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Status and development of the German data centre landscape – Executive Summary

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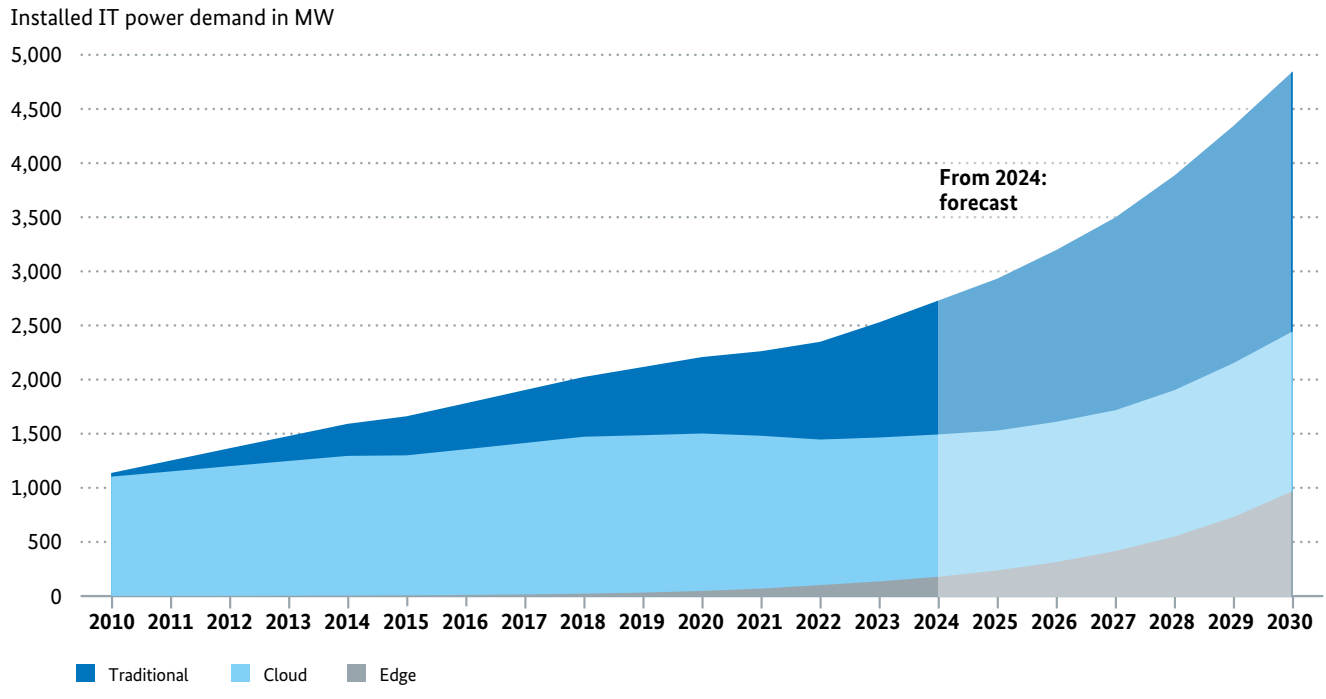
Executive Summary

The growth of the digital economy and digitalisation is accompanied by a strong increase in the need for digital infrastructure and data centres (DCs). Data centres have thus developed into one of the fastest growing, most energy-intensive sectors in Germany. With over 2,000 data centres and an installed IT power demand of over 2,700 MW, Germany is already the largest centre for digital infrastructure in Europe. The central location, political stability, an electricity supply with above-average reliability and one of the largest internet connections in the world combine to make Germany a strategically advantageous place for national and international providers alike. Digitalisation targets, a growing digital economy and new technologies, such as artificial intelligence (AI), lead to growing demand for processing power, storage capacity and data transfer. This demand cannot be met by increasing the efficiency of ICT equipment and existing data centres alone. In order to meet this demand, new data centres can be built, the degree of use of existing centres can be raised, and data capacity can be acquired from abroad. The term "data centres" is to be understood in this context as encompassing buildings and building services engineering as well as IT infrastructure and internet access. Alongside large data centres, many of which are run by service providers, Germany is also home to around 50,000 smaller IT installations, which tend to be run by medium-sized companies.

Since 2010, data centre capacity in Germany has more than doubled, reaching 2,730 MW in 2024, with further growth acceleration to 4,800 MW expected by 2030.

Figure 1: Development of the capacities of data centre and smaller IT installations in Germany from 2010 to 2024 and forecast until 2030.



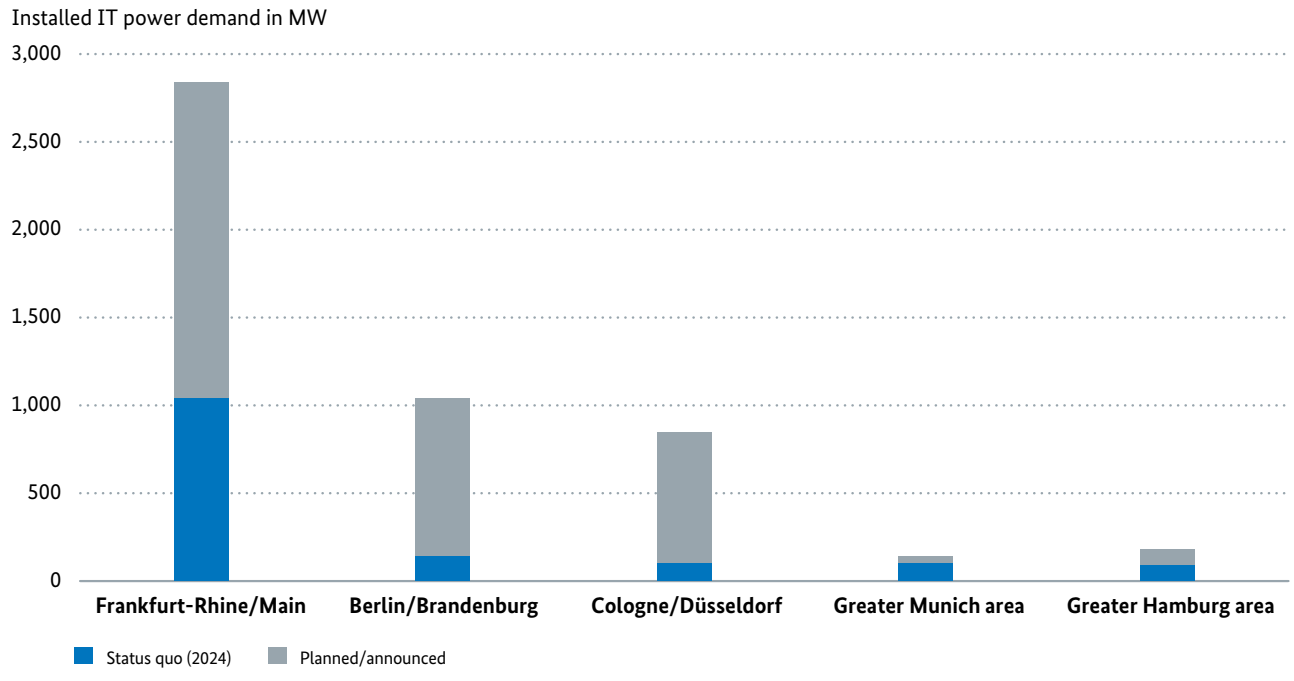
Source: Hintemann et al. (2024a)

The growing need for processing power, storage capacity and data transfer leads to continuous growth of data centre capacities in Germany, the pace of which has even accelerated further in recent years. Since 2010, capacities at data centres and smaller IT installations in Germany have more than doubled to over 2,730 MW in 2024. Calculations indicate a clear further rise in IT capacities to 4,850 MW by 2030 (Bitkom 2024, similarly GDA 2024). If this growth continues apace even after 2030, capacities will reach a scale of over 12,000 MW in 2045.

The growth of capacities is taking place in data centres with an installed IT power demand of over 100 kW. In contrast, capacities at small IT installation with an installed IT power demand under 100 kW have remained largely constant in past years. It is primarily capacities in large data centres with an installed IT power demand of over 5 MW that are exhibiting very clear growth. Between 2010 and 2024, capacities in this segment have increased five-fold, growing from 270 MW to 1,300 MW. There are currently 100 such data centres in Germany. A trend can be observed in pledged investments towards ever larger data centres, e.g. those with an installed IT power demand over 100 MW and in some cases multiple loads over 100 MW at one location. But smaller data centres with an installed IT power demand between 100 kW and 5 MW are also exhibiting strong signs of growth – capacities at data centres in this category increased threefold between 2010 and 2020, growing from 210 MW to 670 MW.

Data centres continue to be highly concentrated in the Frankfurt-Rhine/Main metropolitan area. The Berlin and Rheinisches Revier (Cologne/Düsseldorf) areas are also becoming new data centre hubs.

Figure 2: Data centre installed IT power demand that currently exist of are specifically planned in various German regions.

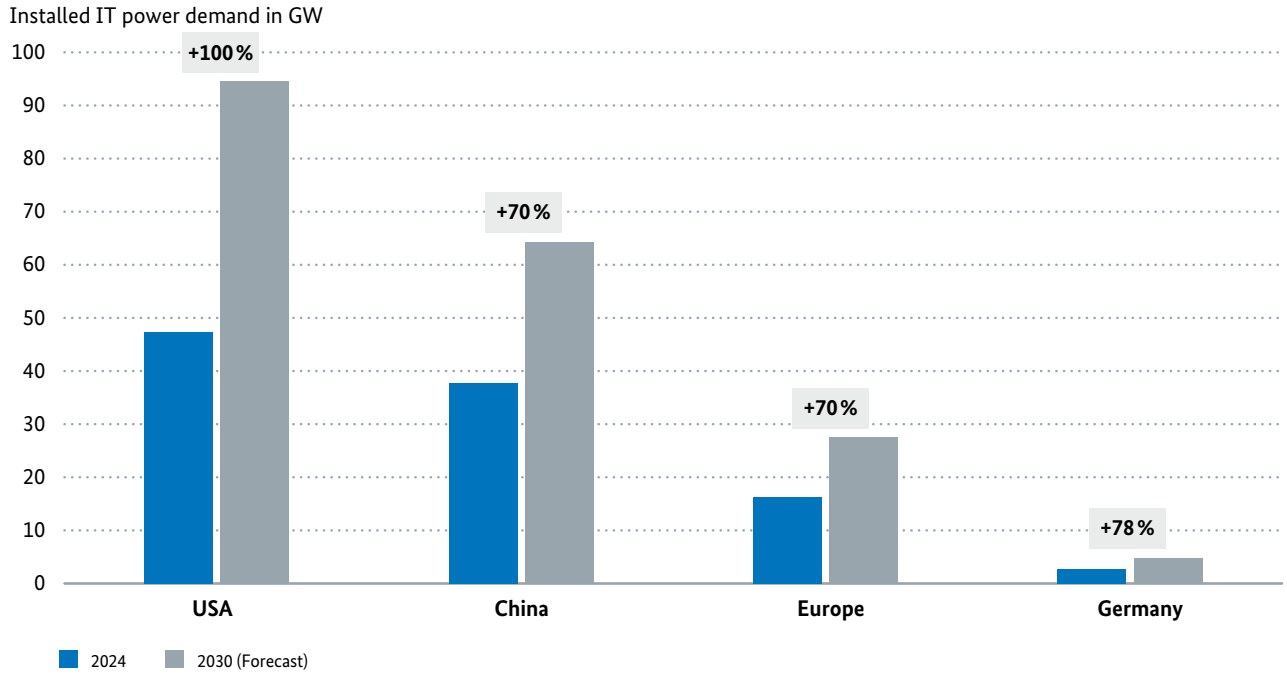


Source: Hintemann et al. (2024a)

The growth of the data centre sector is focused in a few regions of Germany. The Frankfurt-Rhine/Main metropolitan region is particularly attractive due to the DE-CIX network hub for data centre settlements. Multiple new large data centres are currently in planning in and around Berlin, the nation's capital. Microsoft's billion-dollar commitment in the Rhineland region (Cologne/Düsseldorf) and the associated construction of multiple large data centres leads to the assumption that strong growth in data centre capacities will occur in this region in future, as the presence of data centres in a region tends to attract investment in further data centres in that area. The geographical concentration of data centres and data networks can be explained by the "data gravity" phenomenon. This means that large amounts of data develop a "gravitational attraction" of sorts, pulling other data towards them. The reasoning behind the phenomenon lies, for example, in the fact that it takes a great deal of effort to move large amounts of data elsewhere, and many applications that access the data require low latencies. The concentration of large data centres in certain regions is additionally strengthened by the fact that large cloud providers often build three or more data centres in the same region for availability reasons. If a data centre temporarily goes offline, cloud-related services can still be provided from the other data centres in the region.

Germany remains the largest data centre hub in Europe. But China and US are accelerating the expansion of digital infrastructure in their respective countries.

Figure 3: Estimated development of data centre capacities in the United States, China, Europe and Germany in 2024 and 2030.



Source: Hintemann et al. (2024a)

When the capacities of all data centres and smaller IT installations are measured, Germany is the largest data centre hub in Europe. This is primarily due to Germany's strong economy. This position was improved somewhat in recent years, especially when compared with the United Kingdom. However, if one compares the development of data centre capacities in Europe with other regions of the world, then it appears Germany and Europe are likely to fall behind in future. Germany's share of global IT capacities was already in decline in the recent past. Between 2015 and 2024, the global market share of servers installed in data centres in Germany dropped from 3.5% to just under 2.5% (Bitkom 2024).

A key reason for this decline is that Germany is an importer of cloud services. The trends towards more and more applications in the area of artificial intelligence (AI) appears to be significantly accelerating the growth of data centre capacities, especially in the United States and China.

The energy efficiency of the data centre infrastructure and technical building equipment is currently stagnating globally.

In Germany, a tendentially positive trend with a reduction of the "PUE" (Power Usage Effectiveness) indicator to the current average of 1.46 was observed over the past ten years. Efficiency in technical building equipment in data centres has been stagnating globally since 2018. PUE value has ranged from 1.55 to 1.59 since 2018. This means that for every 1 kW of power for IT equipment, around 0.55 to 0.59 kW of power is needed for cooling and electricity supply, as well as other elements of building equipment.

In the past, it was possible to significantly reduce the energy needed for cooling in particular with measures that were relatively easy to implement, such as hot and cold aisle containment, increased room temperature or evaporative cooling. However, further measures, such as liquid cooling, are needed to be able to reduce PUE even further. Additional factors that influence PUE include weather (a lower outdoor temperature means a higher potential for free cooling), installed IT capacity (greater capacity meaning greater efficiency) and time elapsed since coming on stream (a newer centre is likely more modern and thus more energy-efficient).

Leading companies in the field – and in Germany – are building data centres with PUE values ranging from 1.2 to 1.3. This shows that the existing efficiency potential in building equipment has not yet been fully exploited. But a differentiation must be made between possibilities for new versus existing facilities. In the Energy Efficiency Act, Germany has set a PUE value of 1.2 percent as the threshold for new data centres coming online from July 2026 onwards, which will lead to a significant decline in average PUE values. But this only applies if it is assumed that new data centres continue to come online with high processing capacities. China has also made a PUE value of 1.3 in temperate regions and 1.25 in cooler regions a legal requirement for new data centres from 2025 onwards[1] (Xie et al., 2024).

The development of IT infrastructure itself (server, storage and network equipment) is primarily affected by the increasing density of integrated circuits. Ongoing miniaturisation, which is made possible inter alia by modern lithography processes, means that the amount of processing per-

1 See also https://www.nature.com/articles/s41599-024-02963-0

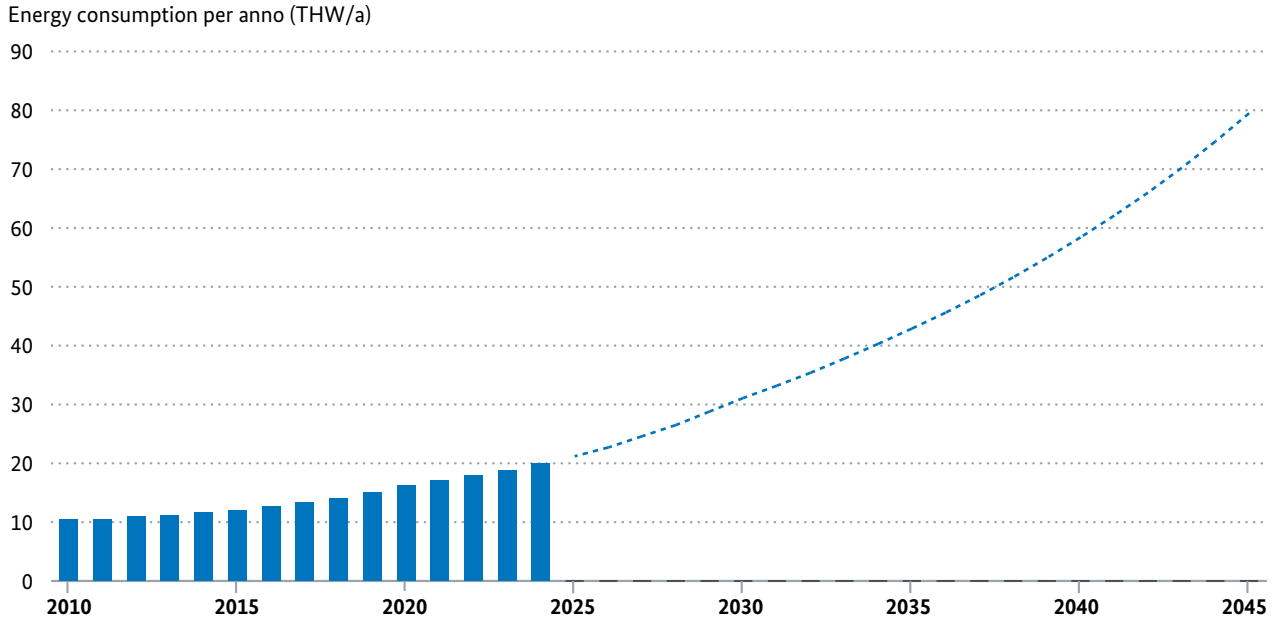
formance that chips can offer per watt of power consumed continues to grow. In some segments of chip manufacturing, this miniaturisation is already beginning to slow down, which can be justified by the long-discussed physical limits posited by Moore's law. However, special processing cores (e.g. tensor cores) for special applications such as machine learning have also enabled quite large leaps in performance in recent years. It is clear that additional performance gains for many chips will not be feasible with miniaturisation alone, as the electric power input that chips require has risen massively in past years and is expected to continue to rise in future – a fact which naturally has implications for the total energy consumption of data centres. But the design of cooling infrastructure is also affected in places where enormous processing clusters require even lower temperatures or in some cases make the use of liquid cooling unavoidable.

Demand scenarios set to bring about a strong increase in energy consumption by data centres – in Germany and worldwide.

The expansion of data centre infrastructures globally is linked with a clear rise in need for electricity. Despite new technologies and innovations in the sector (e.g. new cooling systems at both building and server level) which can lead to lowered electricity needs, the need for electricity for digital infrastructure is expected to continue to rise sig-

Germany remains the largest data centre hub in Europe. But China and US are accelerating the expansion of digital infrastructure in their respective countries.

Figure 4: Development of the electricity needs of data centres and smaller IT installations in Germany in the years 2010 through 2024, and long-term prediction through 2045.



Source: Calculations by Borderstep

nificantly in future. The growing size of data centres – new projects now in some cases comprise multiple hundreds of MW – is also leading to a growing demand for massive grid connections, in some cases even with the transmission grid directly.

Strong growth in data centre capacities can be expected in Germany, as can an ongoing rise in electricity needs. In 2024, data centres and smaller IT installations in Germany required 20 TWh of electricity, a figure which comprised around 4% of Germany's gross electricity consumption of 517 TWh (2023). In 2030, data centres operating in Germany are expected to require 31 TWh of electricity. Without the introduction of the Energy Efficiency Act, electricity consumption would by 2.5 TWh higher in 2030. By 2045, assuming consistent growth, electricity consumption is set to rise to just under 80 TWh, thus comprising around 6% of projected gross electricity consumption (according to the "O45-Strom" long-term scenario). Compared with 2024, this represents an increase of almost 400%. In 2024, CO2 emissions related to electricity consumption amounted to around 6.5 million tonnes. This figure is set to sink to around 4.5 million tonnes in 2030, a change owing to improvements to the electricity mix in Germany.

There is thus significant potential for the use of waste heat from data centres, e.g. for the decarbonisation of heat networks. Assuming that newly built data centres comply with the new legal requirements from the Energy Efficiency Act, around 1 TWh of heat from data centres could be used by end consumers in 2030. In 2035, over 3 TWh of heat from data centres would be available for use. The amount of usable waste heat available would then increase by about 10 TWh per year through the year 2045.

It would benefit the German electricity grid, if data centres were intentionally built in areas where there is high generative capacity for renewable energy.

In the past, data centres were often planned in locations that met internet connectivity and customer needs. The availability of green electricity is playing an increasingly important role in the selection of potential locations for large data centres. Alongside the Frankfurt am Main hotspot, locations like Berlin/Brandenburg and the Rheinisches Revier are currently becoming more important for investors and operators, and northern federal states are also increasingly of interest.

From an electricity grid standpoint, this development is to be welcomed and should receive all possible support. Bringing electricity generation capacities and current sinks closer to one another relieves the burden on the surrounding transmission grid. Currently, the surplus of wind power in northern Germany and the energy consumption needs pooled in the larger Frankfurt am Main area in particular are creating significant strain on the grid. Enabling flexibility from data centres, for example by using emergency backup generators, battery systems and other storage technologies to create a buffer, can increase the added value that data centres bring to the German electricity market and electricity grid, while waste heat can be funnelled into local district heating grids to create added value for the region. But multiple legal requirements must be fulfilled when data centre operators together with players from the energy sector aiming to do so.

Data centres, especially taken together with the digital economy and IT services, play a relevant role in the economy as a whole.

A large part of the added value that data centres create, can be attributed to the services sector, e.g. through IT consultations, managed service providers (MSPs) and cloud-related services. One job for the maintenance and operation of a data centre with 1 MW capacity competes with 20 dedicated jobs at an MSP, which then offers services derived from the processing power of the data centre.

In terms of trade tax, a data centre can definitely play a significant role for a small region (see Hattersheim am Main as an example). However, the headquarters of a shared location or cloud provider cannot be distributed across all its data centre locations, which stand in the way of distributing tax revenue to the involved regions in a way that is proportionate to the land and electrical infrastructure utilised. A new study on the spillover effects of data centres (IW Consult, 2024) makes reference to the decentralised corporate distribution and structure in Germany, which it sees as a strength. Building more data centres alone is not sufficient to realise the effects described in the study; instead ecosystems of IT-focused education institutions, IT service providers and digital companies must be created in the region. These organisations can collectively create new IT competencies, improve on the processing capacity with local jobs and thus develop sustainable digital value creation in the region.

Without also moving digital product manufacturing and IT services to the region, the region is investing its land and electricity in processing capacity, but this only creates a limited number of jobs (about 6) per MW of data centre capacity and often only brings in a small amount of tax revenue. Other spillover effects, e.g. those which take place during the construction period, are of a largely temporary nature.

Estimates from the sector show a focus on increasing productivity, e.g. in the desire to translate the increased corporate productivity brought about by the use of AI into macroeconomic productivity growth, which can realise a value creation potential of 330 billion euros should over 50% of companies in Germany elect to use AI (IW Consult, 2024).

Using AI brings generates costs for processing power and IT services, which means that 30% to 50% of the estimated additional value creation is passed on to IT service and infrastructure providers. This offers an opportunity to create smaller regional data centres and couple these with centres for digital competency and services, which can help medium-sized companies in the region to incorporate the new technologies. Regional providers are economically relevant, as they increase corporate productivity, create jobs and foster competencies in the region. Companies can alternatively rely on international IT and cloud services, a decision which can however lead to a drain of jobs and knowledge out of the German economy. The focus should thus be on developing regional ecosystems that can function in independent, reliable and sustainable ways.

The current regulatory framework for the energy-efficient operation of data centres leads to legal uncertainties. There are also currently no binding requirements for local or regional integrated and structured planning for suitable data centre areas.

Given the need to set up more data centres in Germany and maintain Germany's competitiveness as a place for business and investment, the current

regulatory framework for data centres, which requires them, for example, to use waste heat, has a rather inhibiting effect, particularly due to long and rather unstructured approval processes. This also applies within the context of urban land-use planning, since there is no clearly defined, structured, and cohesive planning approach for suitable areas, which also includes the necessary connection, particularly to heat networks and the power grid. Regarding the relevant approval processes, we would welcome the establishment of binding frameworks between approval authorities and other specialised agencies, as well as the implementation of stricter timelines through processing deadlines for the authorities involved in the planning approval process.

The mandatory implementation of integrated planning and the designation of suitable areas for regional data centre development, which also includes ensuring that heat and electricity grids are available or can be expanded, as well as the mandatory standardisation of communication formats, would help streamline approval processes and improve planning certainty. Furthermore, data centre operators are required to invest significant effort in meeting reporting obligations for energy efficiency indicators, which vary in scope and are based on different legal frameworks. Responsibilities between data centre operators and heat network operators under the Energy Efficiency Act (Energieeffizienzgesetz, EnEfG) could be better clarified to prevent uncertainties in the application of this act. Streamlining, standardising, and consolidating reporting obligations related to sustainability would be beneficial in this regard. The EnEfG should also include clear rules on the division of responsibilities, and legal definitions and regulatory examples concerning the use of waste heat by data centres.

A clear, long-term vision for digital infrastructure in Germany can further drive demand for data centres.

Germany is already a strong and attractive location for both national and international providers of digital infrastructure, including data centre operators, cloud services and specialised IT infrastructure providers, such as high-performance data centres. Germany is also an attractive market for companies offering digitalisation services and for technology companies within the digital economy, offering significant potential for growth. The main reasons for this are as follows:

- Large demand market: Both for digital resources, particularly driven by the digital transformation of the economy, and for data centre capacity throughout Germany which is generated by data protection and data security concerns
- High quality of grid-based power supply, building and electrical infrastructure; technical expertise and DE-CIX as an international internet exchange point
- Political stability
- Education system for electrical engineering and IT, that trains skilled workers for the operation of data centres and the digital sector

However, to realise its growth potential, Germany should develop a strategy for digitalisation and the digital economy with a long-term vision, along with the associated digital infrastructure, and actively promote concrete opportunities for growth. Germany needs a **data centre strategy** for this central part of digital infrastructure.

Specific recommendations for digital policy and the digital economy, aimed at designing a data centre strategy that provides a framework for the construction and operation of data centres in Germany, should focus on the following aspects in particular:

Promoting regional infrastructure: It is essential to invest in regional network infrastructure and hubs for digital infrastructure, particularly in areas with high renewable energy production. Emphasis should be placed on creating ecosystems that integrate energy, digital infrastructure, the digital economy, and IT services tailored to the specific region.

European marketplace: The creation of a common European marketplace for computing capacity would strengthen Europe's competitiveness and foster synergies. This would create new opportunities for import and export with a distinctive branding of "Computing power – Made in Germany".

Strategic partnerships: It is of critical importance to explore strategic options, such as strengthening digital sovereignty through targeted cooperation with international partners. This is particularly relevant for meeting the long-term demand for various classes of computing capacity, such as those required for machine learning.

Promoting innovation: Increased political support for the development of innovative technologies, especially in building equipment efficiency, IT systems, and IT infrastructure operation, would facilitate more cost-effective production of computing capacity. This, in turn, would strengthen the German digital economy and provide it with a competitive edge at global level.

Unique international positioning: In global competition, Germany should distinguish itself through efficiency, sustainability, and sovereignty, positioning itself as a location for high-quality digital infrastructure. Such infrastructure would also bolster the competitiveness and resilience of German key industries and the digital economy.

Further improving the data situation: Data on the development of data centres is still insufficient. The introduction of the data centre register (Rechenzentrumsregister, RZReg) in Germany marks an important step towards greater transparency. However, gaps in the data and unanswered questions remain, particularly concerning the involvement of IT installation operators in colocation data centres when it comes to data reporting. As a result, the estimates on market development and electricity consumption presented in this report are subject to uncertainties. For instance, there is still a lack of essential information on the actual degree of utilisation and efficiency of the IT equipment in the data centres, and data on smaller data centres is also scarce.

Options for action

Germany is already a strong and attractive location for both national and international providers of digital infrastructure, and it is the largest data centre hub in Europe. In principle, the further expansion of data centres enhances the potential to increase the availability of digital resources in Germany.

Infrastructure

Germany's strengths as a business location lie in its digital policy focused on sustainability, well-developed power grid, and high density of internet exchange points. However, infrastructural issues such as inadequate high-speed internet access for businesses in rural areas and a lack of fibre optic coverage are hindering the growth of the digital economy and weakening Germany's competitiveness in this sector. Nationwide expansion of fibre optics and 5G (and future 6G) networks should be integral to an overall digitalisation strategy to enable greater flexibility and geographical diversity in the location of data centres. Enhanced digital infrastructure would also make Germany more attractive to foreign investors, who seek to reduce costs and latency, especially in high-performance and specialised AI data centres.

Specialists

Germany has a well-established network of SMEs providing IT services, which can serve as a foundation for further growth. However, compared to the USA, where digital companies have decades of experience in building large IT systems, Germany often lacks the necessary expertise and personnel with the required digitalisation skills. The shortage of skilled workers is a significant barrier to upgrading and expanding digital infrastructures in Germany. This issue affects not only IT specialists, but also those in the refrigeration, air conditioning, and electrical trades. Promoting skills development, as well as training and further education for specialists in these fields, can enhance Germany's competitiveness and strengthen its position as a data centre hub. In light of the existing skills shortage, targeted initiatives should be developed to nurture IT expertise and secure skilled specialists for digitalisation.

Regional digital ecosystems and the creation of a European marketplace for digital resources

Furthermore, the development of regional digital ecosystems and the creation of a European marketplace for digital resources can enhance Germany's and Europe's competitiveness in terms of digitalisation and data centre hubs. Consistent support for startups and technology companies, as well as the creation of innovation clusters in collaboration with research institutions, would have a positive effect on the development of regional digital ecosystems. Focusing on digital ecosystems maximises the economic value generated by digital infrastructure. Data centre facilities, IT infrastructure providers, IT service providers, consultancies, companies in the digital economy, and research infrastructure should be viewed as part of an integrated ecosystem located within a specific region. Establishing a centre of excellence for energy efficiency in data centres and developing relevant interdisciplinary degree programmes, could help systematically document best practices while offering training and consulting services, similar to models in the USA. The creation of a European marketplace for digital resources can promote the trade of these resources within Europe and strengthen Germany's digital sovereignty.

Regulation

Germany can distinguish itself as a location for digital infrastructure by offering high quality and legal certainty. Data centres in Germany must navigate a wide range of regulations across various areas of law. However, the issue of data security and sovereignty is a key regulatory driver for Germany as a data centre hub. Digital infrastructures based in Germany, and governed by German law, will not only appeal to the domestic market but also to international clients. Streamlining approval procedures for data centres is seen as especially advantageous in competition between data centre locations. Additionally, regulatory proposals such as the introduction of a nationwide heat network register in Germany could improve transparency regarding the availability and utilisation of heat networks. Overall, greater transparency and improved access to data would accelerate the planning and implementation of new data centre infrastructures.

Energy efficiency and flexibilisation

As the power consumption of data centres increases and competition among data centres and locations for their establishment intensifies, the importance of energy efficiency is becoming ever more critical. In this context, Germany could benefit from the comprehensive regulatory framework for energy efficiency provided by the EnEfG. Germany has the opportunity to position itself as a leader in the expansion of sustainable digital infrastructure, particularly in terms of energy-efficient and sustainable data centres. However, there are still gaps in the regulatory framework, especially in areas such as capacity utilisation and the degree of utilisation of IT infrastructure, where the aim is to reduce inefficiencies in software and IT infrastructure. Currently, there is no obligation for IT operators to improve efficiency, despite the fact that IT energy consumption accounts for around 80% of a data centre's total energy consumption. Resource efficiency, especially with regard to water usage in adiabatic cooling, also requires further attention, along with potential corrective measures. In principle, there is a conflict of objectives between minimising water consumption and maximising energy efficiency. This is also emphasised in the Digital Strategy 2025, which is highly forward-thinking and focuses on infrastructure expansion to bridge the digital divide, thereby positioning Germany ahead of other countries.

Digitalisation of the economy

Germany's digital future will primarily be shaped by the degree of digitalisation within traditional industries and the growth of the digital economy. Assuming that Germany successfully implements its own digitalisation strategy, as well as that of the EU, a significant increase in demand for digital resources — and thus for digital infrastructure — can be expected. In particular, the digitalisation of sectors such as retail, healthcare, and manufacturing are pivotal in driving the demand for digital resources. Technological innovations like AI will also fuel the need for greater data processing and storage capacity as part of the broader digitalisation trend. As the digital sector grows significantly and the industrial sector stagnates or declines, economic output is increasingly shifting from industry to services. In addition to skilled workers, the availability and cost of digital resources are key factors for the success of digital products and services. This distinguishes the digital economy from traditional industries, which mainly process, refine, or manufacture raw materials or tradable goods. Given this high dependence on digital resources, growth in the digital economy also leads to a substantial increase in the demand for these resources.

Digitisation of the public sector

The demand for digitalisation from public institutions should not be underestimated. Many processes and services provided to citizens and businesses must be delivered more efficiently and quickly in the future. Moreover, the highly – and often legally – standardised internal processing procedures present significant potential for digitalisation. In many cases, processes such as the submission and processing of building applications are still handled on paper. The demand for digitalisation in the public sector can serve as a driving force for focusing on efficient and sustainable digital infrastructures consistent with green lead markets.