MAP REAL ESTATE MARKET INSIGHT

Frankfurt, November 2023

UNVEILING DATA CENTERS: A RESILIENT REAL ESTATE ASSET CLASS – CURRENT TRENDS (PART I OF II)

Introduction

The digitalization of ever larger areas of modern life is leading to more and more demand for computing power and intensive data traffic via the Internet. This requires enormous growth in the underlying infrastructure, such as →data centers[1] and →connection nodes. Against this background, from the perspective of the real estate industry, the fundamentals of the data center asset class are good and offer solid prospects for a further increase in demand. Stability is also ensured by the fact that the costs of migrating a data center are very substantial and therefore the reliability of tenancy agreements is high for the usual duration of at least 10 years, guaranteeing a stable cash flow. On the other hand, the barriers to entry into the sector are quite high. Construction costs are considerable due to the complexity of the buildings, management is very complex and generally only profitable for specialized operators. In addition, the rapid technological development of the sector leads to short life cycles and high maintenance and upgrading costs.

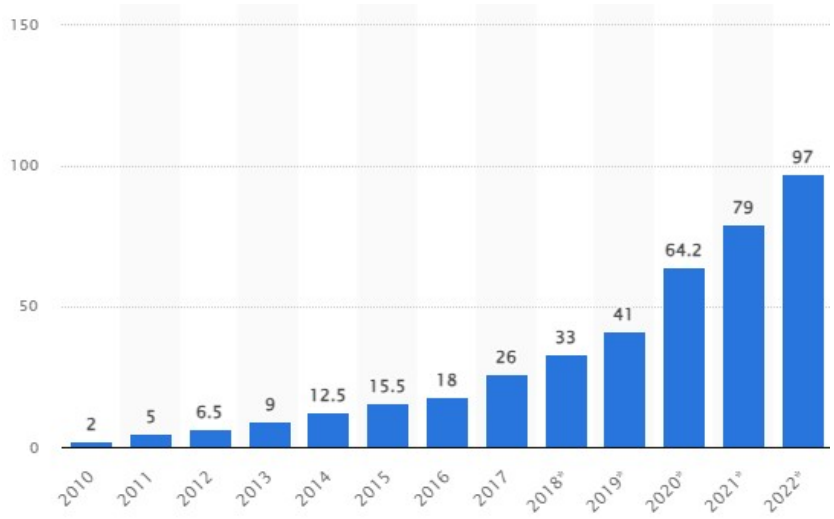
In a series of two Market Insights, we analyze the market for data centers and supplement these with the latest findings presented at the Data Center Strategy Summit 2023, the industry get-together which was organized by the Vogel IT-Akademie in Bad Homburg in October 2023. As usual, we look at the context from the perspective of a real estate investor. In this first part of the series, we provide an overview of the market development in the recent past and explain the reasons which justify the overall positive outlook for the future. We analyze the global market and also the German market in particular. In the upcoming second part of the Market Insight, we will look at selected issues which will gain importance on the German market in the future. These include the challenge of maintaining the security of a low-carbon power supply in the face of high growth, aspects of the path to climate neutrality and energy efficiency in the sector and much more.

History and trends of the global data center market

The growth of the data center market continues unabated worldwide and is developing in parallel with the increasing global exchange of data via the Internet. Figure 1 shows that the volume of data/information created, captured, copied, and consumed worldwide increased 48.5-fold between 2010 and 2022 to a high of 97 →zettabytes. The sharp increase during the Covid-19 pandemic in 2020 which was a boost to demand for many online services is clearly visible.

[1] This and other terms marked with "→" are explained in the glossary in the appendix to this Market Insight.

Figure 1: Volume of Data/Information Created, Captured, Copied, and Consumed Worldwide 2010-2022 – in Zettabytes



*Source: Statista, 2023. https://www.statista.com/statistics/871513/worldwide-data-created/; * = estimations.*

This exorbitant expansion and the accompanying increase in Internet traffic is driven by several key factors and trends, reflecting the reliance on digital technologies and connectivity. Some of these trends, such as the growth in Internet and →mobile connectivity, are already having an impact and will continue to do so in the future. Others, such as →artificial intelligence, seem still at the beginning of their true development, but will shape the future. The following factors are particularly noteworthy:

- *Increasing Internet adoption:* As more people around the world gain access to the Internet, the user base for online services, social media, and e-commerce continues to expand, leading to growing data consumption. By the end of 2023, nearly two-thirds of the global population will have access to the Internet with a total of 5.3 billion users.[2] However, in view of a world population of more than 8 billion people, the potential has not yet been exhausted, especially as the global population continues to grow.
- *Proliferation of →IP networks:* The number of connected devices is expected to reach 29.3 billion by the end of 2023, which equates to 3.6 networked devices per capita.[3]
- *→Mobile connectivity:* Global mobile subscribers will also grow and reach around 5.7 billion by the end of 2023, which means that 70% of the world's population will keep a mobile phone.[4]
- *Video streaming services and social media usage:* The popularity of video streaming, social media platforms and online gaming has led to a significant increase in data traffic. High-definition and →4K video content demand more bandwidth. Industry watcher Sandvine reports that video streaming accounted for two thirds of global internet traffic in the first half of 2022.[5]
- *E-commerce and online shopping:* The convenience of online shopping has led to a surge in e-commerce transactions, including product images, descriptions, and payment processing, all of which contribute to data traffic.

[2] Cisco, 2020: Cisco Annual Internet Report (2018-2023) White Paper. https://www.cisco.com/c/en/us/solutions/collateral/executive-perspectives/annual-internet-report/white-paper-c11-741490.html

[3] Cf. ibid.

[4] Cf. ibid.

[5] Sandvine, 2023: Global Internet Phenomena Report, January 2023.

- *→IoT (Internet of Things):* The proliferation of IoT devices, including smart home appliances, cars, wearables, and industrial sensors, generates vast amounts of data that need to be transmitted and processed. The highest growth is expected for connected car applications.[6] IoT is also a driver of →edge computing, which involves processing data closer to the source rather than in centralized data centers.
- *→Cloud computing:* Businesses and individuals increasingly rely on cloud services for storage, computing, and software applications. This shift to the cloud results in data being transferred to and from data centers, contributing to internet traffic.
- *→Artificial intelligence (AI) and →machine learning (ML):* AI and ML applications require significant computational power and data processing capabilities. Data centers play a crucial role in supporting the training and inference processes of AI/ML models.
- *→Big data and analytics:* The collection and analysis of vast amounts of data for insights and decision-making have become essential for businesses. Data centers provide the infrastructure for storing and processing big data workloads.
- *→Hybrid and →multi-cloud strategies:* Many organizations adopt hybrid and multi-cloud strategies, which involve a combination of →on-premises data centers and cloud services. This complex architecture drives the need for data center connectivity and management.
- *→5G networks:* The rollout of 5G networks enables faster data speeds and lower latency, encouraging the use of data-intensive applications and services.

These trends will ensure further strong growth in global internet traffic in the future. Estimates from various sources agree on this[7], although the volatility and unpredictability of technological developments in the IT sector make precise forecasts difficult. The mobile provider Ericsson regularly publishes an estimate of mobile data traffic. Figure 2 shows the historical development and Figure 3 the current estimate up to 2029. The constant expansion in the past is as striking as the upcoming further growth. Equally impressing is the great importance of video streaming, the share of which will increase very significantly in the coming years (see Figure 3).

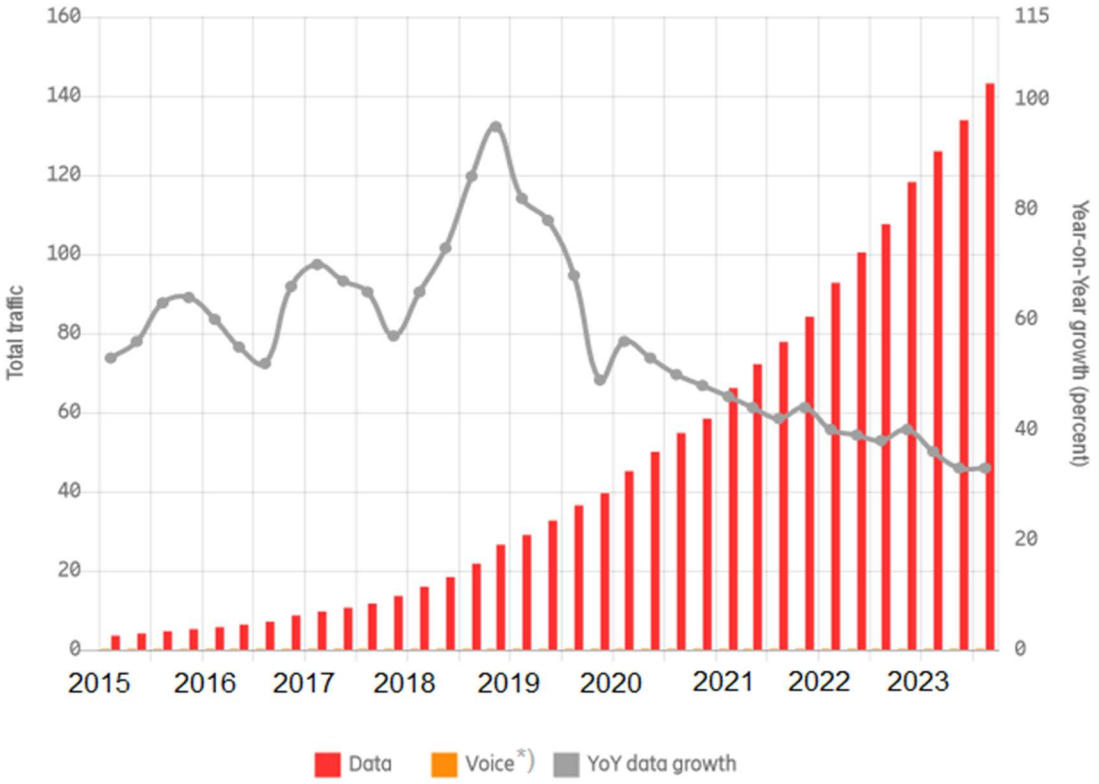
The transmission and processing of these large volumes of data requires a gigantic global infrastructure of data centers which has to expand in the future to accommodate the expected growth. Figure 4, which is based on an international survey of data center operators and was presented on the Datacenter Strategy Summit 2023, illustrates the expansion in hardware infrastructure behind these developments. The number of servers installed in data centers worldwide increased by 45% between 2015 and 2022 to a total of about 86 million.

According to CBRE's global ranking, the largest data center location in the world is Northern Virginia in the USA (see Figure 5). The capacity there exceeded the 2-gigawatt mark for the first time in 2022 (2.132 GW). The European regions of London and Frankfurt are among the top 5 locations. In terms of the size of the individual units on site, there is a clear global trend towards large facilities. At the top of the list are the large →hyperscaler data centers,

[6] Cisco, 2020: Cisco Annual Internet Report (2018-2023) White Paper. https://www.cisco.com/c/en/us/solutions/collateral/executive-perspectives/annual-internet-report/white-paper-c11-741490.html.

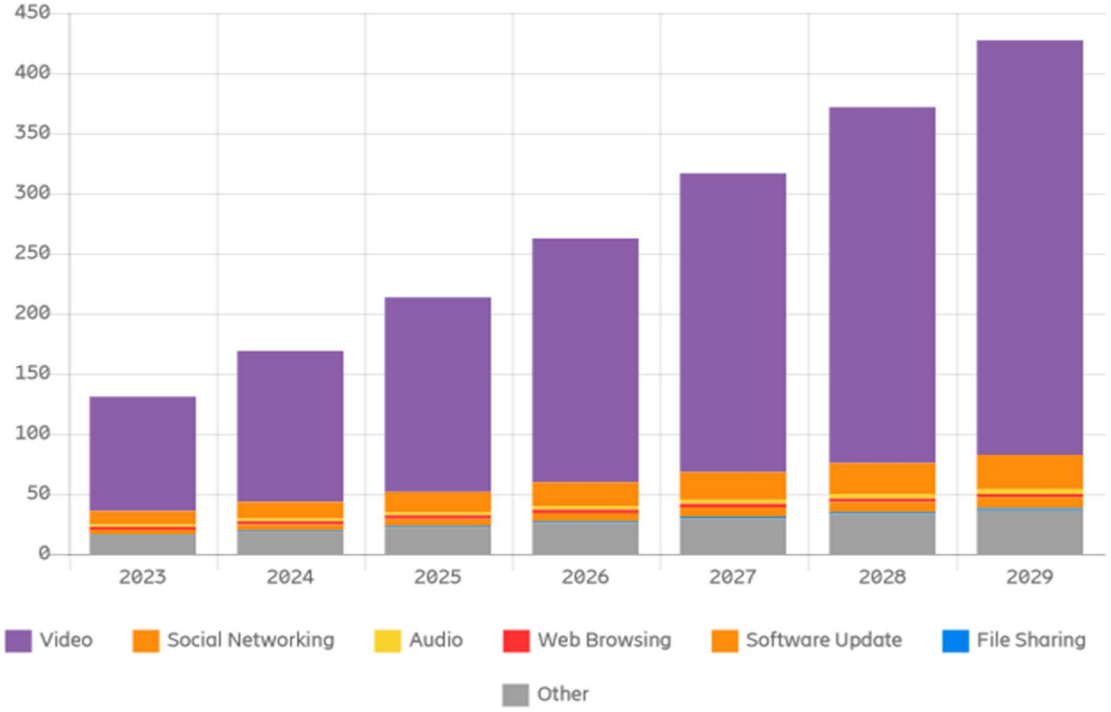
[7] Hintemann, R., 2023: Trends für das Datacenter 2035 – nur heiße Luft? Presentation held on the Datacenter Strategy Summit 2023, Borderstep Institute.

Figure 2: Global Mobile Traffic: Historic Data 2015-2023 – in Exobytes



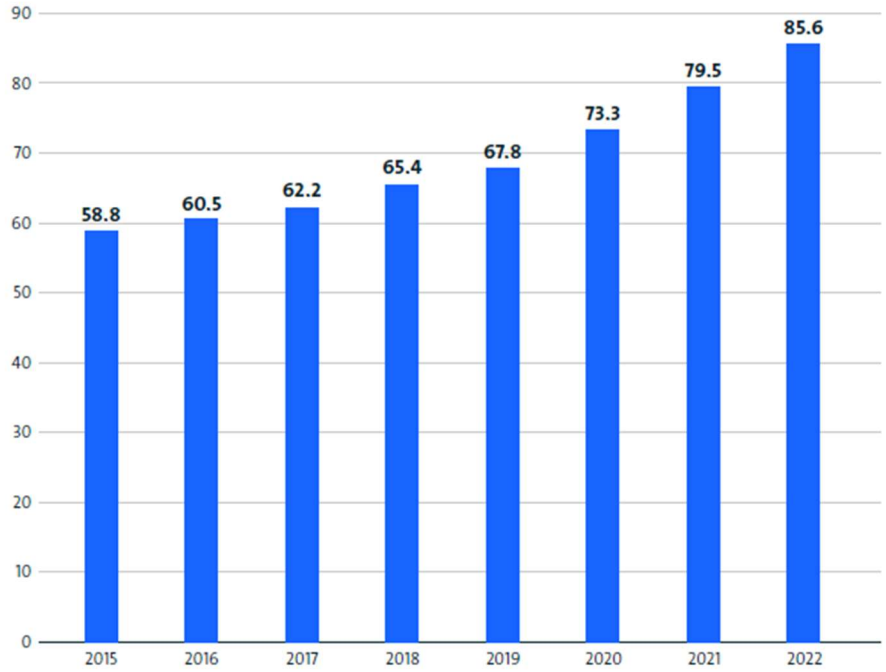
*Source: Ericsson, 2023: Ericsson Mobility Visualizer. https://www.ericsson.com/en/reports-and-papers/mobility-report/mobility-visualizer; mobile network data traffic also includes traffic generated by fixed wireless access (FWA) services; *) = The comparatively low values are almost unrecognizable on the scale of the graph.*

Figure 3: Global Mobile Traffic: Future Development 2023-2029



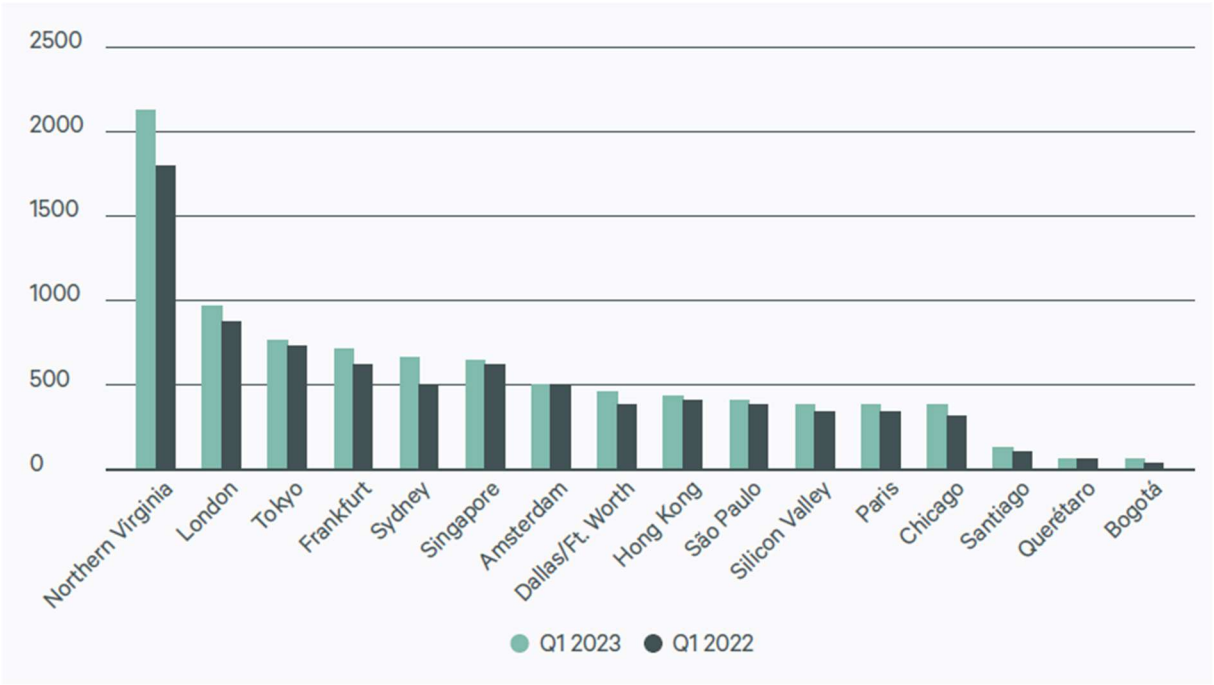
Source: Ericsson, 2023: Ericsson Mobility Visualizer. https://www.ericsson.com/en/reports-and-papers/mobility-report/mobility-visualizer; mobile network data traffic also includes traffic generated by fixed wireless access (FWA) services.

Figure 4: Number of Servers Worldwide in Million Servers – 2015-2022



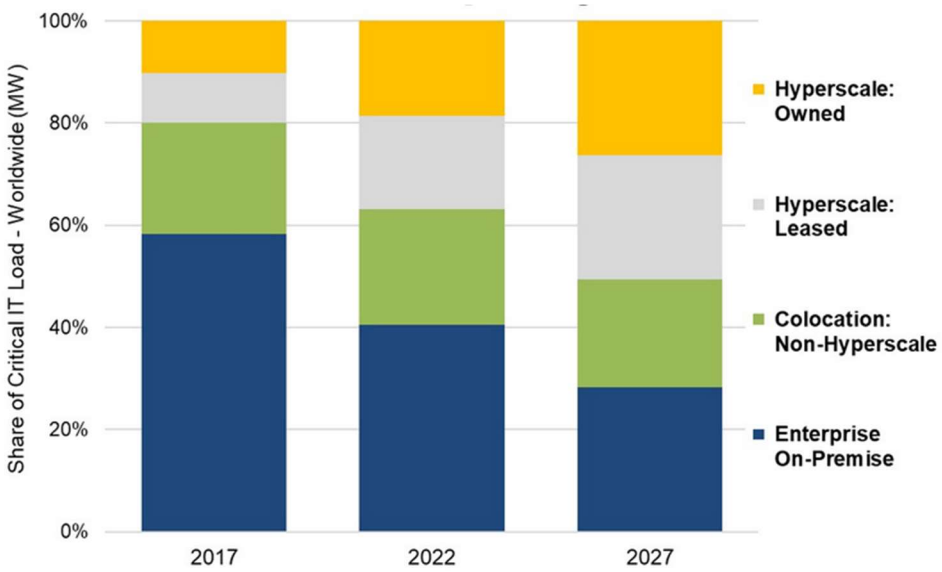
Source: Bitkom, 2023: Rechenzentren in Deutschland. Aktuelle Marktentwicklungen – Update 2023.

Figure 5: Global Data Center Inventory in Megawatts



Source: CBRE, 2023: Global Data Center Trends 2023. Report, CBRE Research.

Figure 6: Data Center Capacity Trends 2017-2027



Source: Synergy, 2023: On-Premise Data Center Capacity Being Increasingly Dwarfed by Hyperscalers and Colocation Companies. https://www.srgresearch.com/articles/on-premise-data-center-capacity-being-increasingly-dwarfed-by-hyperscalers-and-colocation-companies

whose number in the world exceeded 900 in 2022. They accounted for 37% of global capacity (see Figure 6). The chart also shows that this share has risen sharply and will continue to grow according to Synergy, a research group specializing in the industry. It is estimated that the capacity of hyperscalers will double in the next 5 years. The mounting interest in generative AI technology and services is seen as the main driver of the future growth of the hyperscalers. At the same time, →on-premise data centers will become less important.

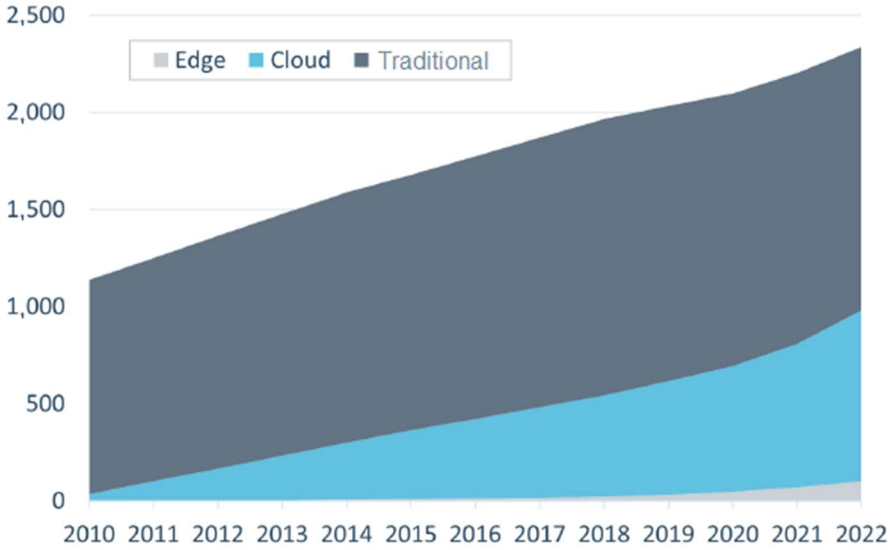
The German data center market

As already mentioned, Germany is an important location for data centers by international standards. Among German regions, Frankfurt is the most important. The main reason for this is →DE-CIX, the world's largest →Internet Exchange Point which is located in Frankfurt. Recent trends of the German market were presented on the Datacenter Strategy Summit 2023. Figure 7 by the Borderstep Institute shows that overall capacity growth in Germany has been constant and quite high, while cloud capacities have become much more important in recent years. In 2022, they account for 38% of total capacity. However, traditional data centers continue to be operated in large numbers in Germany, with a slightly decreasing share. The market for →edge data centers, on the other hand, is still relatively small, but is experiencing high growth rates.

In line with the global trend, larger units were more and more preferred by investors and operators in Germany: more than two thirds of capacity in 2022 were in data centers with a connected load of more than 40kW.[8] Very large data centers with a connected load of more than 5 MW account for 45% in 2022, a share which has risen continuously since 2010. This development is partly due to the growth of cloud data centers.

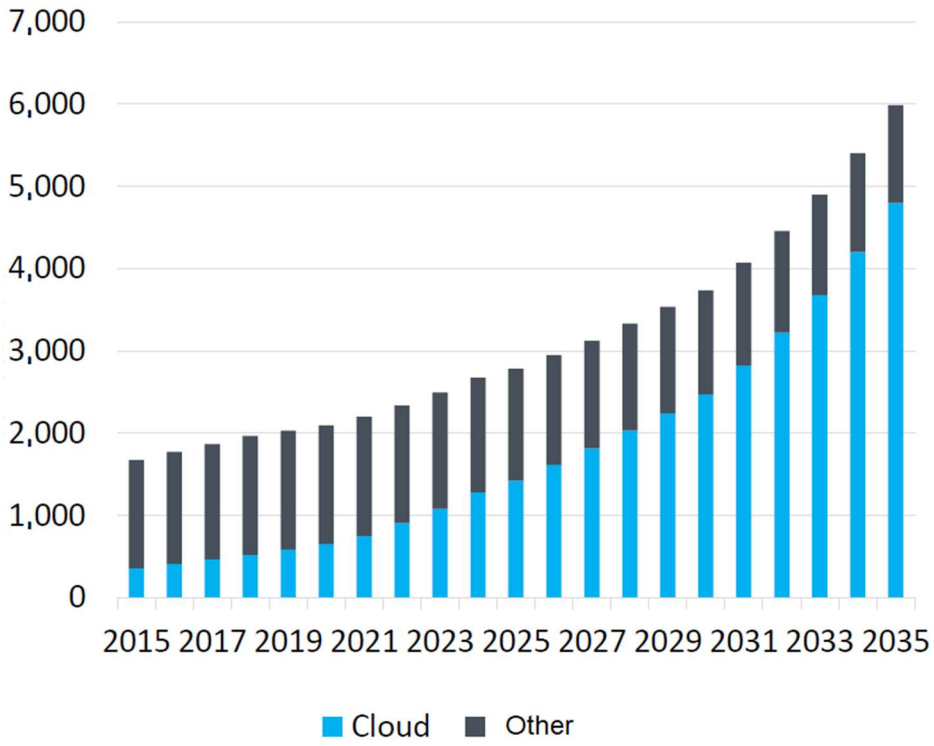
[8] Cf. ibid.

Figure 7: Data Center Capacity in Germany And Share of Cloud And Edge – Capacity in MW 2010-2022



Source: Hintemann, R., 2023: Trends für das Datacenter 2035 – nur heiße Luft? Presentation held on the Datacenter Strategy Summit 2023, Borderstep Institute.

Figure 8: Data Center Market Outlook for Germany 2035 – Capacity in MW 2015-2035



Source: Hintemann, R., 2023: Trends für das Datacenter 2035 – nur heiße Luft? Presentation held on the Datacenter Strategy Summit 2023, Borderstep Institute.

While for the global market a continuation of strong growth is clearly assumed for the reasons mentioned above, the outlook for Germany is a little more uncertain.[9] On the one hand, this is due to unclear legal and economic framework conditions such as the impact of energy efficiency regulations and the development of electricity supply and electricity prices. In the second part of this Market Insight on the data center market, we will examine these risks in detail. On the other hand, the uncertainty is also due to the fact that growth in the area of →cloud computing is dependent on the business decisions of a small number of

[9] Cf. ibid.

→hyperscalers. However, a prognosis presented on the Data Center Strategy Summit 2023 (see Figure 8) expects strong growth for the German Market for the next decade. Similar to the global outlook, expansion in Germany will also be driven by cloud services. The relative importance of all other types of data centers will - according to the forecast - decline sharply.

It was also mentioned at the Summit that between 2015 and 2022 the share of servers in Germany has fallen in relation to all servers worldwide from around 3.5% to just under 3%.[10] This means that expansion in Germany has not been able to keep pace with global growth. Of course, the server structure is influenced by many factors. However, it is also conceivable that this is an indication of deteriorating locational conditions in Germany, especially for data centers. We will discuss this issue in more detail in the forthcoming Market Insight. Here, for a brief overview, we present results from the current market report of the IT industry association →Bitkom, for which experts were asked to assess Germany as a business location for data centers (see Figure 9).

Figure 9: Evaluation of Location Factors for Data Centers in Germany

Source: Bitkom, 2023: Rechenzentren in Deutschland. Aktuelle Marktentwicklungen – Update 2023; online survey of experts by Borderstep Institute in March/April 2023; n=53; question: "In your opinion, how important are the following location factors for data centers (left) and how do you rate Germany as a business location with regard to these location factors (right)?"

For the industry experts, Germany, in addition to its favorable geographical location in the center of Europe, has a major advantage in its solid infrastructure and institutions. In terms of importance as a location factor, a reliable power supply takes the top spot, followed by legal certainty, both of which are rated as very good in the survey. Among the TOP 5 factors, the availability of personnel receives a medium rating, but this is an issue that is currently also relevant in most other industrialized countries. What is striking, however, is the dissatisfaction of the experts surveyed with German electricity prices, which are indeed

[10] Hintemann, R., 2023: Trends für das Datacenter 2035 – nur heiße Luft? Presentation held on the Datacenter Strategy Summit 2023, Borderstep Institute.

high by international standards. Data protection law in Europe and in Germany, otherwise often criticized as being too strictly regulated, is on the other hand clearly a locational advantage for data centers. The General Data Protection Regulation (GDPR) by the EU sets high standards for the handling of personal data. Germany is also rated rather poorly internationally in terms of approval processes of the government and authorities and climate-neutral electricity supply.

Conclusion

In the first of a series of two Market Insights on the data center market, the strong growth of the industry in the past and the good prospects for the future became clear. Numerous trends and developments will contribute to a further expansion of global data traffic. This offers opportunities for the real estate industry, but these must be exploited. The barriers to market entry are very high due to the complexity of the technical requirements placed on data centers. The projects are therefore often carried out with the support of highly specialized experts by the operators themselves, who have a strong interest in having everything under their control later on: plot of land and building, including the technical equipment. The expertise of the real estate sector is often only required for the procurement of land and capital. This is one of the reasons why the asset class is still small in terms of volume. It is telling that the number of real estate experts at the Data Center Strategy Summit was negligible. Nevertheless, investments in data centers yield higher returns than traditional asset classes like office and residential and are very crisis resilient. The sector's decades-long growth has not yet been marred by any setbacks. This was particularly evident in the turmoil of the Covid-19 pandemic. In addition, there are numerous reasons, which we have outlined in this Market Insight, to believe that this robustness will continue in the future. The asset class is attractive and clearly justifies a close look.

Germany is rated positively as a data center location for a variety of reasons and is currently doing well in international comparison. However, there is a risk that this could change in the future. This is one of the topics we will be addressing in the next Market Insight. Important factors such as high electricity prices and a declining willingness on the part of city planners and licensing authorities are clouding future prospects. In the DE-CIX area in Frankfurt in particular, it is easy to see how the sector is in some ways becoming a victim of its great success. The energy supply companies' ability to provide the required amounts of power is becoming increasingly limited. At the start of a project, it takes years to get connected to the grid. This is aggravated by the need to provide this electricity from renewable sources wherever possible. The availability of land is also more limited now, which means that settlements are moving to the surrounding area. A clear commitment to the industry is required from the government and authorities. This also applies to the issue of the shortage of skilled workers, which is becoming an ever greater obstacle to growth, just as it is in other sectors. The realization that this can only be overcome by an increased influx of foreign workers is inevitable. We have already presented the facts that lead to this conclusion in previous Market Insights. Without increased immigration, Germany's position of prosperity cannot be maintained.

Appendix: Glossary[11]

4K video: 4K video refers to ultra-high-definition (UHD) video content characterized by its significantly higher resolution compared to traditional high-definition (HD) video formats. It encompasses video formats with a horizontal resolution of approximately 4,000 pixels, leading to a resolution of around 3840 x 2160 pixels, also known as 2160p. The increased pixel density of 4K video results in sharper, more detailed imagery and offers a superior viewing experience on compatible displays.

5G network: 5G, the fifth generation of wireless technology, represents a significant advancement in telecommunications networks. It promises faster data speeds, lower →latency, and enhanced connectivity compared to previous generations (such as 4G/LTE). With theoretical speeds up to 20 Gbps, 5G technology facilitates near-instantaneous data transfer, enabling a multitude of innovative applications.

Artificial Intelligence (AI): AI refers to the simulation of human intelligence processes by computer systems. It encompasses a broad range of technologies and techniques that enable machines to perform tasks that typically require human intelligence. These tasks include learning, reasoning, problem-solving, perception, language understanding, and decision-making. AI applications span various domains, from robotics and healthcare to finance and entertainment. →*generative AI*

Big data: Big data refers to vast and complex datasets characterized by their volume, velocity, and variety. It encompasses large amounts of structured and unstructured data generated from various sources, including sensors, social media, transactions, and more. The analysis of big data requires specialized tools and technologies capable of processing, storing, and extracting valuable insights from these massive datasets. Big data analytics involves applying advanced algorithms and analytics techniques to uncover patterns, trends, correlations, and other valuable information that can be used for decision-making, business intelligence, research, and innovation.

Bitkom: Bitkom is a leading digital association in Germany, representing companies in the digital economy, technology, and telecommunications sectors. As one of the largest associations of its kind in Europe, Bitkom advocates for the interests of its members, promotes digital innovation, and shapes policies related to digitalization.

Cloud computing: Cloud computing is a technology that enables the delivery of computing services — including servers, storage, databases, networking, software, and more — over the internet. It provides on-demand access to a shared pool of configurable computing resources, allowing individuals and organizations to use and pay for services as needed. This model offers scalability, flexibility, and cost-efficiency by eliminating the need for on-site infrastructure maintenance and management. Users can access applications, store and process data, and utilize computing power remotely through cloud service providers. A private cloud refers to a cloud computing environment dedicated exclusively to a single organization. It is hosted either on-premises within the organization's data centers or by a third-party service provider. The infrastructure and services in a private cloud are tailored to meet the specific needs of the organization, offering greater control, security, and customization. A public cloud involves the delivery of computing services—such as

[11] This glossary was created with the support of Chat-GPT.

servers, storage, databases, and more—by a third-party cloud service provider over the internet. These services are shared among multiple organizations and users on a pay-as-you-go basis, making it a cost-effective option. Cloud computing is categorized into three primary service models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). IaaS offers virtualized computing resources such as virtual machines, storage, and networking components. PaaS provides a platform allowing developers to build and deploy applications without managing the underlying infrastructure. SaaS delivers ready-to-use software applications accessible via the internet.

Computer Center: The terms and "computer center" ("Rechenzentrum") and "data center" are often used interchangeably, but there can be some nuances in their meanings, depending on context and regional preferences. "Computer center" could imply a more narrow focus on computing operations and hardware management, while "data center" might encompass a broader range of functions, including storage, networking, and data management in addition to computing.

Connection node: A connection node, also known as a network node, is a crucial element in computer networks. It acts as a point for devices to communicate and share data. Examples include routers, switches, hubs, and gateways. These nodes manage and direct data flow within networks, ensuring efficient communication between devices and systems. Internet connection nodes form the backbone of the internet infrastructure, ensuring the efficient and secure transmission of data between interconnected devices and networks. Their strategic placement and configuration significantly impact the speed, reliability, and security of internet connections.

Data center: A data center is a central physical facility that houses enterprise computers, network, storage and other IT equipment to support business operations. The computers in a data center contain or support business-critical applications, services and data. Data centers come in all sizes - they can fill a closet, a dedicated room or a warehouse. Some companies with a lot of IT equipment in their data centers may need more than one data center. Companies can also rent server space and have their data center maintained by third-party providers. A data center can expand beyond a physical facility by adding operations or storage with a private or public cloud. In a virtualized data center, virtualization technologies are used to separate the physical resources from the software and applications that run on them, allowing for greater resource utilization. →*computer center*

DE-CIX: DE-CIX, short for "Deutscher Commercial Internet Exchange", is the world's largest and most renowned →Internet Exchange Points (IXP). Headquartered in Frankfurt, Germany, DE-CIX operates numerous Internet Exchange platforms globally, facilitating the direct exchange of internet traffic between →internet service providers (ISPs), and other network operators. It enhances connectivity, reduces →latency, and optimizes internet traffic routes. DE-CIX serves as a vital location for global internet traffic exchange due to its strategic geographic position and the concentration of international network infrastructures.

Edge computing: Edge computing refers to a decentralized computing paradigm that brings computation and data storage closer to the location where it's needed, rather than relying solely on centralized data centers or →cloud computing environments. This approach processes data near the "edge" of the network, closer to the devices

generating or consuming the data. Edge computing reduces →latency, optimizes bandwidth usage, and enables faster response times for critical applications. It involves deploying computing infrastructure, such as servers, data analytics, and content delivery networks, in proximity to where data is generated. Edge computing finds applications in scenarios like →IoT devices, autonomous vehicles, and smart infrastructure.

Generative artificial intelligence (generative AI): Generative AI is a subset of →*artificial intelligence* which focuses on creating content or data rather than analyzing or interpreting existing information. This technology uses machine learning algorithms to generate new, original content. Generative AI can create images, texts, music, videos, and other media, often producing highly realistic and novel outputs.

Hybrid cloud computing: A hybrid cloud strategy involves the use of a combination of public and private →*cloud computing* services, as well as →*on-premises* infrastructure. It allows organizations to leverage the benefits of both environments by integrating and managing workloads across multiple platforms. This approach offers flexibility, scalability, and the ability to optimize resources based on specific needs. For instance, sensitive data can be kept on a private cloud for security reasons, while less critical applications may utilize the cost-effective public cloud.

Hyperscaler: Hyperscaler refers to a select group of companies that provide cloud computing services on a massive scale. These companies operate vast data centers (often also called hyperscalers) with extensive computing resources, storage capacity, and global networking infrastructure. They offer cloud services to businesses, organizations, and individuals worldwide. The hyperscale infrastructure of these companies allows them to handle enormous amounts of data, accommodate high traffic volumes, and provide scalable computing resources on-demand. Notable hyperscalers include industry giants like Amazon Web Services (AWS), Microsoft Azure, Google Cloud Platform (GCP), and others.

Infrastructure as a Service (IaaS): →*cloud computing*

Internet Exchange Point (IXP): An Internet Exchange Point (IXP) serves as a physical location where multiple →internet service providers (ISPs) and networks come together to exchange internet traffic. IXPs facilitate the direct interconnection of networks, allowing them to exchange data and efficiently route traffic between their respective networks.

Internet of Things (IoT): The Internet of Things (IoT) refers to a network of interconnected physical devices, sensors, and objects embedded with sensors, software, and connectivity capabilities that enable them to collect and exchange data. These devices can range from everyday objects like home appliances, wearables, and vehicles to industrial machinery and smart city infrastructure. IoT devices are designed to gather and transmit data over the internet or other networks, allowing them to communicate with each other, share information, and perform automated tasks without human intervention. They collect real-time data from their surroundings, enabling monitoring, analysis, and control of various systems and environments.

Internet Service Provider (ISP): An Internet Service Provider (ISP) is a company or organization that provides access to the internet and related services to individuals, businesses, and other entities. ISPs offer various types of internet connectivity, including broadband, fiber-optic, DSL, cable, satellite, and wireless connections. ISPs serve as the bridge between users and the internet, delivering connectivity through their network infrastructure.

IP network: IP (Internet Protocol) networks are communication networks that utilize the Internet Protocol for transmitting data packets between devices. These networks form the backbone of the internet and are fundamental to modern digital communication. IP networks allow devices, such as computers, smartphones, servers etc. to connect and communicate with each other across the globe. Each device on an IP network is assigned a unique numerical label known as an IP address, enabling data packets to be routed accurately to their destinations.

Latency: Latency refers to the time delay between the initiation of a data transfer and the moment when the transfer begins or completes. It is commonly used to describe the time (=latency time) taken for data to travel from its source to its destination, typically measured in milliseconds.

Machine learning (ML): Machine learning is a branch of →*artificial intelligence* which focuses on developing algorithms and models that enable computers to learn from data and make predictions or decisions without being explicitly programmed for each task. It involves the use of statistical techniques to enable systems to improve their performance on a specific task over time as they are exposed to more data. The goal of machine learning is to enable computers to learn patterns and relationships from data to make accurate predictions or take actions.

Mobile connectivity: Mobile connectivity refers to the ability of mobile devices, such as smartphones, tablets, and →IoT gadgets, to connect to telecommunications networks for data exchange and communication. It encompasses the technologies and infrastructure that enable these devices to establish connections and access the internet or other networks. Mobile connectivity relies on cellular networks provided by telecommunications companies.

Mulitcloud computing: A multicloud (→*cloud computing*) strategy involves using services from multiple cloud providers to avoid vendor lock-in, optimize performance, and diversify risk. Organizations employing a multicloud approach utilize different cloud services from various providers simultaneously. This strategy enables them to select the best-suited services from different vendors based on features, costs, geographic availability, or specific functionalities. It helps mitigate risks associated with relying on a single provider and allows for greater customization and flexibility in meeting diverse business needs.

On-premise data center: An on-premise data center refers to a facility owned, managed, and operated by an organization within its own physical premises or dedicated location. It houses computing hardware, servers, networking equipment, storage, and other infrastructure required to store, process, and manage data and applications.

Platform as a Service (PaaS): →*cloud computing*

Private cloud computing: →*cloud computing*

Public cloud computing: →*cloud computing*

Software as a Service (SaaS): →*cloud computing*

Zettabyte: A zettabyte is a unit of digital information measurement, representing an enormous volume of data. It is equivalent to one sextillion bytes, or 2^{70} bytes. To put it into perspective, one zettabyte is a thousand exabytes, a million petabytes, a billion terabytes, or a trillion gigabytes.

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