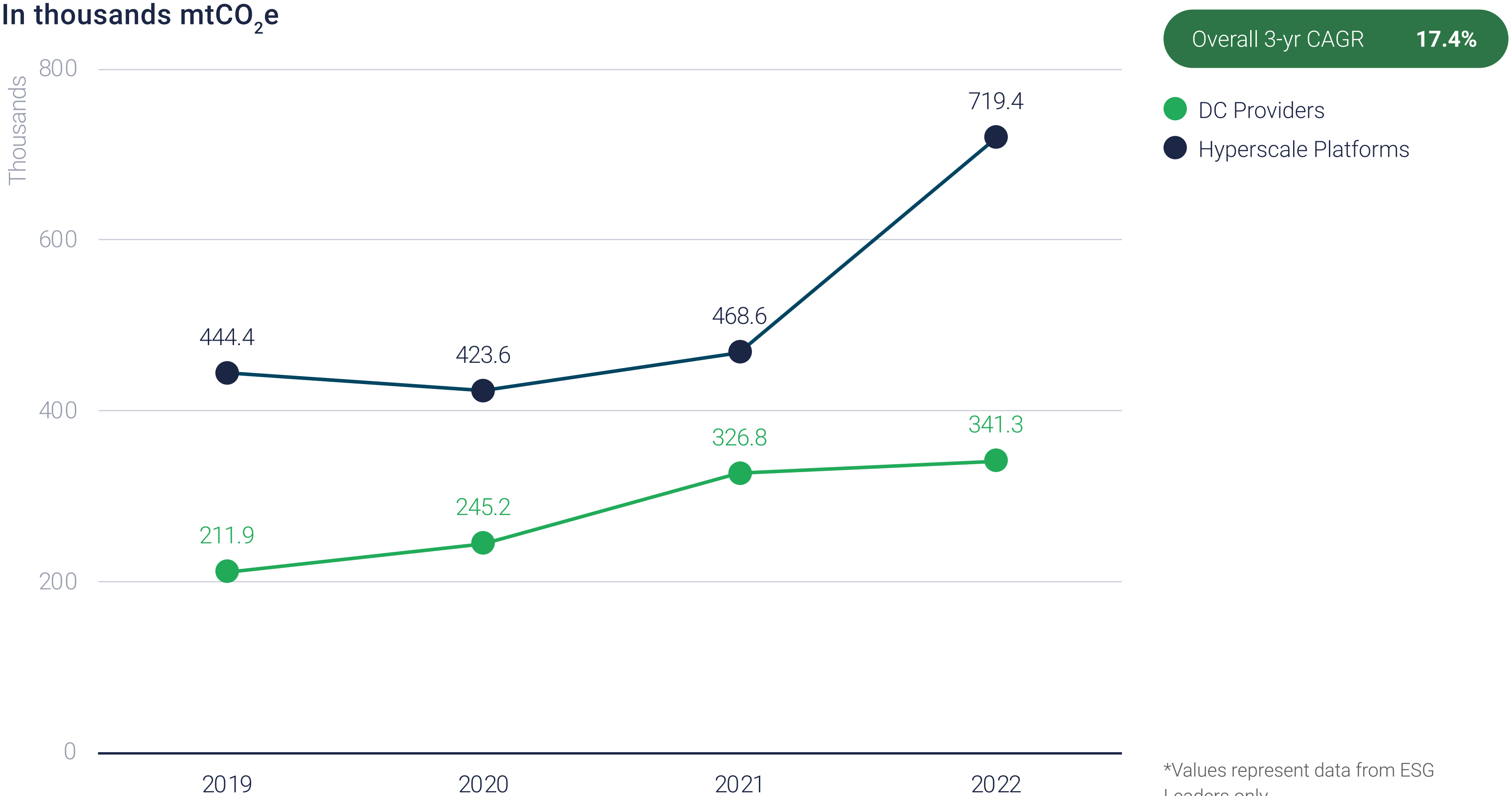


3-yr CAGR **17.4%**

*Values represent data from ESG Leaders only

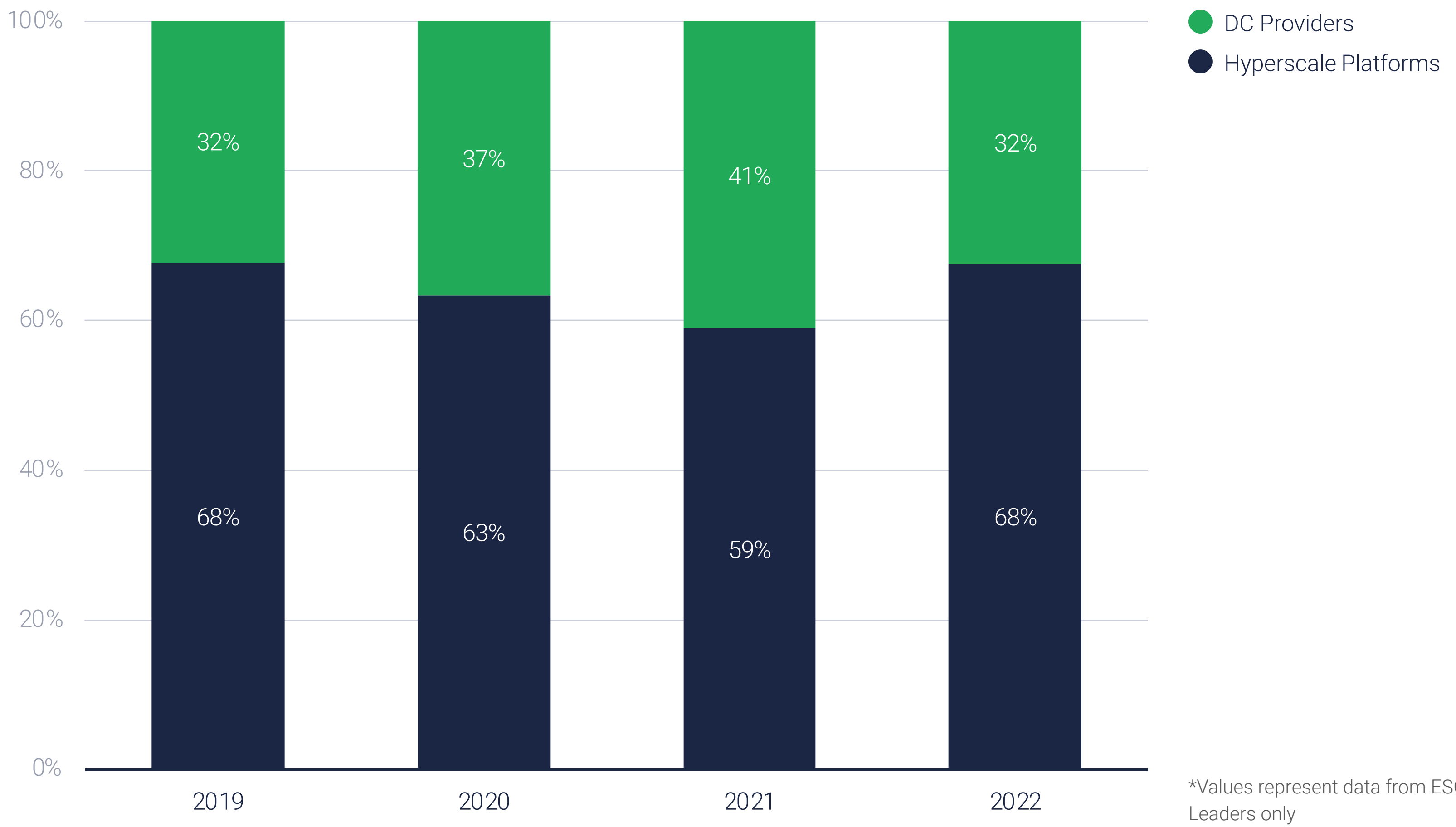
Scope 1 Emissions: Hyperscale Platforms vs. Data Centre Providers

In thousands $mtCO_2e$



*Values represent data from ESG Leaders only

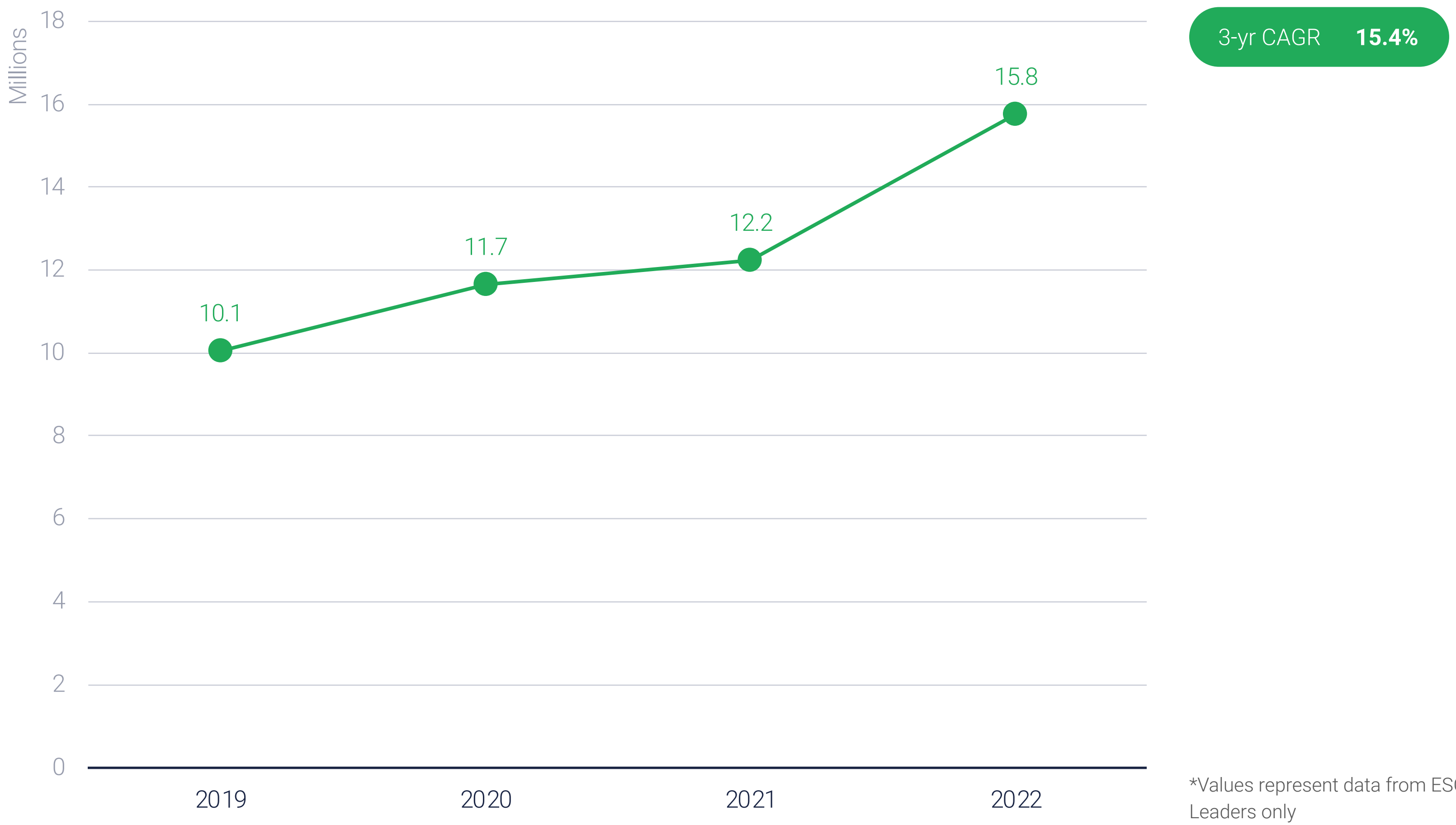
Scope 1 Emissions (%): Hyperscale Platforms vs. Data Centre Providers



*Values represent data from ESG Leaders only

Scope 2 (location-based) Emissions: Data Centre Providers

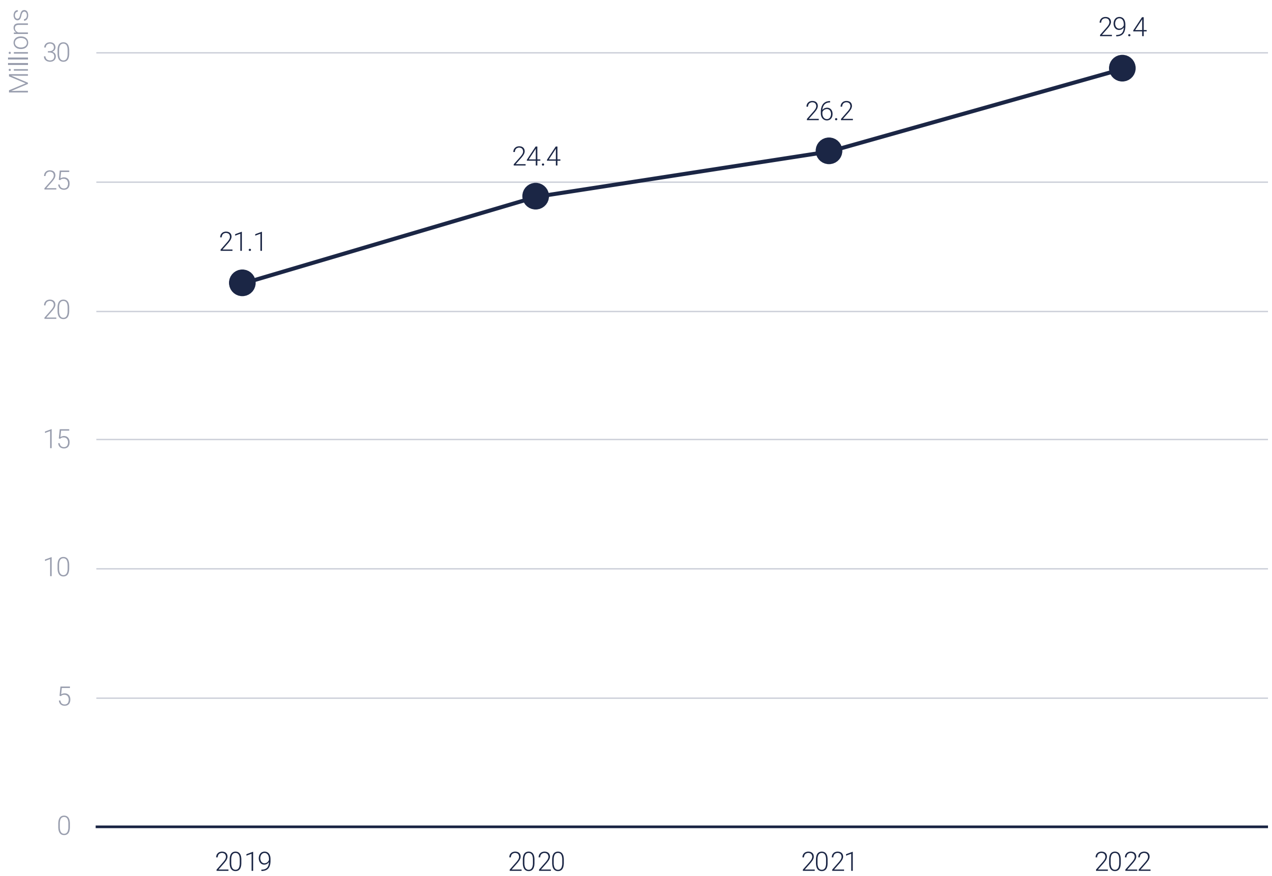
In millions $mtCO_2e$



*Values represent data from ESG Leaders only

Scope 2 (location-based) Emissions: Hyperscale Platforms

In millions $mtCO_2e$

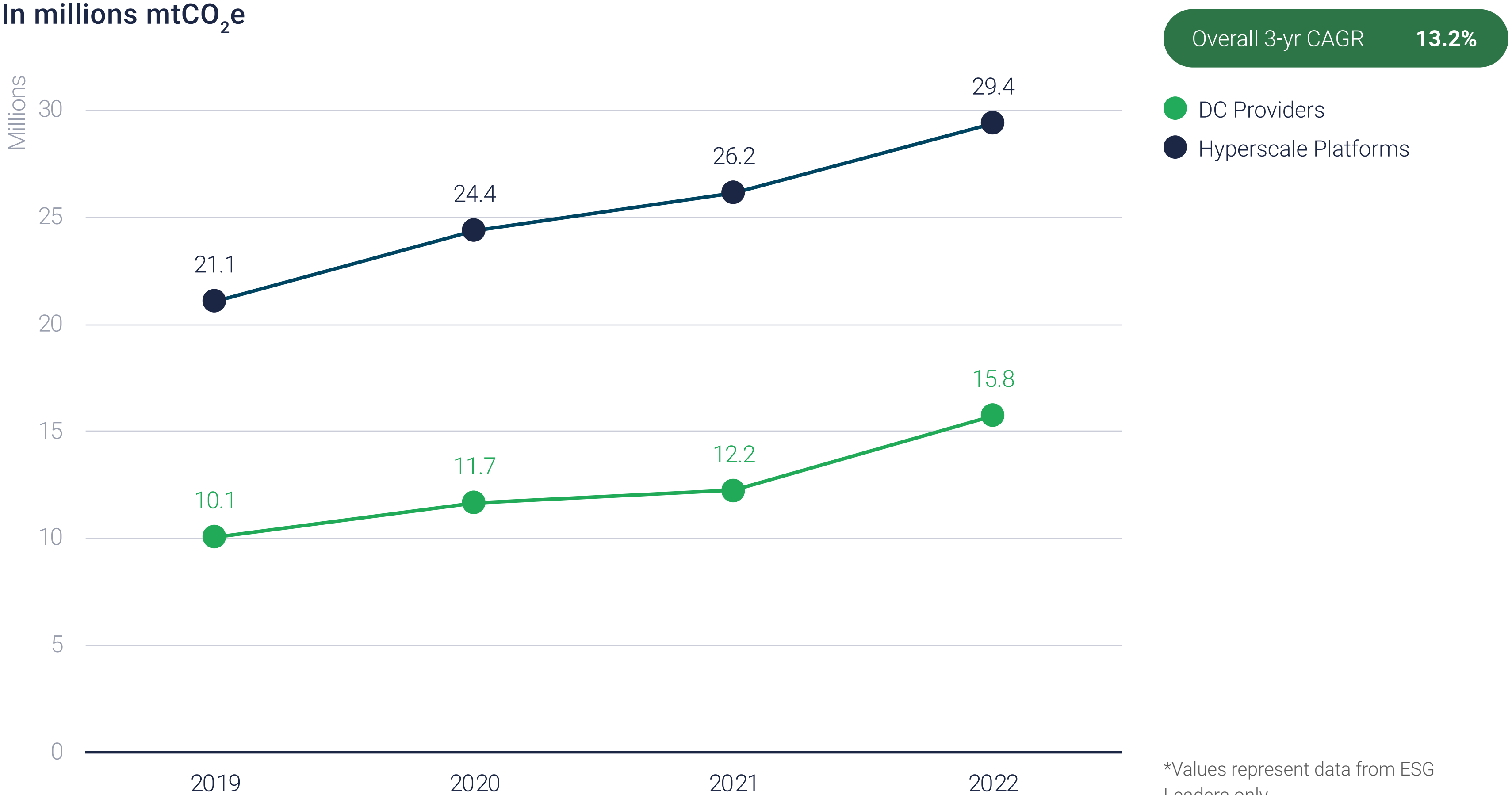


3-yr CAGR **11.7%**

*Values represent data from ESG Leaders only

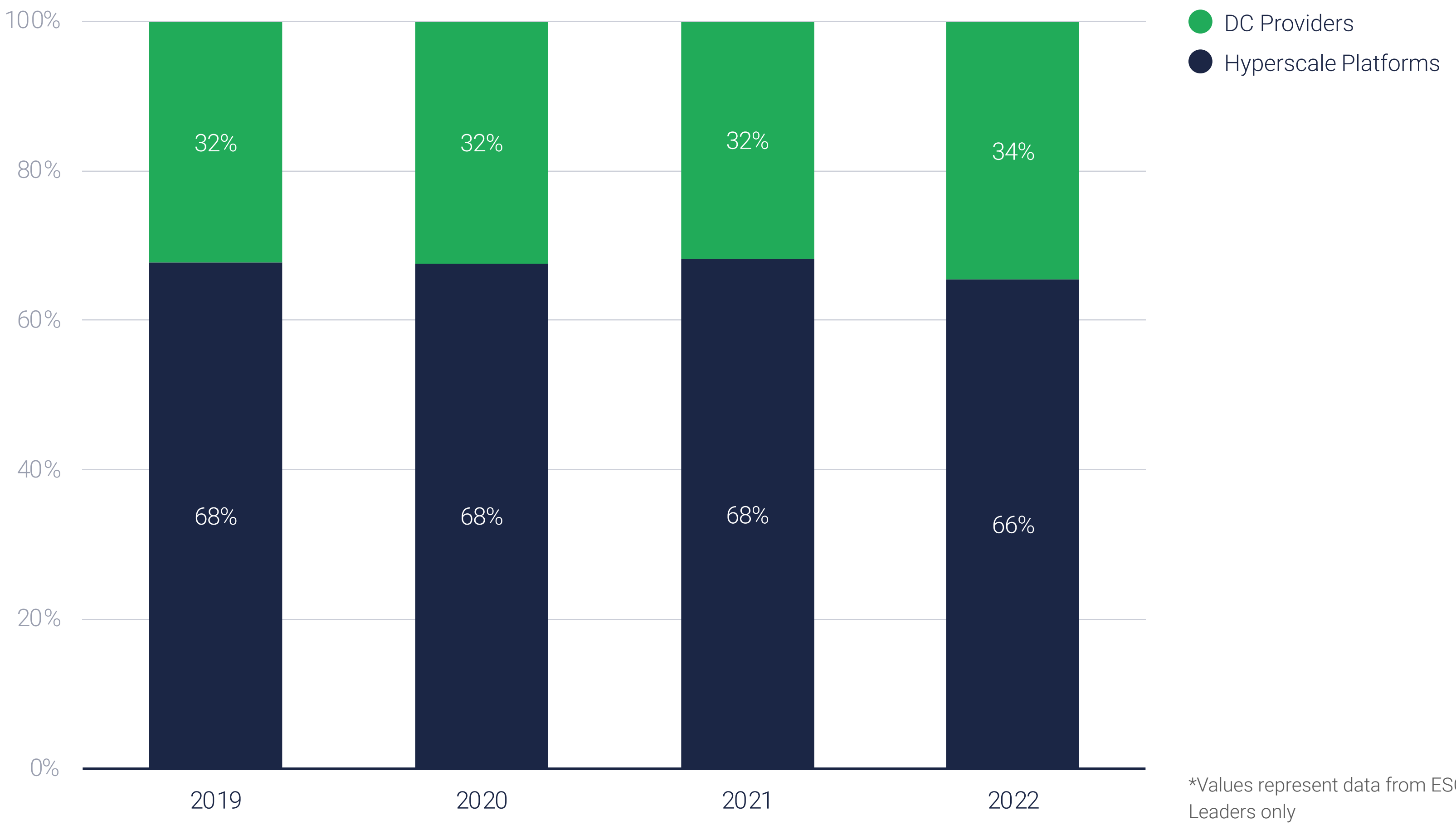
Scope 2 (location-based) Emissions: Hyperscale Platforms vs. Data Centre Providers

In millions $mtCO_2e$



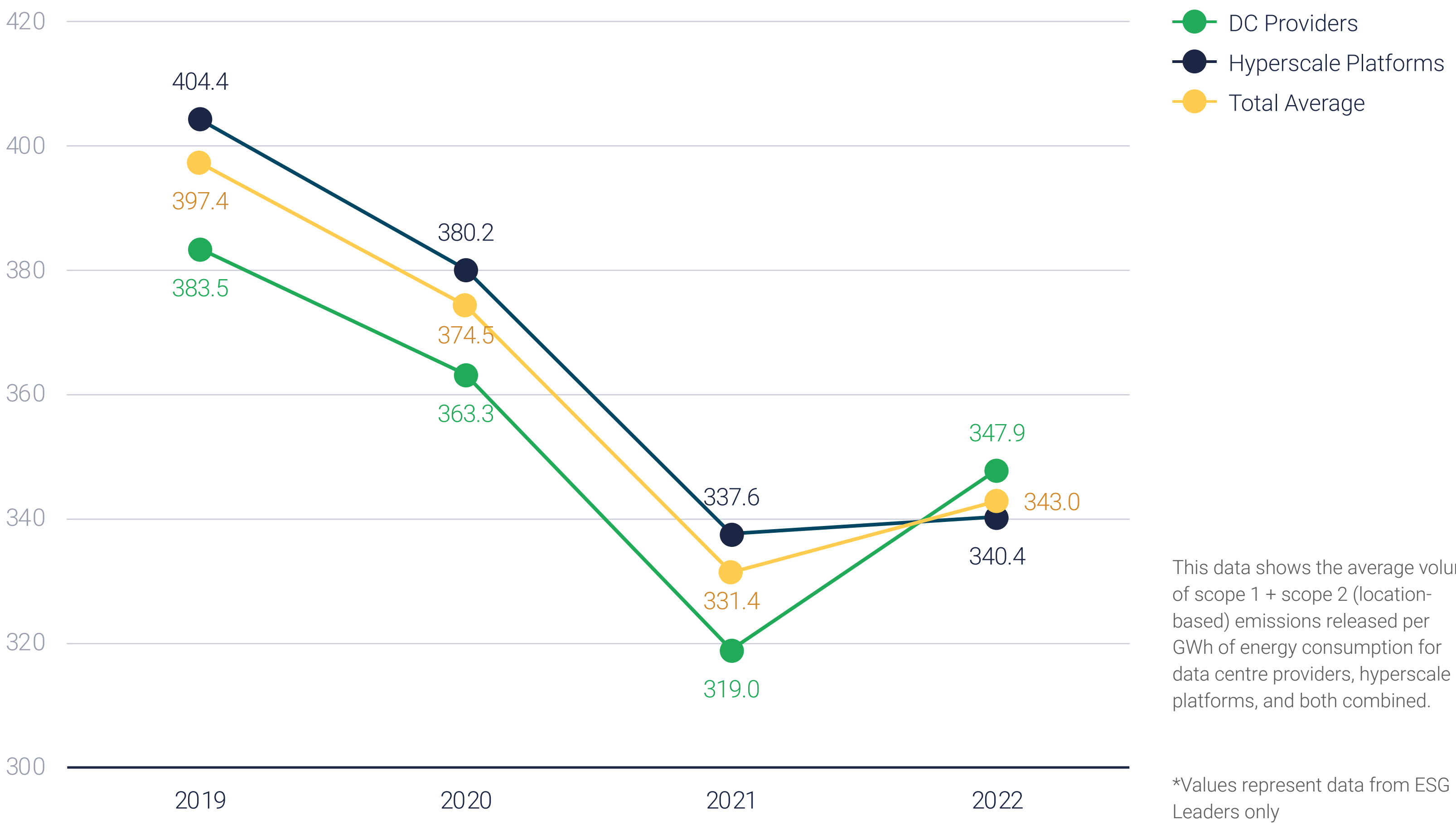
*Values represent data from ESG Leaders only

Scope 2 (Location-based) Emissions (%): Hyperscale Platforms vs. Data Centre Providers



*Values represent data from ESG Leaders only

Average Emissions per GWh of Energy Usage ($mtCO_2e/GWh$)



This data shows the average volume of scope 1 + scope 2 (location-based) emissions released per GWh of energy consumption for data centre providers, hyperscale platforms, and both combined.

*Values represent data from ESG Leaders only

Carbon Emissions
Hyperscale vs. Global Colocation Insights

CO_2 EMISSIONS

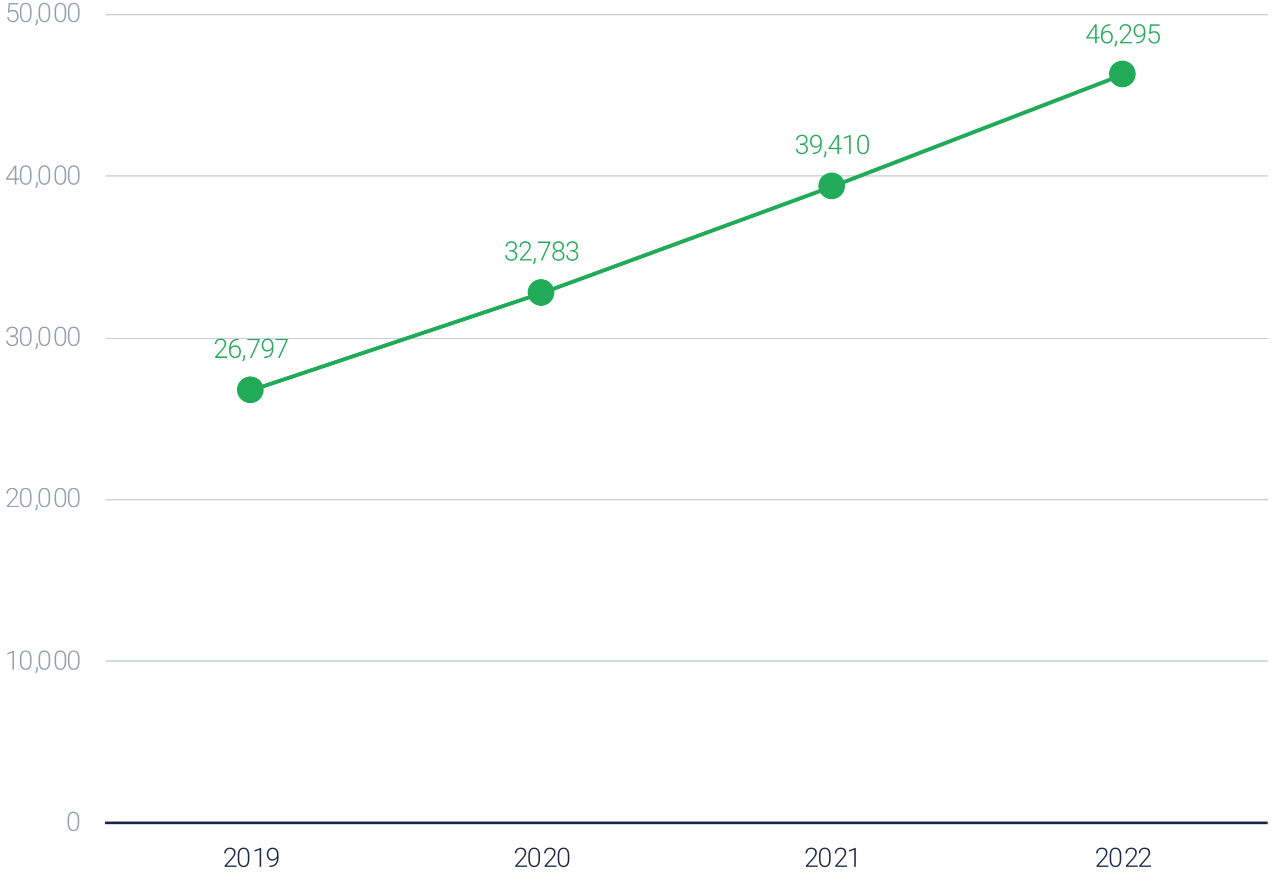
- Overall, there has been a global increase in the volume of CO_2 emissions every year since 2019.
  - Scope 1 emissions for data centre providers increased from 211,906 $mtCO_2e$ in 2019 to 341,282 $mtCO_2e$ in 2022.
  - Hyperscalers increased their scope 1 emissions from 6.47 million $mtCO_2e$ in 2019 to 719,443 million $mtCO_2e$ in 2022.
  - Location-based scope 2 emissions have also increased from 2019. Data centre platforms went from 10.1 million $mtCO_2e$ of location-based scope 2 emissions in 2019 to 15.8 million $mtCO_2e$ in 2022. Similarly, hyperscale platforms emissions have increased from 21.1 million $mtCO_2e$ to 29.4 million $mtCO_2e$ during the same period.

- Though the total volume of GHG emissions has increased, the average data centre GHG emissions per GWh of energy consumption has decreased over the same period.
  - For data centre providers, the average emissions per GWh of energy consumption has decreased from 383.5 $mtCO_2e$/GWh in 2019 to 347.9 $mtCO_2e$/GWh in 2022.
  - Hyperscale platforms also show a similar trend with the average emissions per GWh of energy consumption decreasing from 404.4 $mtCO_2e$/GWh in 2019 to 340.4 $mtCO_2e$/GWh in 2022.
  - While there has been fluctuations, the overall average data centre emissions per GWh of energy consumption has decreased from 397.4 $mtCO_2e$/GWh in 2019 to 343.0 $mtCO_2e$/GWh in 2022.
  - This average decrease can be attributed to new data centres being built and developed with energy efficiency and sustainability in mind (e.g. more efficient equipment and cooling technologies) alongside the installation and use of renewable energy.

- There is variation between companies on their CO2 emissions reduction. While some companies are decreasing their average emissions per GWh of energy consumption, many others have increased their emissions due to rapid growth and expansion of their services.

- Scope 3 emissions, which are not yet widely reported in the industry, is also a major source of carbon emissions.
  - In the data centre industry, the purchase of goods and electronics contributes to significant amounts of indirect emissions.
  - Electronics are often imported from overseas and heavy machinery and materials need to be transported for the construction of data centres.
  - In order to reduce these emissions, operators should be considering recycling and refurbishing computers, power supply, and other electronics to increase their longevity, reduce the purchase of new resources, and reduce the amount of waste being generated.

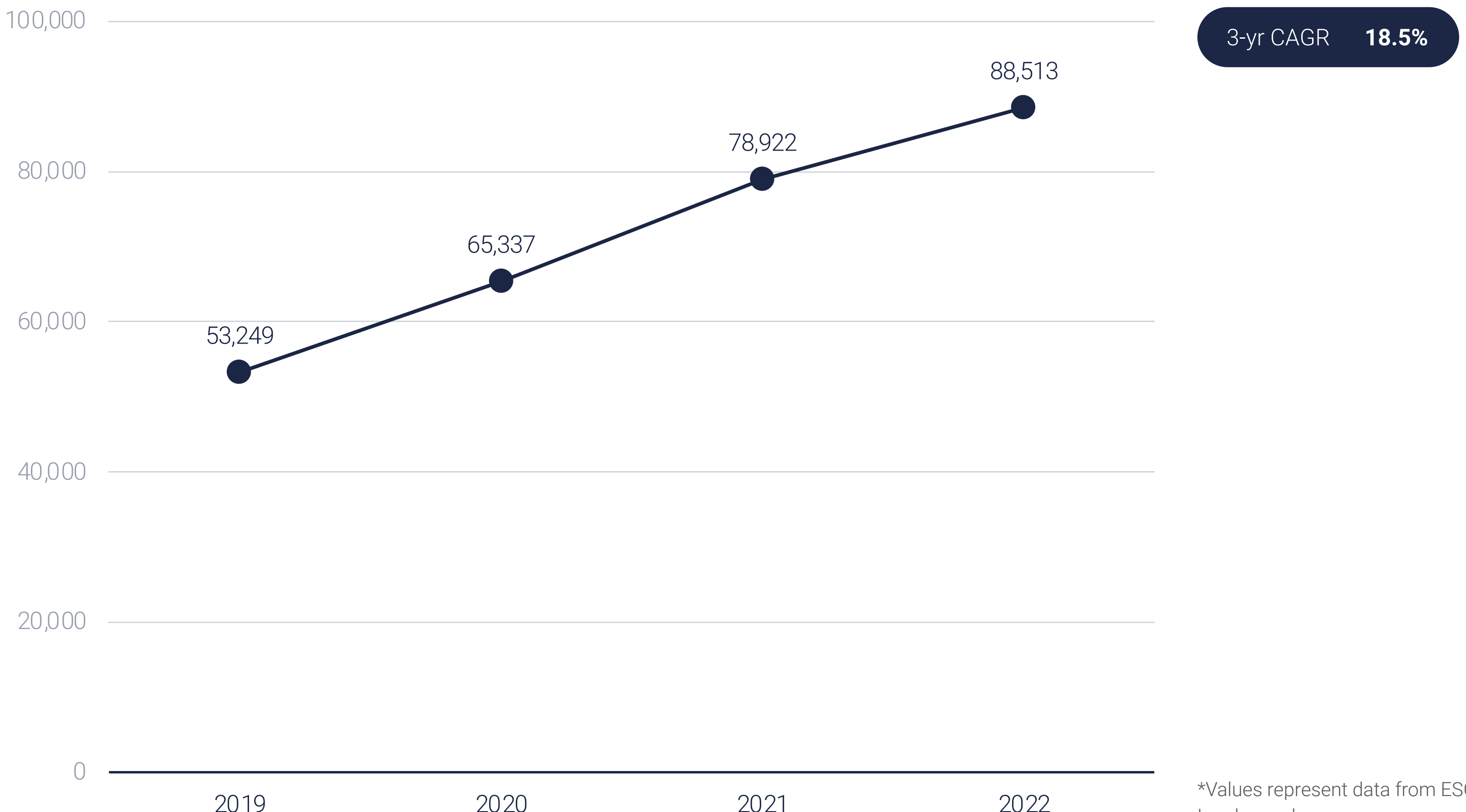
Total Energy Usage (GWh): Data Centre Providers



3-yr CAGR **20.0%**

*Values represent data from ESG Leaders only

Total Energy Usage (GWh): Hyperscale Platforms

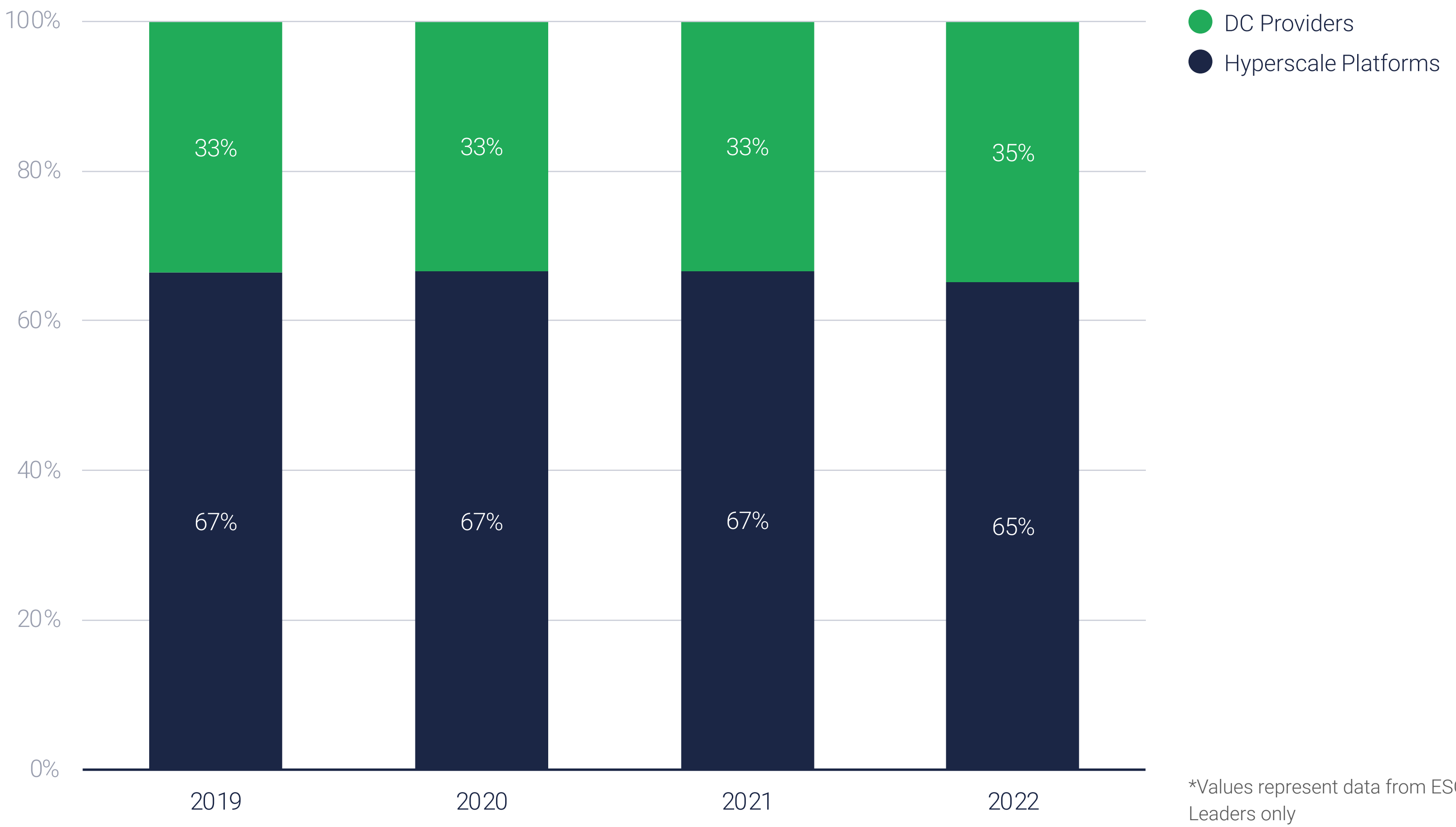


*Values represent data from ESG Leaders only

Total Energy Usage (GWh): Hyperscale Platforms vs. Data Centre Providers

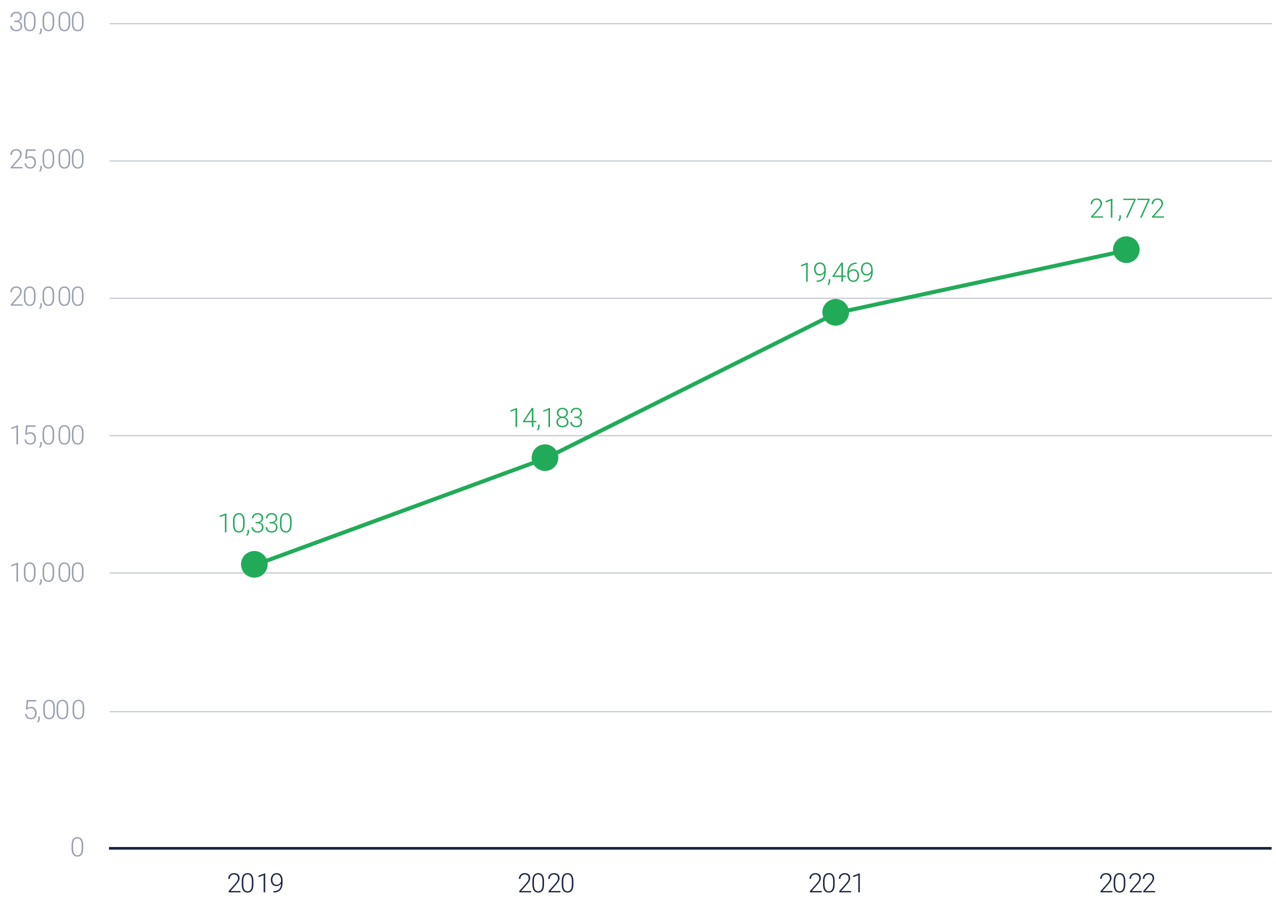
*Values represent data from ESG Leaders only

Total Energy Usage (%): Hyperscale Platforms vs. Data Centre Providers



*Values represent data from ESG Leaders only

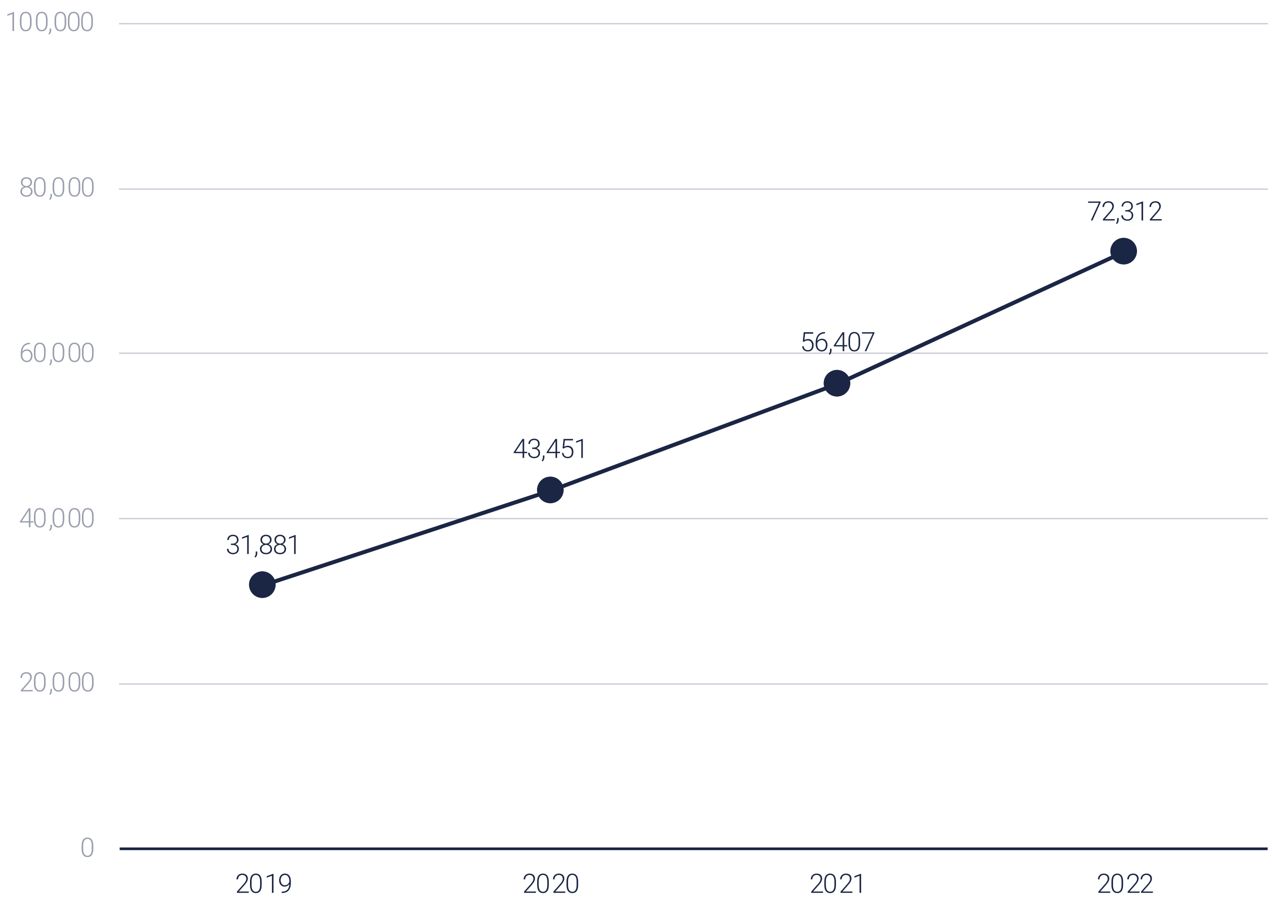
Total Renewable Energy Usage (GWh): Data Centre Providers



3-yr CAGR **28.2%**

*Values represent data from ESG Leaders only

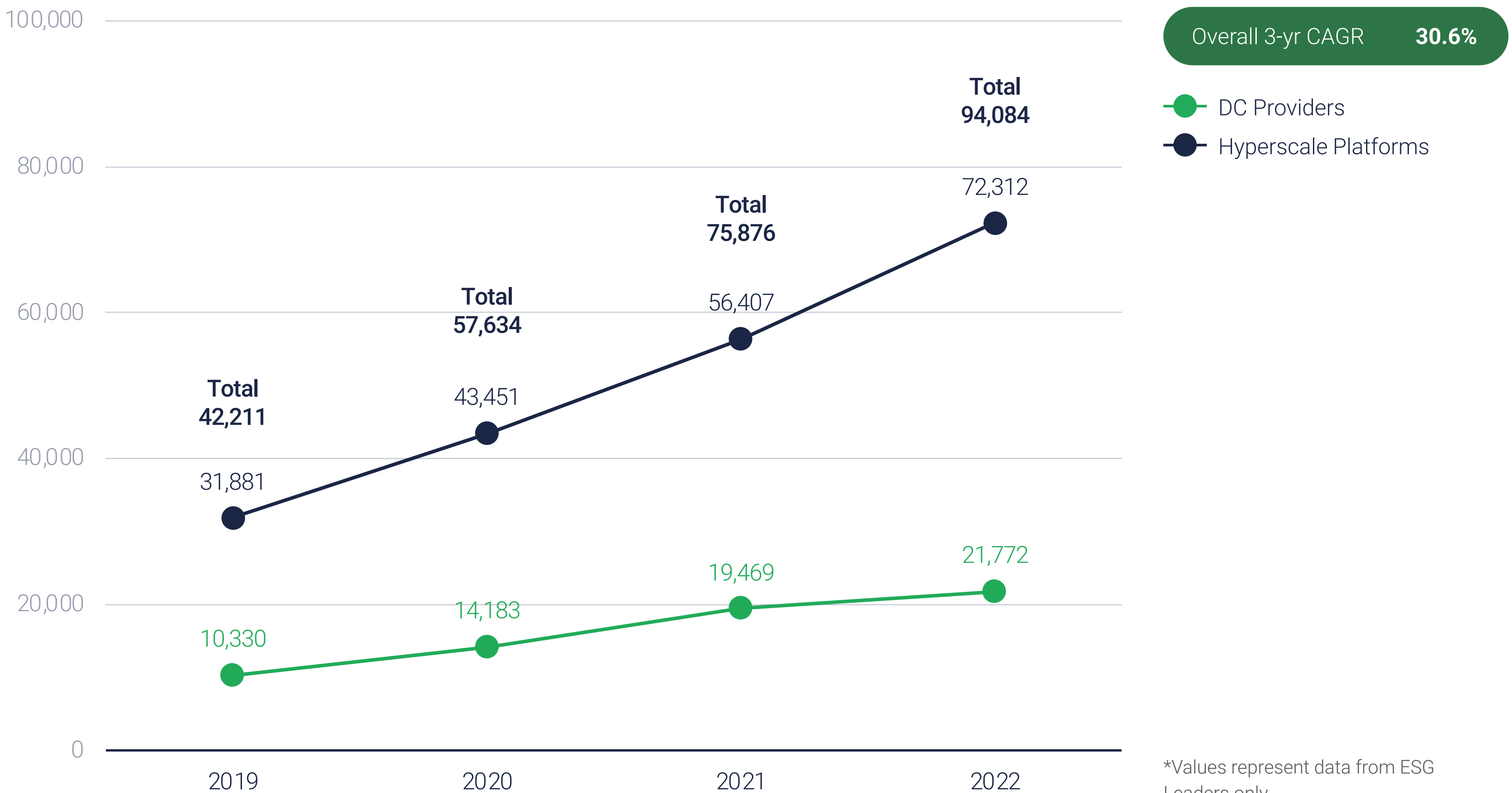
Total Renewable Energy Usage (GWh): Hyperscale Platforms



3-yr CAGR **31.4%**

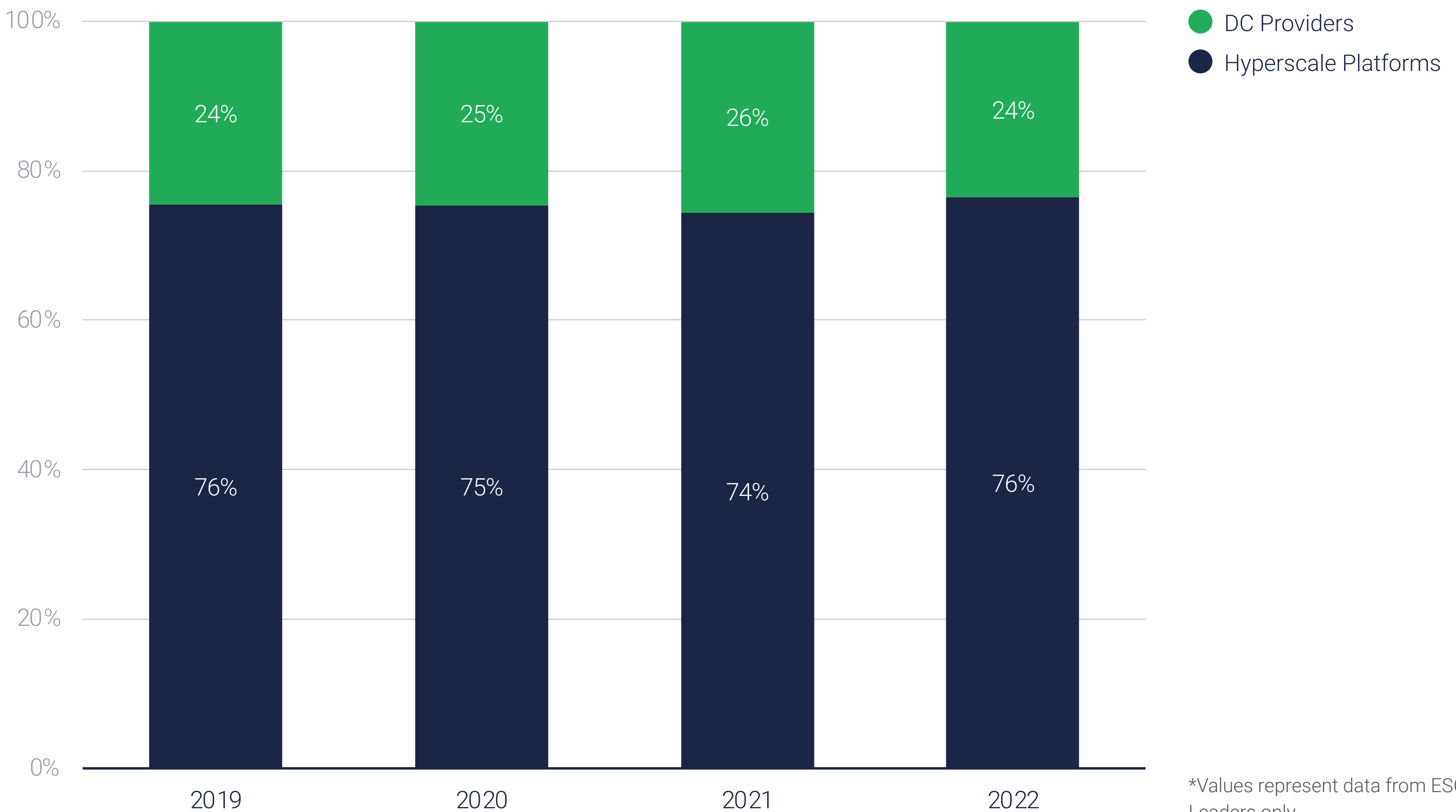
*Values represent data from ESG Leaders only

Total Renewable Energy Usage (GWh): Hyperscale Platforms vs. Data Centre Providers



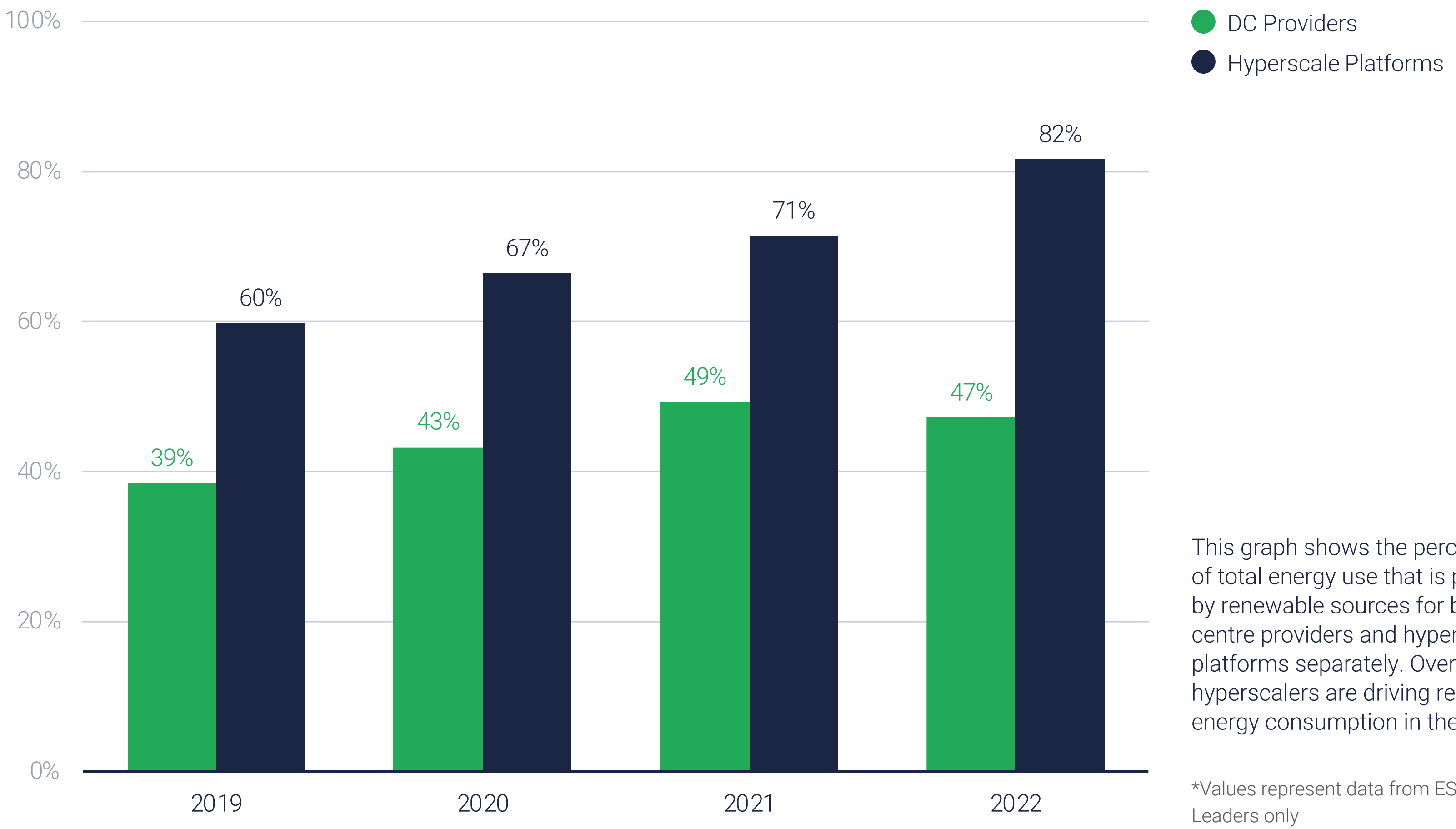
*Values represent data from ESG Leaders only

Total Energy Usage (%): Hyperscale Platforms vs. Data Centre Providers



*Values represent data from ESG Leaders only

Renewable Energy Usage (GWh): % by Total Energy Usage



This graph shows the percentage of total energy use that is provided by renewable sources for both data centre providers and hyperscale platforms separately. Overall, hyperscalers are driving renewable energy consumption in the market.

*Values represent data from ESG Leaders only

Energy Consumption Insights

ENERGY CONSUMPTION

- Similar to carbon emissions, total energy consumption in the data centre industry has been increasing year over year due to increasing demand and IT requirements.
  - Data centre providers nearly doubled energy consumption in the four years from 2019 to 2022, from 26,797 GWh to 46,295 GWh.
  - Hyperscale platforms also increased their energy consumption over the same period - but at a slower pace from a larger base, from 53,249 GWh to 88,513 GWh.

- At 65%, hyperscale platforms account for a larger proportion of total energy usage than data centre providers in 2022.

RENEWABLE ENERGY CONSUMPTION

- With increased concerns over energy efficiency and reducing reliance on fossil fuels, the data centre market has rapidly adopted the use of renewable and carbon-free energy sources.
  - Over the course of 4 years, data centre providers have more than doubled their renewable energy use, increasing from 10,330 GWh in 2019 to 21,772 GWh in 2022.
  - Hyperscalers show a similar trend, increasing renewable energy usage from 31,881 GWh in 2019 to 72,312 GWh in 2022.

- Hyperscale platforms take up a larger proportion of renewable energy use at 76% in 2022.

- An important stat to consider is how much of the market's total energy consumption is from renewable energy sources.
  - In 2022, 47% of the data centre provider market's energy came from renewable energy, an increase of 8% from 2019.
  - Hyperscalers have been able to use renewable energy to supply 82% of their energy use. This is also a significant increase from 60% in 2019.

- Renewable energy comes from either on-site renewable energy such as solar panels, and/or purchased renewable energy.

- Other clean energy sources besides solar, wind, and hydro are also a widely discussed topic, with hydrogen fuel cells and nuclear being the main alternatives.

Total Renewable Energy Usage by Data Centre Providers (2022)

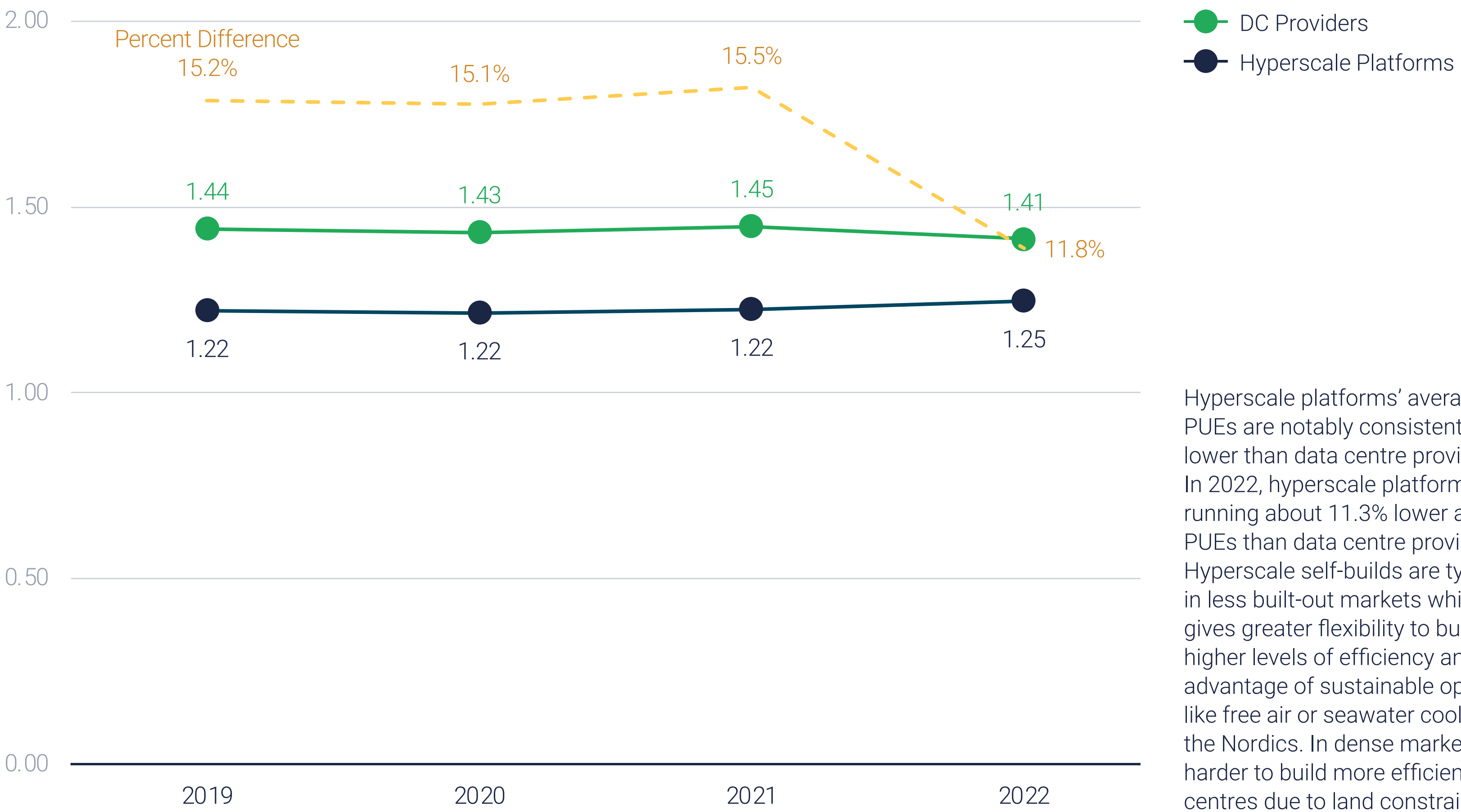
COMPANY	RENEWABLE ENERGY USAGE (GWh)	% RENEWABLE ENERGY USAGE
EQUINIX	7,430	96%
DIGITAL REALTY	5,233	49%
GDS万国数据	1,811	36%
CyrusOne	1,722	51%
IRON MOUNTAIN DATA CENTERS	1,002	57%
STTelemedia Global Data Centres	878	52%
DATABANK	489	47%
QTS	454	22%

Total Renewable Energy Usage by Hyperscale Platforms (2022)

COMPANY	RENEWABLE ENERGY USAGE (GWh)	% RENEWABLE ENERGY USAGE
Google	21,776	98%
Microsoft	18,153	97%
amazon*	16,141	90%
Meta	11,167	100%
Apple	2,138	100%
ORACLE	1,477	63%
Alibaba	1,102	12%
Tencent	358	7%

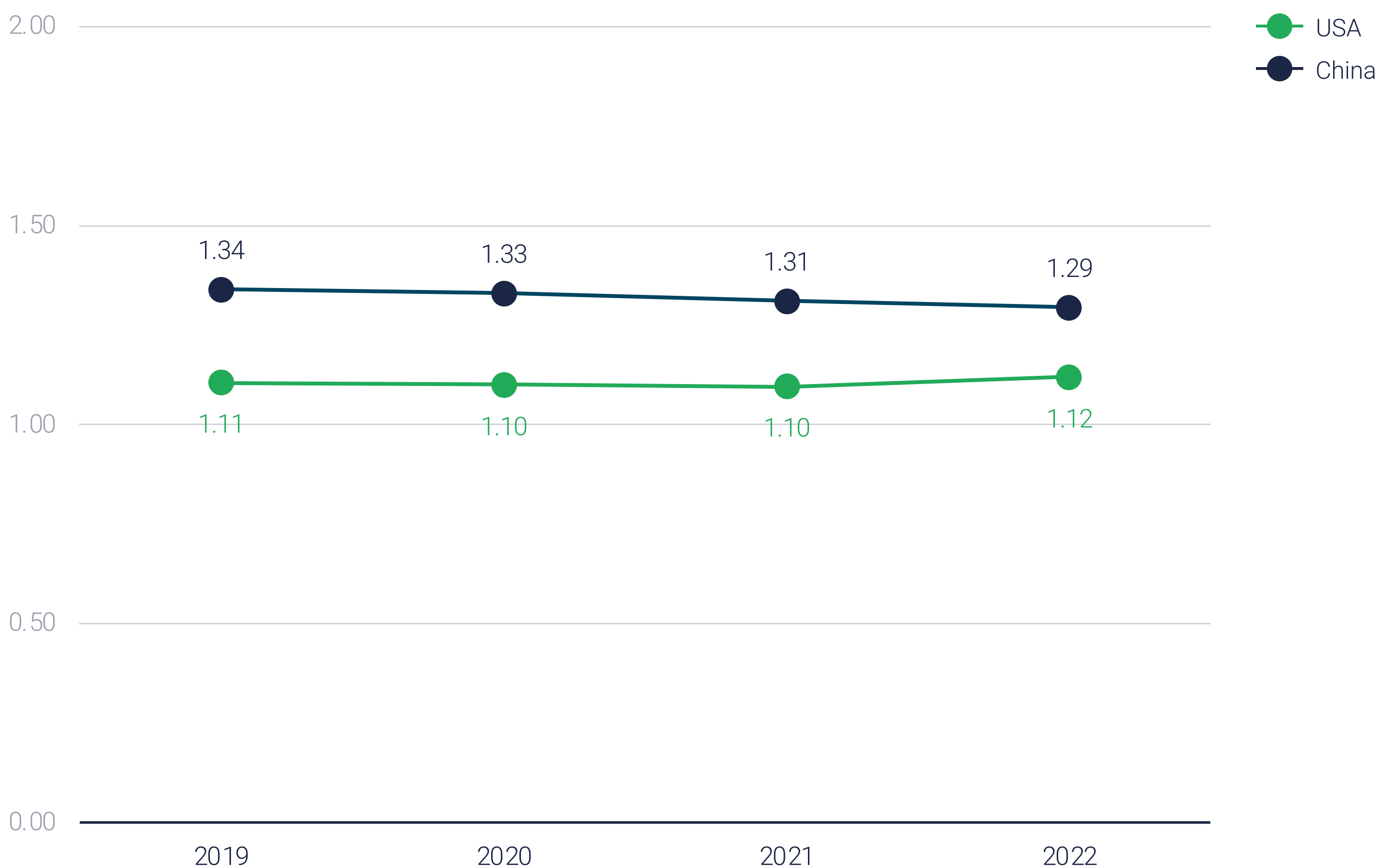
*Structure Research estimate

Average Annual Operating PUE: Hyperscale Platforms vs. Data Centre Providers



Hyperscale platforms' average PUEs are notably consistently lower than data centre providers. In 2022, hyperscale platforms were running about 11.3% lower average PUEs than data centre providers. Hyperscale self-builds are typically in less built-out markets which gives greater flexibility to build at higher levels of efficiency and take advantage of sustainable options like free air or seawater cooling, e.g. the Nordics. In dense markets, it is harder to build more efficient data centres due to land constraints.

Average Annual Operating PUE: US Hyperscalers vs. Chinese Hyperscalers



PUE Insights, Chinese vs. USA Hyperscalers

PUE INSIGHTS

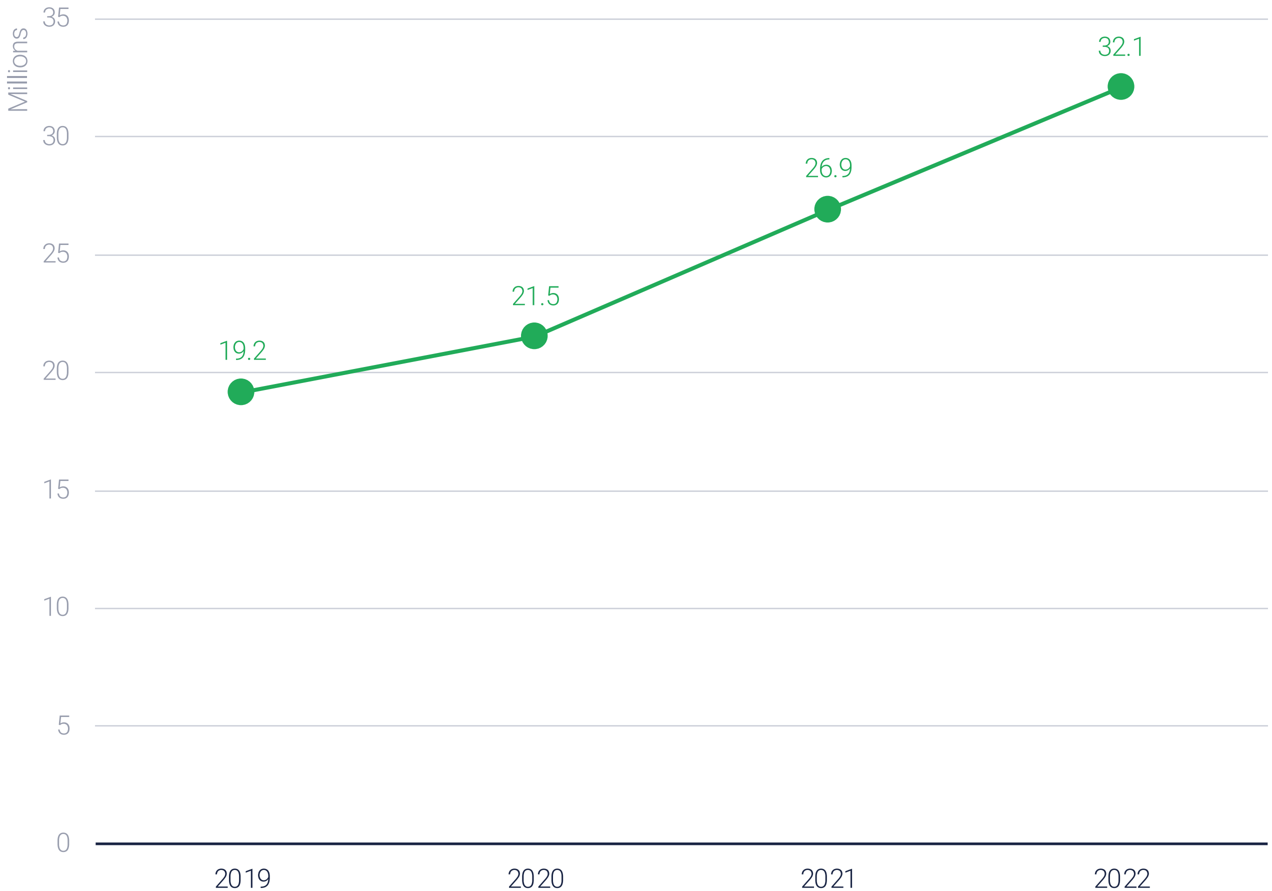
- PUE, which is a widely used metric to determine energy efficiency, is a measure of the total data centre energy consumption over the IT equipment energy consumption.
- The closer the PUE is to 1, the more efficient the data centre is as more of the energy is going directly to the IT equipment.
- Average PUE for data centre providers decreased from 1.44 in 2019 to 1.41 in 2022. This can be attributed to better technology efficiency and designs.
  - Well established data centre providers with the resources to retrofit existing data centres to more efficient technologies as well as providers with more recent, energy efficient builds brings the PUE average lower.
  - Most providers are setting target PUEs between 1.2 - 1.3 within the next decade.
- Average PUE for hyperscalers slightly increased from 1.22 in 2019 to 1.25 in 2022, but it is still markedly lower than the data centre providers average and some of the best in the industry.
- Hyperscalers often self build with sustainability and efficiency in the forefront, and they have the resources to achieve low PUEs.

US VS. CHINA DIFFERENCES

- US Hyperscalers consistently have more efficient PUEs than Chinese hyperscalers. US hyperscalers had a relatively low and stable PUE average between 1.10 to 1.12 from 2019 to 2022. Chinese hyperscalers have started to push for better PUEs and have been able to decrease average PUEs from 1.34 in 2019 to 1.29 in 2022.

Water Usage: Data Centre Providers

In millions m^3

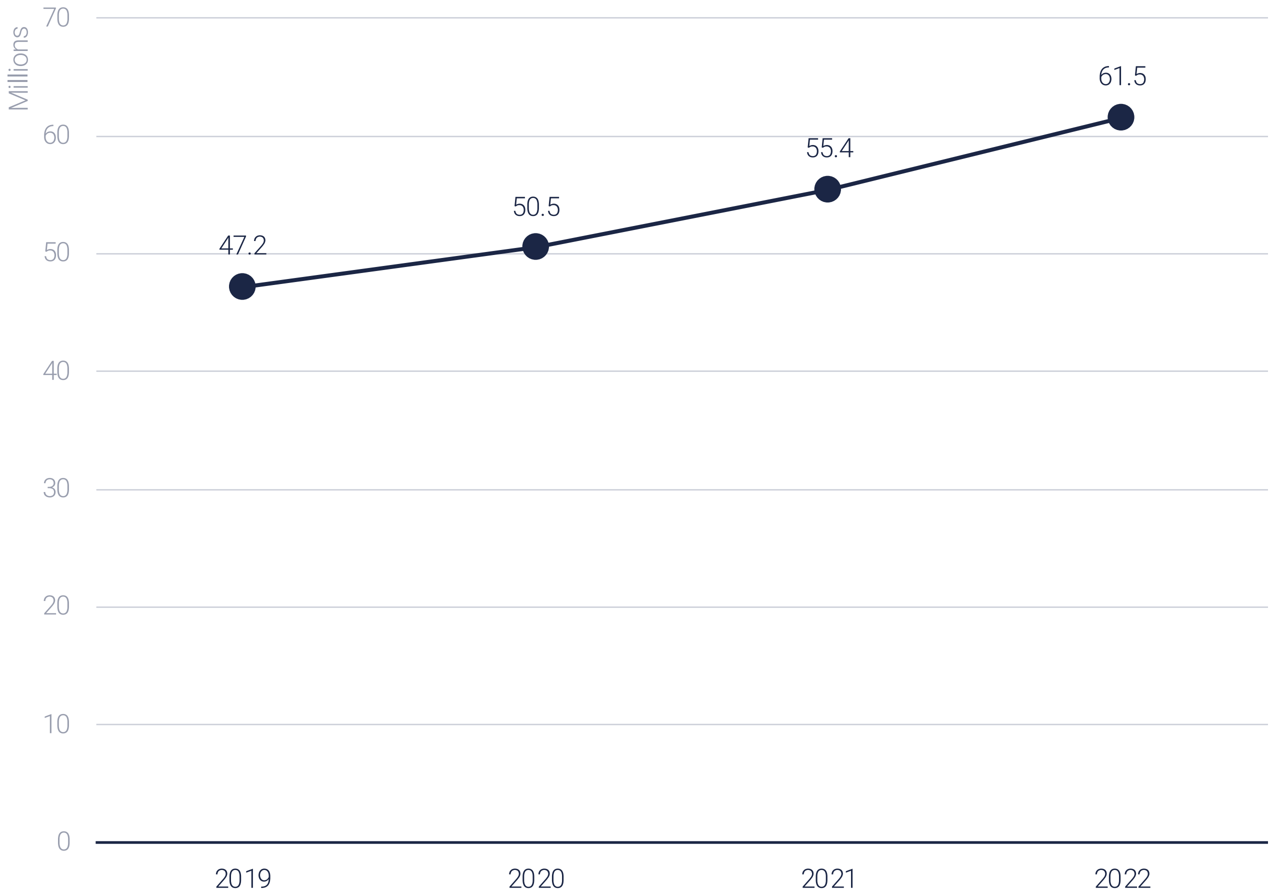


3-yr CAGR **18.7%**

*Values represent data from ESG Leaders only

Water Usage: Hyperscale Platforms

In millions m³



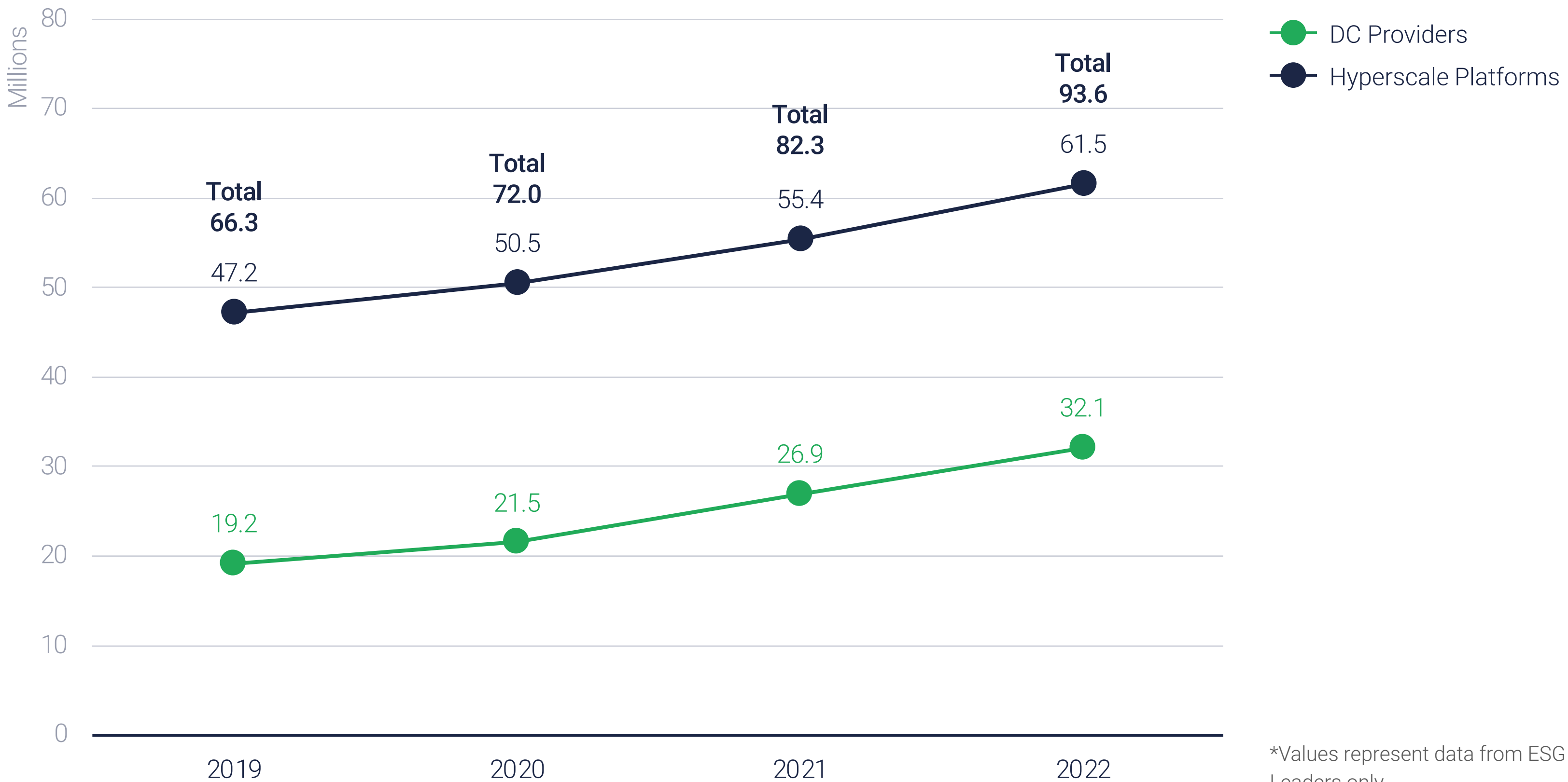
3-yr CAGR **9.3%**

*Values represent data from ESG Leaders only

Total Water Usage:
Hyperscale Platforms vs. Data Centre Providers

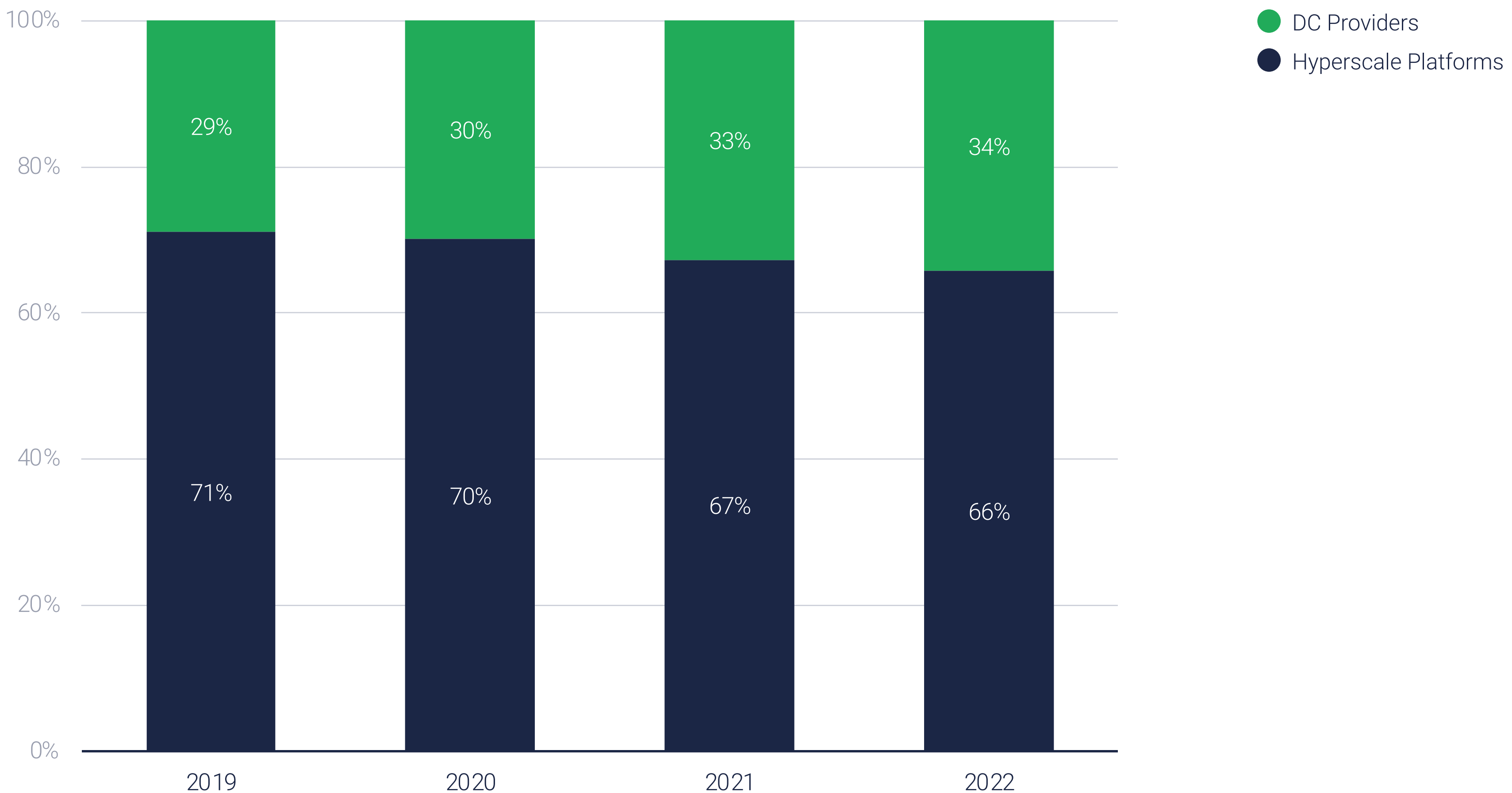
In millions m^3

Overall 3-yr CAGR **12.2%**



*Values represent data from ESG Leaders only

Water Usage: Hyperscale Platforms vs. Data Centre Providers



Water Consumption Insights

- Water is primarily used in data centres for cooling systems, and both data centre providers and hyperscale platforms have increased water consumption over the past 4 years to support data centre systems as IT demands and densities grow.
  - Data centre providers have increased water consumption from about 19.2 million m^3 in 2019 to 32.1 million m^3 in 2022.
  - Hyperscalers have also increased water consumption from 47.2 million m^3 in 2019 to 61.5 million m^3 in 2022.

- Hyperscalers have been using more water than data centre providers , and in 2022 made up 66% of the total water consumption between the two.

- Racks in data centres now run at higher densities than ever before, releasing more heat and requiring more resources to appropriately cool them. This is especially true with the rapid adoption of AI and other HPC workloads.

- Cooling these increased densities will require innovative cooling solutions such as liquid or immersion cooling, which drives the water usage higher compared to air cooling.

- Sourcing water is a concern for many locales, especially in water scarce areas. Aside from drawing potable water, other options used include sea water or non-potable/recycled water to:
  - The use of potable water in data centres is a growing concern, especially in water scarce areas. Alternatives to potable water that has been utilized in existing data centres include using seawater or non-potable/recycled water in cooling systems, as well as on-site rainwater harvesting.

- Larger data centre companies have goals to be water positive alongside emissions goals. They aim to restore more water than is consumed by their data centre operations.

About the Authors

JABEZ TAN
Head of Research

JT@STRUCTURERESEARCH.IO

VIVIAN KONG
Research Associate

VK@STRUCTURERESEARCH.IO

Jabez Tan is the Head of Research at Structure Research, an independent Toronto and Singapore-based research and consulting firm devoted to the cloud and data centre infrastructure services markets, with a specialization in the hyperscale value chain.

Mr. Tan is based in Los Angeles and his coverage focuses on the data centre infrastructure market — primarily retail and hyperscale colocation providers — but also interconnection and cloud infrastructure companies. Mr. Tan leads Structure Research's coverage of the Asia-Pacific region and building of the firm's proprietary market share data and deep-dive supply and demand analysis on a growing set of global data centre markets.

Mr. Tan served as the lead analyst and subject matter expert for over $2 billion in data centre M&A transactions providing in-depth due diligence and strategic advisory. He is a regular keynote speaker at industry events that include infra/STRUCTURE, Structure APEX, Structure Invest, Datacloud Global Congress, Cloud Expo Asia, Data Centre World, W.Media Data Centre Convention, The Data Center Podcast, Submarine Networks World, The Cube and MarketplaceLIVE.

Mr. Tan is quoted in publications such as The Straits Times Singapore, The Business Times Singapore, South China Morning Post, Channel News Asia, Data Economy, The Tech Capital, Data Center Knowledge, Data Centre Dynamics, Data Center Frontier, InterGlobix, The Deal, Nikkei Asian Review and Singapore Business Review.

Mr. Tan holds a BSc in Aerospace Engineering from the University of Maryland, College Park. He was also a platoon sergeant in the Singapore Armed Forces and is fluent in Mandarin Chinese.

Vivian Kong is a Research Associate with Structure Research, an independent Toronto and Singapore-based research and consulting firm devoted to the Internet infrastructure ecosystem, with a specialization in the hyperscale value chain. Ms. Kong currently resides in Toronto, Canada and her coverage is focused on the data centre, interconnection and cloud markets, while also supporting public company, M&A and data centre metric tracking for all of Structure Research's proprietary datasets. Ms. Kong holds a Bachelor of Science and Master of Science, with a specialization in Geography, Environmental and Medical Science – both from Western University in Canada.

Disclosures

The opinions, forecasts, and recommendations contained in this report are those of the analysts preparing the report and are based upon the information available to them as of the date of the report.

The analysts are basing their opinions upon information they have received from sources they believe to be accurate and reliable. The completeness and/or accuracy is neither implied nor guaranteed. The opinions and recommendations are subject to change without notice.

The report is provided to clients of Structure Research for informational purposes only and is not an offer or a solicitation for the purchase or sale of any financial instrument. No part of this material may be (i) copied, photocopied or duplicated in any form by any means or (ii) redistributed without Structure Research's prior written consent.

Analyst Certification: We, Jabez Tan, Vivian Kong, hereby certify that the views expressed in the foregoing research report accurately reflect our personal views about the subject securities and issue(s) as of the date of this report. We further certify that no part of our compensation was, is, or will be directly, or indirectly, related to the specific recommendations or views contained in this research report.

We do not own any shares in companies mentioned in this report, unless otherwise indicated with a #.

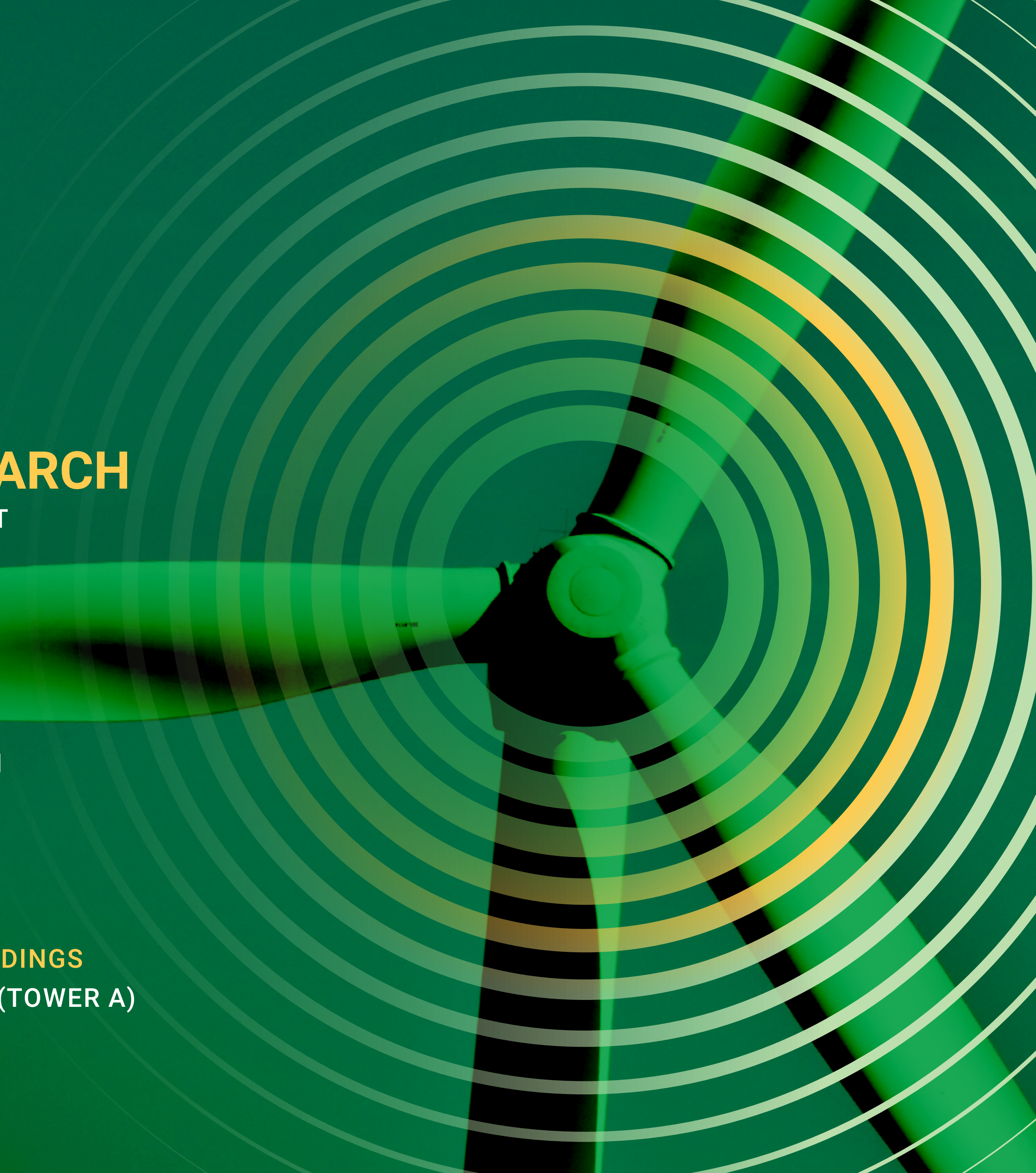
For information about our services, please email us at:
info@structureresearch.net

ABOUT STRUCTURE RESEARCH

Structure Research is an independent research and consulting firm with a special focus on the hosting and cloud segments within the Internet infrastructure market. We are devoted to understanding, tracking and projecting the future of hosting and cloud infrastructure service providers. Managing Director Philbert Shih founded Structure Research in September 2011.

Structure Research works with service providers, vendors, institutional investors, venture capital firms and IT users as a research and advisory partner. Our subscription-based revenue model includes regular opinion and analysis, company, trend and topic reports, financial models, and consulting services. The company has six associates and is based in Toronto, Canada, with offices in Los Angeles, CA, Miami, FL, and London, UK.

STRUCTURE
RESEARCH



STRUCTURE RESEARCH
INFO@STRUCTURERESEARCH.NET

1655 DUPONT STREET, SUITE #101
TORONTO, ONTARIO
CANADA M6P 3T1
TEL: +1 647 822 1404

STRUCTURE RESEARCH ASIA HOLDINGS
33 UBI AVENUE 3 #06-58, VERTEX (TOWER A)
SINGAPORE 408868
TEL: +65 9388 0570