



INSIGHT STUDY

Sustainable AI: The Fourth Wave in Data Center Demand

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Content

Chapter 1: Introduction	4
... How Technology and Financing from Siemens Propel This Wave Forward	
... Four Key Elements Driving Data Center Demand – with AI Bringing the Latest Wave	
Chapter 2: The Challenge for Data Centers in Enabling AI's Demand	5
Chapter 3: Siemens' Role: Enabling Sustainable Growth	6
Chapter 4: The Critical Role Investing and Financing Plays in the Fourth Wave	8
Chapter 5: Deep-Dive: Financing Sustainability in Hyperscale Data Centers	9
... Case Highlights: DataBank, Vantage Data Centers	



Executive Summary

Amidst the fourth wave of data center demand most recently fueled by AI, **smart infrastructure that propels decarbonization and tailored financing** that enables cost-friendly technological upgrade will play a crucial role in driving the sustainability of data centers and thus – **sustainability of AI development**.

This Insight Paper breaks down **how AI development is creating new challenges for the data center industry**, from evaluating their digitalization journey, reducing energy footprint while meeting rising demand, to growing a low-carbon facility portfolio in a budget-friendly manner. With a deeper look into the trend of **hyperscale data centers**, the paper also presents case studies from the US and Europe, highlighting **how Siemens uniquely combines technology and financing** to address the challenges of computing demands, power efficiency, and capital needs along sustainable AI development.

Through Siemens' technological innovations and financial services, the paper showcases a path towards environmentally responsible and economically viable data center operations.



1 Chapter 1: Introduction

How Technology and Financing from Siemens Propel This Wave Forward

In the rapidly-changing landscape of digital infrastructure¹, we find ourselves on the cusp of what experts are calling **the „fourth wave“ of data center demand**. This development has been propelled by three key elements over the last years – **off-premises data centers, the Internet of Things (IoT), and cloud computing**. More recently, the **exponential growth of artificial intelligence (AI)**, specifically Machine Learning (ML) and the rise of advanced Large Language Models (LLM) – is set to become the fourth wave of key driver redefining the way we interact with technology and the digital world and help shape the building blocks of the industrial metaverse. At the heart of this transformation is the data center, the unsung hero of our increasingly interconnected world.

With artificial intelligence (AI) being the key driver in this fourth wave of demand, technology companies such as Siemens play pivotal roles in supporting this considerable shift through technology and financing solutions².

Four Key Elements Driving Data Center Demand – with AI Bringing the Latest Wave

1. **Off-premises data centers – which include migrating to co-location or managed service providers** – shift investment from users to third parties, while providing the necessary infrastructure for reliable and scalable data management.
2. While offering several advantages including improved security, redundancy, and cost-effectiveness, **IoT generates new dimensions of data**, such as a vast amount of sensor data, that require processing and analysis within these centers.
3. **Cloud computing** has democratized access to computing resources, enabling organizations of diverse sizes to scale their computational infrastructure, and
4. **AI trends such as Deep Learning and LLMs** are now pushing the next frontier of what's possible with large datasets – such as cutting-edge pattern recognition, predictive analytics, and content generation – that require complex model tuning and training.

2 Chapter 2: The Challenge for Data Centers in Enabling AI's Demand

AI is no longer confined to science fiction; it's a reality that's here to stay. Major technology companies are heavily investing in AI technologies, recognizing their potential to revolutionize industries across the board. According to the International Energy Agency (IEA), around the globe, **data centers currently account for 1 to 1.5 percent of global electricity use.**³

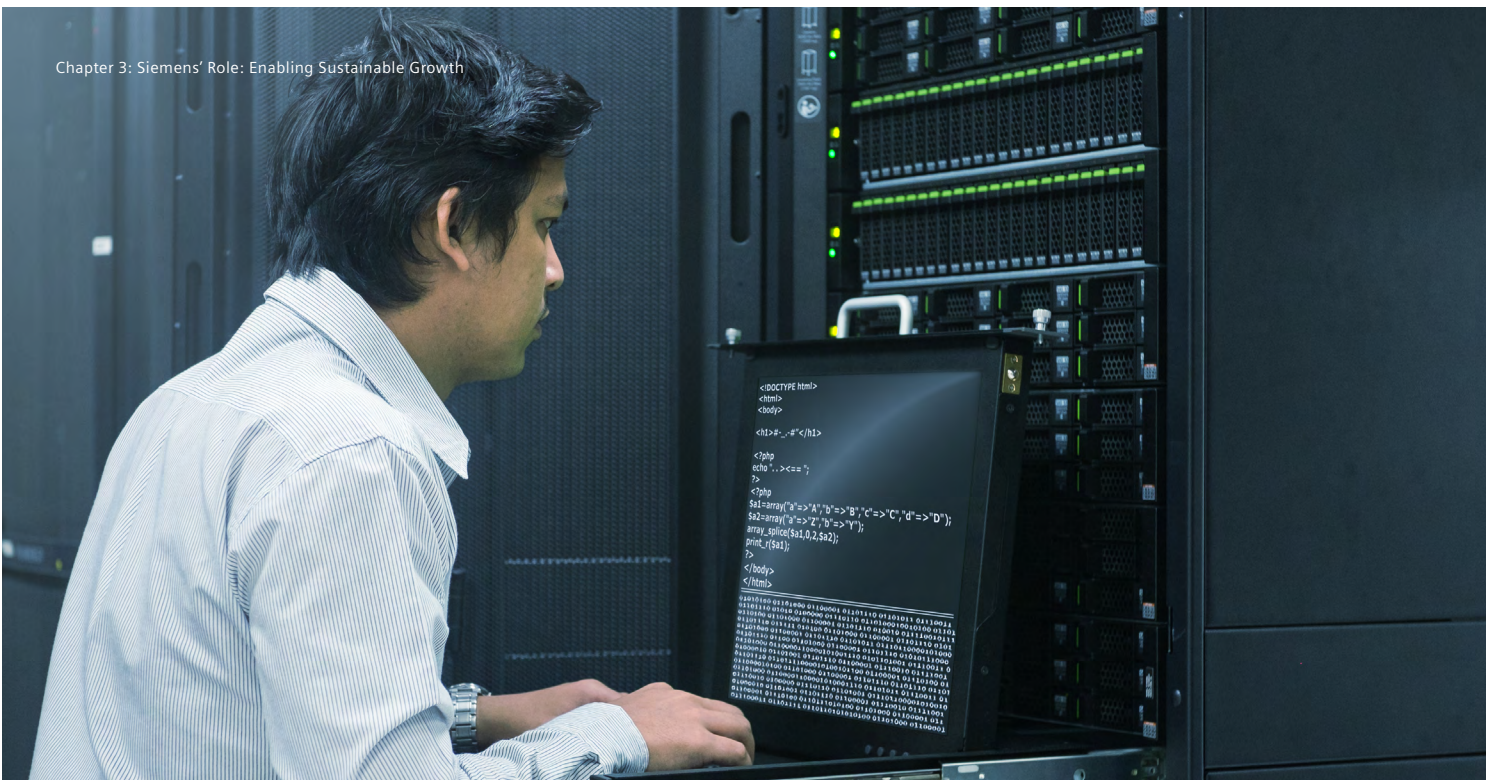
With its immense computing appetite, AI – particularly neural networks in deep learning, such as transformer models that power generative AI applications – demands a lot of computing power. As AI models become more complex and require larger datasets for training, **data centers are being pushed to their limits in terms of processing capabilities and power consumption**⁴. Suitable sites and sustainable power sources are now at a premium.

Data center industry vacancy rates are at all-time lows, and power availability is becoming scarcer. The wider situation of operational challenges and sustainability pressure, as analysed by the Uptime Institute in its 2022 study⁵, is indicative of the growing reliance on data-driven technologies across various sectors. Finding suitable locations for data centers and ensuring a reliable power supply have become increasingly challenging.

To address these challenges and ensure the long-term vitality and efficiency of the data center industry, **a focus on sustainability and efficiency is paramount.** Power efficiency and cooling are measured by metrics such as Power Usage Effectiveness (PUE), IT load allocation, and sustainable power procurement. Efforts to allocate IT loads⁶ efficiently within data centers and procure sustainable power sources, such as renewable energy, are essential steps towards ensuring that the industry can meet the growing demand without compromising its environmental responsibilities.

In addition, the data center industry is developing **innovation methods to re-allocate their existing cooling infrastructure** to accommodate the new heat loads generated by AI servers in their existing data halls. Applying AI solutions to optimize the performance of their existing cooling infrastructure is one solution gaining traction. The other is applying new liquid cooling solutions to their IT infrastructure.

However, while innovative solutions emerge on the technological front, the data center industry still face **evolving demands of a competitive, fast-paced market**, influencing critical factors such as capital requirements and construction timelines. **Finding solutions that seamlessly combine technology and financing becomes a critical catalyst** in ensuring the sector's economic and environmental progress.



3 Chapter 3: Siemens' Role: Enabling Sustainable Growth

As online usage continues to soar, organizations must evaluate their digitalization and sustainability strategies to account for the surge in utilization⁷. Amidst this growth, Siemens – helping customers bridge physical and virtual domains to solve real-world problems – is uniquely positioned and committed to championing sustainable growth in the data center industry⁸. With **Siemens Xcelerator**, an open digital business platform, Siemens offers a curated portfolio of connected hardware and software, a powerful ecosystem of partners, and an extensive marketplace. By combining these capabilities, data center operators can adapt to technological changes and execute their digital transformation.

Data center solutions⁹, such as our Industrial **Automation DataCenter** – a fully configured solution designed to cater to all IT requirements specif-

ically in production environments – can help companies address sustainability concerns. By delivering scalable and reliable systems, Siemens continues to play a critical role in transforming data centers for a better tomorrow.

Another innovative Siemens solution is the **White Space Cooling for Data Centers**¹⁰ which uses AI to dynamically match cooling to IT load in real-time, optimizing energy efficiency and minimizing operational costs. Additionally, **coupling data centers with district heating networks**¹¹ allows for the reuse of waste heat from data centers, potentially saving millions of tons of CO₂ annually.

A crucial aspect of maintaining data center operations is **security with solutions**¹² that safeguard data centers from physical threats. Technologies such as access control, biometric sensors, and intelligent video surveillance are employed to ensure data integrity and uptime.



“ Many major world governments have made big commitments on decarbonization, and they’ve all identified the data center industry as a key player in driving decarbonization. We will see more and more regulation and more need to report on overall energy consumption, energy mix, and carbon versus non-carbon. More regulation is coming, which will drive more transparency, which will drive the need for more control, more information, and more data.

The efficiencies that you can get from representing the real world, digitally go much broader and much deeper than just simply, the building of your new facility. It can also make your operations more efficient, it can make your employability better, and it can make it easier to train new people on what’s happening in the environment. But it can also help customers make decisions about capacity – the possibilities are near limitless.”

Ciaran Flanagan, Global Head of Sales,
Data Center Verticals, Siemens



“ Financing is crucial for promoting sustainability in the data center industry. Through supporting the adoption of energy-efficient technologies, encouraging the use of renewable energy sources, and facilitating investments in sustainable data center infrastructure, Siemens Financial Services (SFS) empowers data center operators to implement state-of-the-art technology by providing capital and expertise that drives sustainability throughout the industry.”

Nicole Spill, Director- Financing Solution Partner for Smart Infrastructure, Siemens Financial Services

4 Chapter 4: The Critical Role Investing and Financing Plays in the Fourth Wave

Data centers face various development stages throughout their lifecycles, each with unique capital needs. Different forms of capital support or financing arrangements are often needed when companies start to develop and construct portfolios of data centers, or when they plan to expand the facilities to capture a larger market share as they enter a growth phase, or when they look to adopt new sustainability upgrades to optimize their technologies. Siemens Financial Services (SFS) plays an important role in enabling sustainable growth in the global data center industry through investments and tailored financing solutions that support customers’ growth ambitions.

Our commitment extends to all stages of the sustainability journey, whether in the planning and goal-setting phase, beginning early investments, or financing to advance sustainability goals. **From jumpstarting facility portfolio, reducing energy consumption, and ensuring uninterrupted data flow while supporting growth in a budget-friendly manner** – SFS is enabling the data center industry’s adoption of energy management and cybersecurity solutions by aligning financing with individual business needs¹³.

5 Chapter 5: Deep-Dive: Financing Sustainability in Hyperscale Data Centers

The industry's growth, accentuated by the recent shift towards remote work, our well-connected lives, and the demand for information in real-time has created a pressing need for capital investment. Predictions from Global Market Insights, Inc.¹⁴ suggest that **the hyperscale data center sector will surpass an astounding USD 65 billion by 2025**, up from USD 20 billion in 2018. This surge in demand for data center services has catalyzed an expansion in data center construction, both domestically and globally. With over 8,000 data centers worldwide, these facilities are poised to transform as technological advancements and digital demand continue to shape global markets. In particular, the U.S. is the largest data center market by number of

facilities – with over 5,300 data centers based on 2023 figures compiled by Statista, most of any country worldwide.¹⁵ In particular, the growth of hyperscale data centers – facilities that serve massive amounts of mission-critical and scalable computing loads, primarily to cloud services and AI customers such as large technology companies – is fueling the **CapEx buildouts**. These hyperscale customers are both self-building data centers and increasingly utilizing experienced operators such as CloudHQ to build, operate and finance the construction of these mega data centers. With a deep understanding of the sector's fast-developing technology and business models, Siemens is unique in its ability to provide both technology and financing solutions.





Case Highlights



DataBank, a prominent player in the field – with an investment from SFS – is set to transform into one of the largest U.S. data center operators, significantly expanding its capacity and reach. This collaboration aligns with Siemens' broader goal of bridging the physical and digital worlds, underpinned by the Cloud migration trend and the growing need for low-latency, high-bandwidth networks. In this context, colocation data centers like those in DataBank's portfolio play a pivotal role, offering enhanced efficiency, interconnectivity, and economies of scale.

In alignment with Siemens' aim to **help hyperscale data centers embark on sustainability transformation**, SFS has provided an aggregate \$230 million in financing to several of one customer's hyperscale data center projects in Virginia, Oregon, Atlanta, and Arizona totaling 628 MWs on lease to hyperscale tenants, and discussions are ongoing in exploring additional project financing opportunities. The customer has worked with Siemens Smart Infrastructure (SI) since 2015 and, through the SFS relationship, this collaboration has been elevated to broader discussions for innovative technology. Notably, the customer is committed to developing and operating data centers in a sustainable manner, such as achieving 100% of energy sources from renewable power, consistent with Siemens' sustainability commitment.

Case Highlights



Another instance of SFS's involvement is financing **Vantage Data Centers**¹⁶, a global hyperscale data center provider based in the U.S. that expanded into the EMEA market in 2020 with a USD 2 billion investment pipeline. Seeking to bolster its presence in Europe, Vantage approached the European banking market to fund greenfield projects in Zurich, Berlin, and Frankfurt, securing two distinct

secured loan transactions co-financed by SFS. This financial support, totaling up to EUR 790 million from several lenders, empowered Vantage to advance its sustainable growth in data center operations across regions, showcasing how Siemens can **help leading data center players grow at a fast pace**, while supporting the sector's sustainability practice globally.



Conclusion

The fourth wave of data center demand, driven by AI and similar transformative technologies, is reshaping the sector as we know it, introducing new challenges for the sector to navigate. Siemens, with its rich history of innovation, commitment to sustainability, and financing expertise, is at the forefront of merging the evolution of AI with sustainable development – a crucial step forward in **helping data centers connect technological innovation with decarbonization and resource efficiency.**

Through innovative practices such as smart thermal systems, state-of-the-art security and production environment solutions, as well as tailored financing that supports distinct phase of data center growth, Siemens is paving the way for a future where digital technologies aligns with a environmental responsibility.

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Siemens Financial Services
80200 Munich, Germany

For more information:

Phone: +49 89 636 40019

E-mail: communications.sfs@siemens.com

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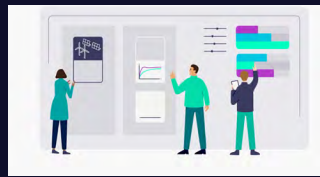


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